Alaska Outer Continental Shelf

OCS EIS/EA
BOEM 2018-050

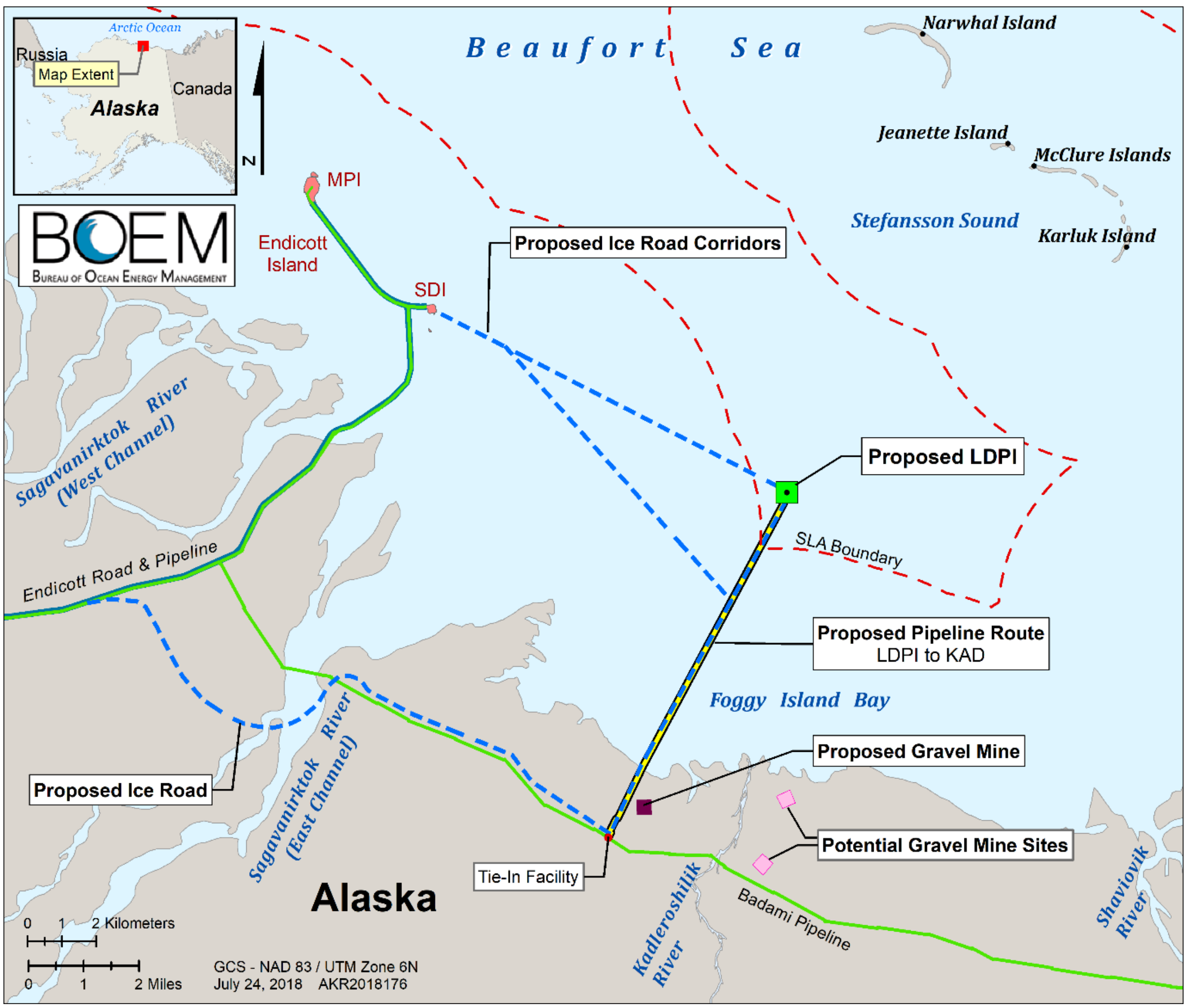
Liberty Development and Production Plan

Beaufort Sea, Alaska

Estimated Lead Agency Total Costs Associated with Developing and Producing this EIS:
$1,634,000

Final Environmental Impact Statement

Volume 1. Executive Summary and Chapters 1 through 6



Bureau of Ocean Energy Management

U.S. Department of the Interior
Bureau of Ocean Energy Management
Alaska OCS Region

August 2018

Alaska Outer Continental Shelf

OCS EIS/EA
BOEM 2018-050

Liberty Development and Production Plan

Beaufort Sea, Alaska

Final Environmental Impact Statement

Volume 1. Executive Summary and Chapters 1 through 6

Prepared by
Bureau of Ocean Energy Management, Alaska OCS Region

Cooperating Agencies
U.S. Department of the Interior, Bureau of Safety and Environmental Enforcement

U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, National Marine Fisheries Service

Environmental Protection Agency

U.S. Department of Defense, U.S. Army Corps of Engineers

State of Alaska, Department of Natural Resources

U.S. Department of the Interior
Bureau of Ocean Energy Management
Alaska OCS Region

August 2018

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COVER SHEET

Liberty Development and Production Plan
Beaufort Sea, Alaska
Environmental Impact Statement

Draft ( ) **Final (X)**

Type of Action: Administrative (X) Legislative ( )

Area of Potential Effect: Offshore marine environment, Beaufort Sea coastal plain, and the North Slope Borough of Alaska.

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Abstract

Hilcorp Alaska, LLC (HAK) proposes to produce oil from the Liberty Prospect (OCS Lease Y-1650, OCS-Y-1586, and OCS-Y-1886) located in Foggy Island Bay in the Beaufort Sea, northeast of the Prudhoe Bay Unit and east of the Duck Island Unit in Alaska. HAK submitted a Development and Production Plan (DPP) to BOEM on September 18, 2015, and a revised DPP on March 15, 2017.

BOEM received 46,678 comments during scoping. All comments, including those gathered in local Scoping Meetings, are available at www.regulations.gov.

HAK determined that the Liberty Prospect contains approximately 120 million barrels of recoverable crude oil. HAK proposes to construct a gravel island approximately 5 miles north of the Kadleroshilik River and 7.3 miles southeast of the existing Endicott Satellite Drilling Island (SDI) in approximately 19 feet of water. Sixteen wells would be drilled. Production facilities on Liberty Island would include producing wells designed to produce up to 65,000 barrels of crude oil and 120 million standard cubic feet of natural gas per day. The life of the proposed Liberty Prospect development is anticipated to be approximately 15 to 20 years.

Oil produced from the island would be piped through a pipe-in-pipe (PIP) subsea pipeline consisting of a 12-inch diameter inner pipe and a 16-inch diameter outer pipe. Subsea pipe would run 5.6 miles then transition to an elevated 1.5-mile long onshore pipeline to a tie in with the existing onshore Badami oil pipeline This infrastructure would transport sales-quality oil (hydrocarbons) to the Trans-Alaska Pipeline System.

This Final Environmental Impact Statement (EIS) assesses the Proposed Action and alternatives: Alternative 1 (Proposed Action: the Liberty Development and Production Plan), Alternative 2 (the no action alternative) Alternative 3A (Relocate LDPI Approximately 1 Mile to the East), Alternative 3B (Relocate LDPI Approximately 1.5 miles to the Southwest), Alternative 4A (Relocate Oil and Gas Processing to Endicott SDI), Alternative 4B (Relocate Oil and Gas Processing to a New Onshore Facility), Alternative 5A (East Kadleroshilik River Mine Site #2), and Alternative 5B (East Kadleroshilik River Mine Site #3).

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Acronyms and Abbreviations

µg....................................micrograms
µg/cm^3 ....micrograms per cubic centimeter
µg/m^3 ....micrograms per cubic meter
µg/g ....micrograms per gram
µg/L ....micrograms per liter
µm ....micrometer
µPa................................micropascal
AAAQS ....Alaska Ambient Air Quality Standards
ACMP............................Alaska Coastal Management Program
ACP ....Arctic Coastal Plain / Area Contingency Plan
ADEC ....Alaska Department of Environmental Conservation
ADF&G ....Alaska Department of Fish and Game
ADNR............................Alaska Department of Natural Resources
ADOLWD ....Alaska Department of Labor and Workforce Development
AES ....ASRC [Arctic Slope Regional Corporation] Energy Services, Alaska, Inc.
AEWC ....Alaska Eskimo Whaling Commission
AFMP ....Arctic Fishery Management Plan
AFN ....Alaska Federation of Natives
AGDC............................Alaska Gasline Development Corporation
AGL...............................above ground level
AHRS ....Alaska Heritage Resources Survey
AI/AN............................American Indian and Alaskan Native populations
AK LNG ....Alaska Liquefied Natural Gas Pipeline Project
AKNHP ....Alaska Natural Heritage Program
AKPDES ....Alaska Pollutant Discharge Elimination System
AMAP ....Arctic Monitoring and Assessment Programme
AMNWR ....Alaska Maritime National Wildlife Refuge
ANC ....Alaska Nanuuq Commission
ANCSA ....Alaska Native Claims Settlement Act
ANILCA ....Alaska National Interest Land Conservation Act
ANIMIDA ....Arctic Nearshore Impact Monitoring in the Development Area
ANS ....Alaska North Slope
ANWR...........................Arctic National Wildlife Refuge
AO ....Arctic Oscillation
AOCSR..........................Alaska OCS Region
APDES ....Alaska Pollutant Discharge Elimination System
API ....American Petroleum Institute
APD ....Application for Permit to Drill
APPS ....Act to Prevent Pollution from Ships
AQRP ....Air Quality Regulatory Program
AQRV............................air quality related values
AQCR............................air quality control regions
ARBO............................Arctic Region biological opinion
ARCWEST....................Arctic Whale Ecology Study
ARRT ....Alaska Regional Response Team
ASA ....aquatic site assessment
ASAMM ....Aerial Surveys of Arctic Marine Mammals
ASAP.............................Alaska Stand Alone Gas Pipeline
ASL ....above sea level
ASRC ....Arctic Slope Regional Corporation
ASWG ....Alaska Shorebird Working Group
atm.................................atmosphere (of Air Pressure)
AWC..............................Anadromous Waters Catalog of Alaska

AWI .... Wainwright Airport
B.P. .... before present
BACT .... best available control technology
Bbbl .... billion barrels of oil
bbl................................ barrel = 42 U.S. gallons
bbls/d or BOPD .... barrels of oil per day
BC................................. black carbon
BCB .... Bering-Chukchi-Beaufort Seas Stock of Bowhead Whales
Bcf .... billion cubic feet
Bcfg .... billion cubic feet of gas
BE................................. biological evaluation
BGEPA......................... Bald and Golden Eagle Protection Act
BIA .... Biologically Important Areas
BLM .... Bureau of Land Management
BMPs............................ best management practices
BO .... biological opinion
BOD............................. biological oxygen demand
BOEM .... Bureau of Ocean Energy Management
BOEMRE .... Bureau of Ocean Energy Management, Regulation, and Enforcement
BOP .... blowout preventer (system)
BOPD or bbls/d .... barrels of oil per day
BOWFEST .... Bowhead Whale Feeding Ecology Study
BP .... British Petroleum
BPXA .... British Petroleum Exploration (Alaska), Inc.
BS .... boundary segment(s) or Beaufort Sea
BSEE .... Bureau of Safety and Environmental Enforcement
BSMP .... Beaufort Sea Monitoring Program
BWASP .... Bowhead Whale Aerial Survey Project
C/N .... carbon/nitrogen ratio
CAA.............................. Conflict Avoidance Agreement
CAAA........................... Clean Air Act Amendments (1990)
CAB.............................. chemical and benthos
CAH.............................. Central Arctic (Caribou) Herd
cANIMIDA................... Continuation of the Arctic Nearshore Impact Monitoring in the Development Area Project
CAVM .... Circumpolar Arctic vegetation map
CAVMT........................ Circumpolar Arctic Vegetation Mapping Team
CBD.............................. Center for Biological Diversity
CBH.............................. Cape Bathurst Caribou Herd
CBMP........................... Circumpolar Biodiversity Monitoring Program (Arctic Council's)
CBS .... Chukchi-Bering Seas stock of Polar Bears
CDC.............................. Centers for Disease Control
CEQ .... Council on Environmental Quality
CER .... categorical exclusion review
CFCs............................. chlorofluorocarbons
CFR .... Code of Federal Regulations
CHAOZ .... Chukchi Acoustic Oceanography and Zooplankton (program)
CHARS......................... Canadian High Arctic Research Station
CI .... confidence interval
CIAP .... Coastal Impact Assistance Program
CIP................................ Capital Improvement Program
CITES........................... Convention on International Trade in Endangered Species of Wild Fauna and Flora
COMIDA...................... Chukchi Sea offshore monitoring in drilling area
COMIDA-CAB .... Chukchi Sea offshore monitoring in drilling area, chemical and benthos
Court of Appeals........... U.S. Court of Appeals for the Ninth Circuit
cp .... centipoise (measure of viscosity)

CPAI..............................Conoco-Phillips Alaska Incorporated [2x in 5]
CPF................................Central Processing Facility
CTD...............................conductivity, temperature, and depth
CTS................................compound threshold shift
CWA..............................Clean Water Act
cy...................................cubic yards
CZARA ....Coastal Zone Act Reauthorization Amendments of 1990
CZM ....coastal zone management
dB ....decibels
dB_{RMS}..............................decibels, root mean square
DBO ....Distributed Biological Observatory
DEIS..............................Draft Environmental Impact Statement
DEW..............................distant early warning (system)
DO ....dissolved oxygen
DOC/USDOC................Department of Commerce
DOI/USDOI...................Department of the Interior
DOT/USDOT ....Department of Transportation
DPP................................Development and Production Plan
DPS................................distinct population segment
Draft SEIS ....Draft Supplemental Environmental Impact Statement
DWH ....Deepwater Horizon
EA..................................Environmental Assessment
ECS................................Eastern Chukchi Sea
EEZ................................Exclusive Economic Zone
EFH ....essential fish habitat
EIA ....environmental impact analysis
EIS.................................Environmental Impact Statement
EJ...................................environmental justice
ENP ....Eastern Northern Pacific
EO..................................Executive Order
EOFL.............................end of field life
EOR...............................enhanced oil recovery
EP ....Exploration Plan
EPA ...............................U.S. Environmental Protection Agency
EPS................................Eastern Pacific Stock
ERA...............................environmental resource area
ESA ....Endangered Species Act
ESI.................................Environmental Sensitivity Index
ESP................................Environmental Studies Program
EVOS ....Exxon Valdez Oil Spill
EWC..............................Eskimo Walrus Commission
FDA/USFDA.................Food and Drug Administration
FEIS...............................Final Environmental Impact Statement
FERC.............................Federal Energy Regulatory Commission
FHWG ....Fisheries Hydroacoustic Working Group
FM ....frequency modulated
FMP...............................Fishery Management Plan
FONSI ....Finding of No Significant Impact
FOSC.............................Federal On-Scene Coordinator
FR..................................Federal Register
FSB................................Federal Subsistence Board
FSE................................full-scale exercises with response equipment deployment.
FWPCA ....Federal Water Pollution Control Act
FWS/USFWS ................U.S. Fish and Wildlife Service
G&G..............................geological and geophysical
g/m^3 ....grams per cubic meter

g/min............................ grams per minute
GBS .... gravity-based structure
GHG .... greenhouse gases
GHGRP......................... Greenhouse Gas Reporting Program
GIUE .... government initiated unannounced exercises
GLS .... grouped land segments
GMT-1.......................... Greater Mooses Tooth-1 Project
GMT-2.......................... Greater Mooses Tooth-2 Project
GOM............................. Gulf of Mexico
GP................................. General Permit
gpd................................ gallons per day
GPS............................... global positioning system
H_2S............................... hydrogen sulfide
ha .... hectares
HAB.............................. harmful algae blooms
HACCP......................... Hazard Analysis and Critical Control Point Plan
HAK .... Hilcorp Alaska, LLC
HAP .... hazardous air pollutants
HCs............................... hydrocarbons
HCC.............................. high conservation concern
HDD .... horizontal directional drilling
HR .... high resolution
HRZ.............................. Highly Radioactive Zone
HSWUA .... Hanna Shoal Walrus Use Area
IAP................................ Integrated Activity Plan
IARPC .... Interagency Arctic Research Policy Committee
IBA .... important bird area
ICAS............................. Inupiat Community of the Arctic Slope
IHA............................... Incidental Harassment Authorization
IMO .... International Maritime Organization
IMT............................... incident management team
INC............................... incident of non-compliance
IPCC............................. Intergovernmental Panel on Climate Change
IPF .... impact-producing factor
ISC................................ Ice Seal Committee
ISER .... Institute for Social and Economic Research
ITA .... Incidental Take Authorization
ITL................................ information to lessees (clauses)
ITR................................ incidental take regulation
IUCN .... International Union for Conservation of Nature
IWC .... International Whaling Commission
LA................................. launch area
LBCHU......................... Ledyard Bay Critical Habitat Unit
LDPI .... Liberty Development and Production Island
LGM .... last glacial maximum
LIDAR.......................... light detection and ranging
LNG.............................. liquefied natural gas
LOA.............................. letter of authorization
LOSC............................ Local On-Scene Coordinator
LOWC .... loss of well control
LPG .... liquid petroleum gas
LS .... land segment
m/s .... meters per second
m^3/s.............................. cubic meters per second
MAIs............................. maximum allowable increases
MARPOL .... International Convention for the Prevention of Pollution from Ships

Mbbl ....thousand barrels
MBR..............................membrane bioreactor
MBTA ....Migratory Bird Treaty Act
MC................................mesoscale cyclones
Mcf ....thousand cubic feet
Mcf/d ....thousand cubic feet per day
Mcfg ....thousand cubic feet of gas
md.................................millidarcy (measure of permeability)
MGD.............................million gallons per day
MLLW...........................mean lower low water
MMbbl...........................million barrels
MMBO ....million barrels of oil
MMC ....Marine Mammal Commission
MMcf.............................million cubic feet
MMcfg...........................million cubic feet of gas
MML ....Marine Mammal Laboratory (Alaska Fisheries Science Center)
MMPA...........................Marine Mammal Protection Act
MMS..............................Minerals Management Service
MMscfd ....million standard cubic feet per day
MMT ....million metric tons
MOA..............................memorandum of agreement
MODU...........................mobile offshore drilling unit
MOR..............................moderate oil residue
MOU..............................Memorandum of Understanding
MOVES.........................motor vehicle emissions simulator
MPI................................Main Production Island
MSD ....marine sanitation devices
MSFCMA......................Magnuson-Stevens Fishery Conservation and Management Act
MTR ....marine transit route
MWCS...........................marine well containment system
NAAQS ....National Ambient Air Quality Standards
NABC............................Northwest Arctic Borough Code
NAE...............................National Academy of Engineering
NAO ....North Atlantic Oscillation
NASA ....National Aeronautics and Space Administration
NCP ....National Contingency Plan
NEPA ....National Environmental Policy Act
NFF...............................National Forest Foundation
NFS................................National Forest System
NGL...............................natural gas liquids
NGO ....non-governmental organization
NHPA ....National Historic Preservation Act
NRHP ....National Register of Historic Places
NISA..............................National Invasive Species Act of 1996
NMFS ....National Marine Fisheries Service
NOAA ....National Oceanic and Atmospheric Administration
NOI...............................notice of intent
NO_x...............................nitrogen oxides
NPDES ....National Pollutant Discharge Elimination System
NPFMC ....North Pacific Fisheries Management Council
NPR-A...........................National Petroleum Reserve-Alaska
NPREP ....National Preparedness Response Exercise Program
NPS................................National Park Service
NRC..............................National Research Council or National Response Center
NRDA............................natural resource damage assessment
NSB ....North Slope Borough

NSBSAC....................... North Slope Borough Science Advisory Committee
NSIDC.......................... National Snow and Ice Data Center
NSPS .... new source performance standards
NTACs.......................... nondiscretionary terms and conditions
NTL .... notice to lessees
NWAB.......................... Northwest Arctic Borough
O_3................................. ozone
OCRM .... ocean and coastal resource management
OCS .... Outer Continental Shelf
OCSLA......................... Outer Continental Shelf Lands Act
ODCE .... Ocean Discharge Criteria Evaluation
OFC .... Ocean and Fisheries Canada
OGP .... International Association of Oil and Gas Producers
OMB .... Office of Management and Budget
ONRR........................... Office of Natural Resource Revenue
OPA/OPA-90................ Oil Pollution Act of 1990
ORE .... (BOEM) Office of Resource Evaluation
OSC .... on-scene coordinator
OSFR .... oil spill financial responsibility
OSHA .... Occupational Safety and Health Administration
OSPD........................... Oil Spill Preparedness Division
OSR .... oil spill response
OSRA .... Oil Spill Risk Analysis
OSRB........................... oil spill response barge
OSRO .... Oil Spill Removal Organization
OSRP .... Oil Spill Response Plan
OSRV .... oil spill response vessel
OWM........................... oil weathering model
PAC .... Pacific Outer Continental Shelf (OCS) Region
PACs............................ poly aromatic compounds
PAH .... polycyclic aromatic hydrocarbons
PAME .... Protection of the Arctic Marine Environment
PAR .... photosynthetically active radiation
PBR .... potential biological removal
PCB .... polychlorinated biphenyl
PCH .... Porcupine Caribou Herd
PDO .... Pacific Decadal Oscillation
PEA .... Programmatic Environmental Assessment
PEIS............................. Programmatic Environmental Impact Statement
PEL .... permissible exposure limit
PHMSA .... Pipeline and Hazardous Materials Safety Administration
PINC............................ National Office Potential Incident of Noncompliance
PIP .... pipe-in-pipe
PL .... proposed pipeline
PM .... particulate matter
PM_{10}............................ coarse particulate matter with an aerodynamic diameter of 10 micrometers or less
$PM_{2.5}$ .... fine particulate matter with an aerodynamic diameter of 2.5 micrometers or less
PMC............................. Polar Mesoscale Cyclone
PO_4............................... phosphate ion
ppb .... parts per billion
ppbv .... parts per billion by volume
ppm.............................. parts per million
ppmv .... parts per million by volume
ppt................................ parts per trillion
PSD.............................. prevention of significant deterioration
psi .... pounds per square inch

psig ....pounds per square inch gauge pressure
PSO................................protected species observer
psu ....practical salinity unit
PTS ....permanent threshold shift
RCRA ....Resource Conservation and Recovery Act
RD ....regional director
RE..................................Resource Evaluation
RFFA ....reasonably foreseeable future actions
RHA ....Rivers and Harbors Act
RMS ....root mean squared
ROD ....Record of Decision
ROI ....record of increase
ROMS............................Regional Ocean Modeling System
ROW..............................right-of-way
RP ....responsible party or recommended practice
RPMs ....reasonably prudent measures
RS/FO ....regional supervisor/field operations
SAR ....search and rescue or Stock Assessment Reports
SBS................................Southern Beaufort Sea Stock of Polar Bears
SCC ....social cost of carbon
SCR ....selective catalytic reduction
SD..................................standard deviation
SDH ....social determinants of health
SDI ....satellite drilling island
Secretary........................Secretary of the Interior or Commerce
SEIS...............................Supplemental Environmental Impact Statement
SEL................................sound exposure level
SEMS ....Safety and Environmental Management System
SFF ....summer fall feeding
SHPO.............................State Historic Preservation Officer
SIL ....significant impact level
SIP ....state implementation plan
SL ....significance level (in air quality standards)
SLA ....Submerged Lands Act
SLIE ....seaward landfast ice edge
SLS ....spring lead system
SOA ....State of Alaska
SOP................................suspension of production
SPCC ....Spill Prevention Control and Countermeasure (Plan)
SSO................................sub-surface oil
SSOR ....sub-surface oil residue
stb ....stock-tank or standard barrel
STP ....seawater treatment plant
SUA ....subsistence use area
Sv...................................Sverdrups
TAH...............................total aromatic hydrocarbons
TAPS ....Trans-Alaska Pipeline System
TAqH.............................total aqueous hydrocarbons
Tcf ....trillion cubic feet
Tcfg ....trillion cubic feet of gas
TCH ....Teshekpuk Lake Caribou Herd
TEK ....traditional ecological knowledge
TLV ....threshold limit values
TOC ....total organic carbon
TPH ....Tuktoyaktuk Peninsula (Caribou) Herd
TSLA ....Teshakpuk Lake Special Management Area

TSP .... total suspended particles
TSS .... total suspended solids
TTS .... temporary threshold shift
UAF .... University of Alaska, Fairbanks
UC .... Unified Command
UIC .... underground injection control
uERD .... ultra extended-reach drilling
UERR .... undiscovered economically recoverable resources
ULSD............................ Ultra-Low Sulfur Diesel Fuel
UME .... unusual mortality event
UNFCC.......................... United Nations Framework Convention on Climate Change
Unified Plan.................. Unified Plan for Preparedness to Oil Discharges and Hazardous Substance Release
USACE......................... U.S. Army Corps of Engineers
USC .... United States Code
USCG .... U.S. Coast Guard
USDOC/DOC .... U.S. Department of Commerce
USDOI/DOI.................. U.S. Department of the Interior
USDOT/DOT .... U.S. Department of Transportation
USEPA/EPA................. U.S. Environmental Protection Agency
USFDA/FDA................ U.S. Food and Drug Administration
USFS .... U.S. Forest Service
USFWS/FWS .... U.S. Fish and Wildlife Service
USGCRP....................... U.S. Global Change Research Program
USGS............................ U.S. Geological Survey
UTRR .... undiscovered technically recoverable resources
UV .... ultraviolet
VGP .... Vessel General Permit
VLOS............................ very large oil spill
VOC.............................. volatile organic compounds
VSM .... vertical support member (supports above-ground oil and gas pipelines)
WAH .... Western Arctic (Caribou) Herd
WCD............................. worst-case discharge
WHO .... World Health Organization
WNP .... Western Northern Pacific
WOUS .... waters of the United States
WPS.............................. Western Pacific Stock
WQS .... Alaska State Water Quality Standards
WRO............................. Water Resources Office (Alaska Dept. of Natural Resources)
XSS............................... excess suspended sediment

Executive Summary

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EXECUTIVE SUMMARY

INTRODUCTION

The Bureau of Ocean Energy Management (BOEM) has prepared this Environmental Impact Statement (EIS) to analyze the impacts of the Liberty Development and Production Plan (DPP) submitted by Hilcorp, Alaska, LLC (HAK) on September 8, 2015 and amended on May 26, 2017.

PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the Proposed Action is to recover and process oil from the Liberty oil field and transport sales-quality oil to market. The need for this action is established by BOEM's responsibility under the Outer Continental Shelf Lands Act (OCSLA) to make OCS lands available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs. The OCSLA also specifies the submittal and review processes for proposed DPPs, and establishes the circumstances under which proposed DPPs are to be approved, modified, or disapproved.

REGULATORY AND ADMINISTRATIVE FRAMEWORK

A number of Federal agencies are using this EIS to meet their own regulatory (and in some cases, National Environmental Policy Act [NEPA]) requirements concerning activities described within the Liberty DPP that fall under their respective jurisdiction. BSEE, the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (USACE), and the National Marine Fisheries Service (NMFS) are all adopting this EIS to satisfy NEPA requirements associated with their proposed regulatory actions concerning various activities described in the DPP.

The U.S. Fish and Wildlife Service (FWS), the Pipeline and Hazardous Materials Safety Administration (PHMSA), and the State of Alaska, Department of Natural Resources (ADNR) will use the environmental analysis contained herein to inform their regulatory reviews of various activities described in the DPP.

SCOPING

Scoping is the ongoing public process to identify issues, alternatives, and mitigation measures to be considered for in-depth analysis in the EIS. As part of the scoping process, BOEM considered:

- Prior plans to develop the Liberty reservoir, along with alternative approaches identified in previous NEPA reviews;
- Public responses provided during scoping meetings held in Anchorage, Fairbanks, Barrow, Kaktovik, and Nuiqsut during November 2015;
- Information provided to BOEM as part of tribal and Alaska Native Settlement Claims Act (ANSCA) corporation consultations;
- Public comments submitted to www.regulations.gov during the scoping period; and
- Input from Cooperating Agencies.

BOEM held a series of meetings with the Cooperating Agencies from fall 2015 though spring 2016 to develop, screen, and select alternatives for full analysis in the Draft EIS. BOEM held a workshop for alternatives development in February 2016 with all Cooperating Agencies, and provided draft alternatives for cooperating agency review in June 2016.

BOEM conducted a screening process to determine which of the suggested alternatives were technically and economically feasible, met the Purpose and Need, and were "reasonable" alternatives to consider under NEPA. Based on this screening process, BOEM retained three Action Alternatives (each comprised of multiple sub-Alternatives), in addition to the Proposed Action and No Action alternative required by NEPA. Suggested alternatives which were screened out during this process are described in Section 2.4, Alternatives Considered but Not Carried Forward for Further Analysis.

Proposed Action and Alternatives

Preferred Alternative

The preferred alternative is the Proposed Action (Alternative 1) because it best fulfills BOEM's statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors.

Proposed Action

The Proposed Action (Figure ES-1) entails construction of a self-contained offshore drilling and production facility located on an artificial gravel island to be called the Liberty Development and Production Island (LDPI), with a pipeline to shore that will tie in to the existing Badami Pipeline.

The proposed LDPI and surrounding infrastructure would have a design life of approximately 25 years. Other specifications include:

- The LDPI would be located approximately 5 miles north of the Kadleroshilik River and 7.3 miles southeast of the existing Endicott SDI.
- The LDPI would be built in approximately 19 feet of water with the elevation of the top of the LDPI +15 feet above Mean Lower Low Water (MLLW) level.
- Work surface of approximately 9.3 acres.
- Seabed footprint of approximately 24 acres.

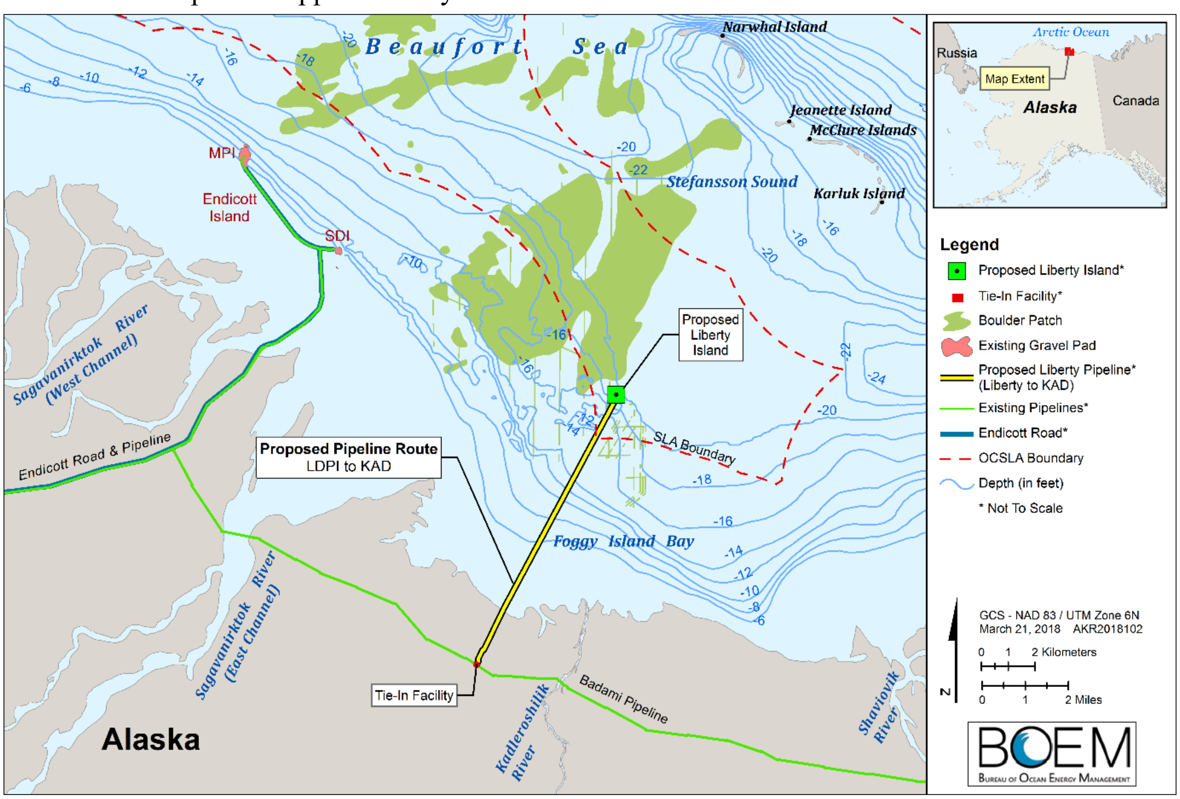

Figure ES-1 Proposed Action Area

Associated onshore facilities and activities to support the Proposed Action would include ice road construction, construction of gravel pads to support the pipeline tie-in location and Badami ice road crossing, ice pad construction, construction of a hovercraft shelter and small boat dock, and development of a gravel mine site west of the Kadleroshilik River.

ALTERNATIVE 2 (NO ACTION)

Alternative 2 is the "No Action" Alternative. Under this Alternative, the Proposed Action would not be approved and the actions described in the Liberty DPP would not take place. No mineral resources would be extracted from the three leases comprising the Liberty Unit and none of the impacts (both positive and negative) described in Chapter 4 (Environmental Impacts) of the EIS would be realized.

Under the No Action Alternative, there would be no need for other Federal or State permits or regulatory authorizations for activities described in the proposed DPP, e.g. National Pollution Discharge Elimination System (NPDES) permits, 404 permits, incidental take authorizations, etc.

All current oil and gas activity on the Beaufort Sea OCS and State waters, including the operations at Northstar, would continue as described in Chapter 5 (Cumulative Impacts) of the Final EIS.

ALTERNATIVE 3 (ALTERNATE LDPI LOCATIONS)

BOEM developed two sub-alternatives based on public and Cooperating Agency comments suggesting that BOEM evaluate alternate LDPI locations that would minimize impacts to the Boulder Patch. After obtaining and analyzing additional technical information concerning the feasibility of various alternative LDPI locations, BOEM identified two reasonable alternative LDPI locations for analysis in the EIS.

Alternative 3A (Figure ES-2) would relocate the LDPI to a site approximately one mile to the east, which would result in the island being approximately this distance further away from the densest areas of the Boulder Patch. This alternative would place approximately 0.25 miles of the pipeline into an area with 100 percent possibility of overflood occurrence (overflooding is the fluvial process that causes strudel scour; see Section 3.1.2.4.1 for more information) that would require pipeline design changes to limit the risk of wear or upheaval buckling.

Alternative 3B (Figure ES-3) places the LDPI approximately 1.5 miles closer to shore (which would be into State of Alaska [SOA] waters). This Alternative moves the LDPI approximately one mile further away from the densest areas of the Boulder Patch. This alternative would increase the length of all wellbores by about 3,300 feet to an average length of approximately 17,200 feet as compared to an average wellbore length of approximately 13,900 feet for the Proposed Action.

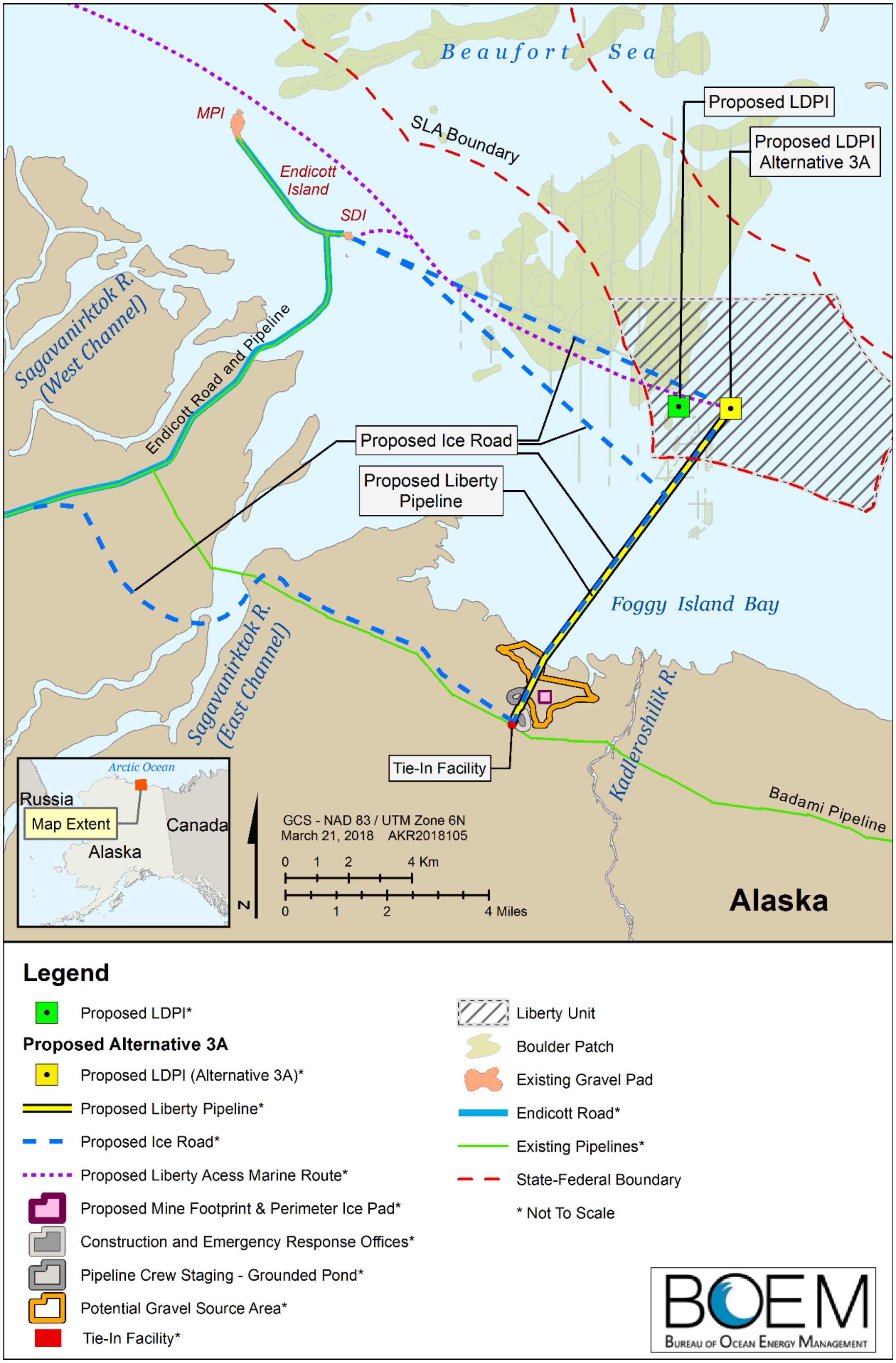

Figure ES-2 Alternative 3A: LDPI Moved Approximately 1 Mile to the East

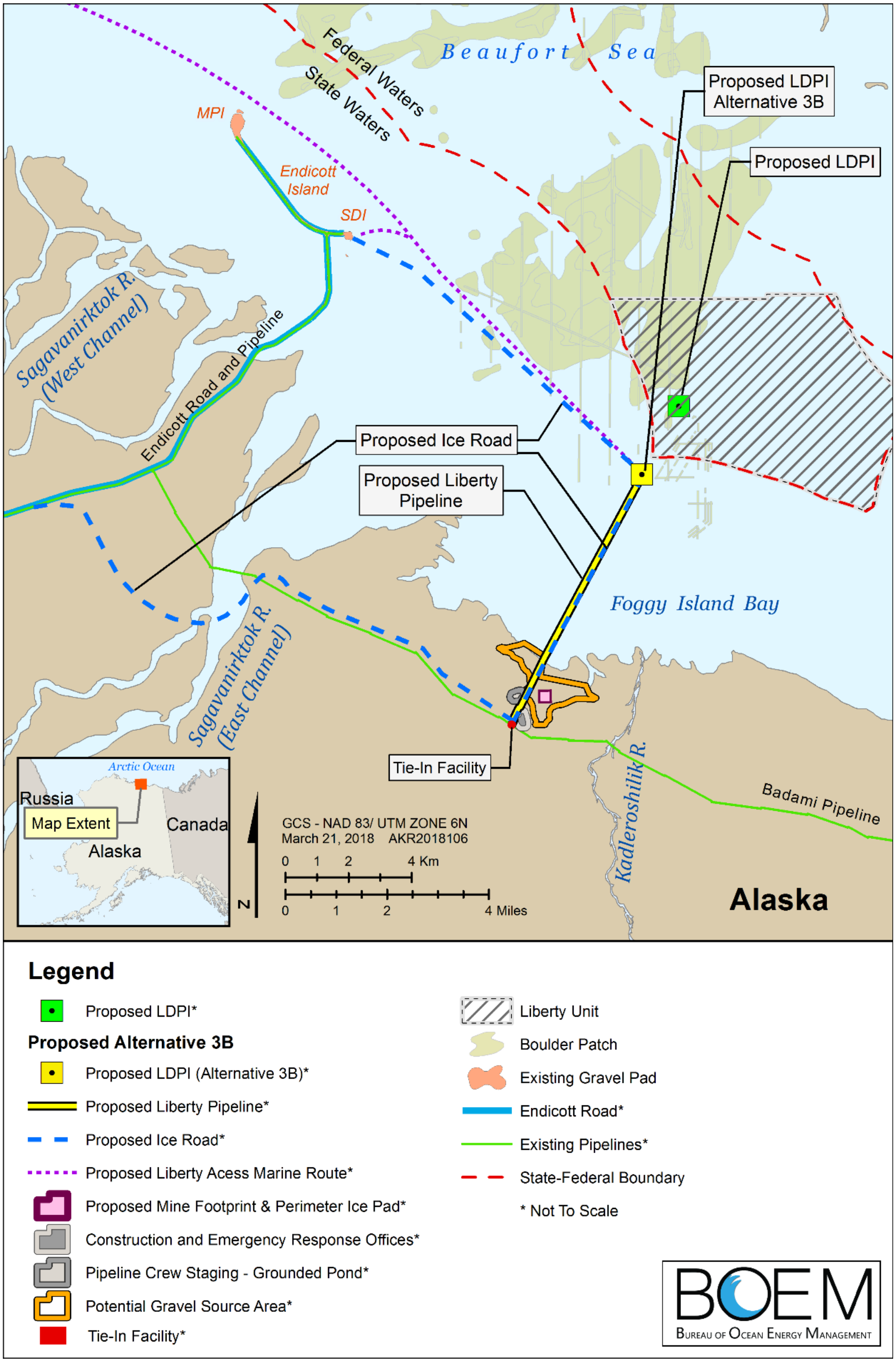

Figure ES-3 Alternative 3B: LDPI Moved Approximately 1.5 Miles to the Southwest

ALTERNATIVE 4 (RELOCATE OIL AND GAS PROCESSING OFF OF LDPI)

This Alternative also has two sub-alternatives. Alternative 4A (Figure ES-4) would move oil and gas processing facilities from the LDPI to the existing Endicott SDI facility. Alternative 4B (Figure ES-5) would move oil and gas processing facilities from the LDPI to a new onshore facility.

Both sub-alternatives match the Proposed Action in that the LDPI would be constructed and house wells to access the reservoir, and a pipeline would still be necessary to transport fluid to shore. They differ from the Proposed Action in that fluid transported via pipeline from the LDPI would be an unprocessed solution of oil, gas, water, and other constituents (termed a 3-phase line) as opposed to processed oil.

These alternatives were developed as a result of scoping comments suggesting that onshore processing may minimize impacts to marine resources and subsistence harvest practices from on-island equipment noise and vibration.

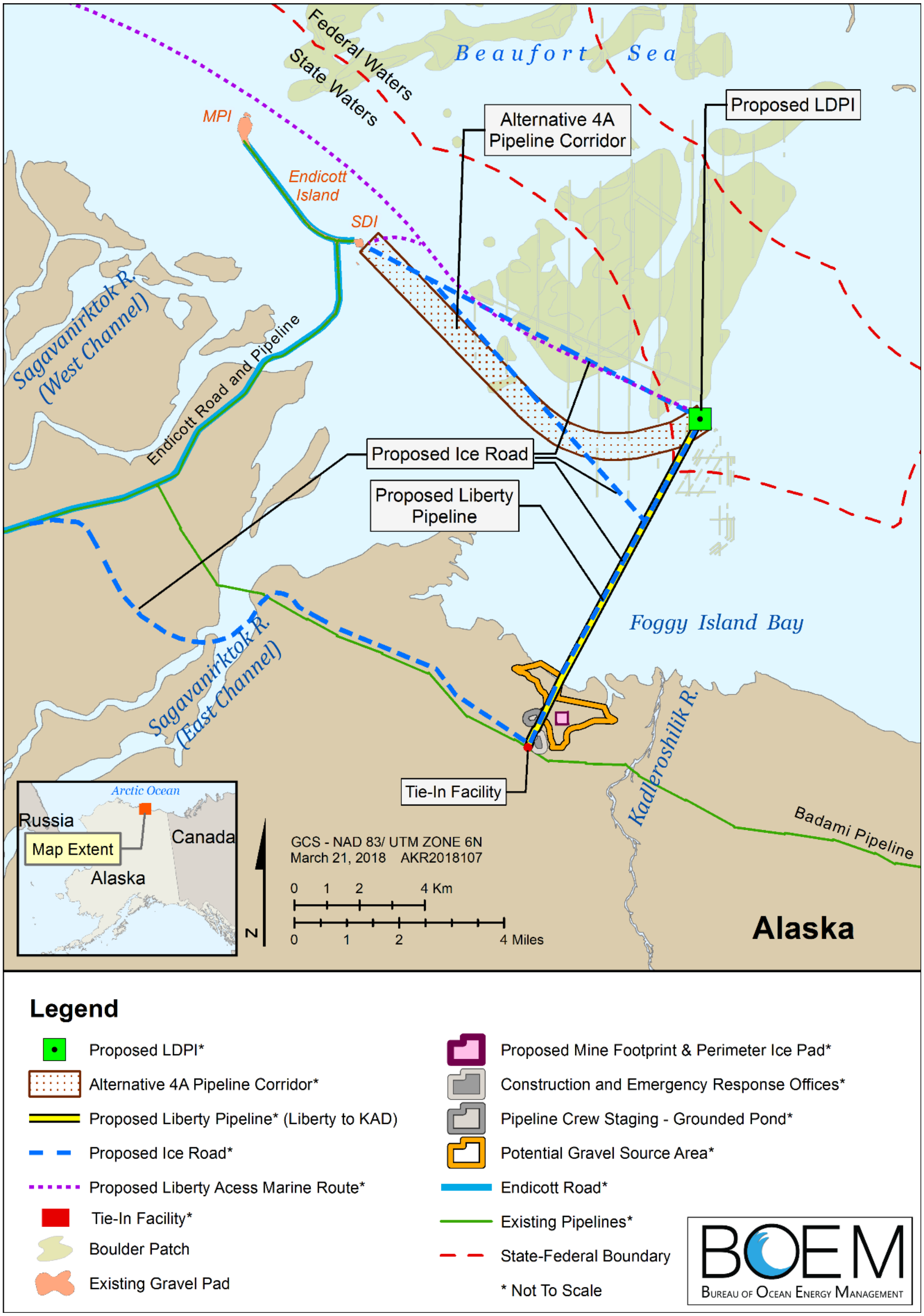

Figure ES-4 Alternative 4A: Endicott Processing and Alternate Pipeline Route

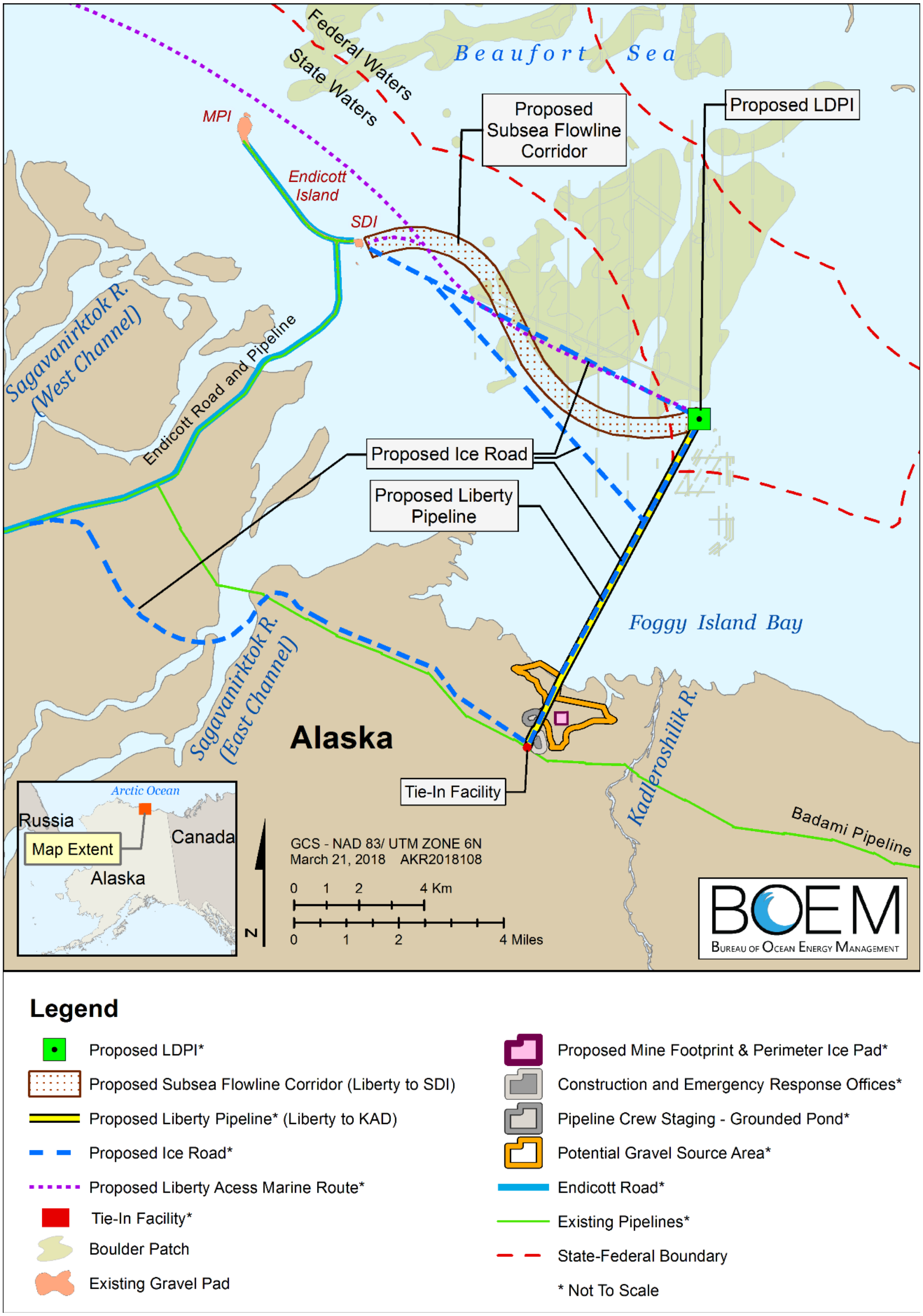

Figure ES-5 Alternative 4B: Onshore Processing

ALTERNATIVE 5 (ALTERNATE GRAVEL SOURCES)

Three sub-alternatives for Alternative 5 were analyzed in the DEIS. Each considered a different proposed gravel mine site location.

These sub-alternatives were developed in response to scoping comments suggesting BOEM analyze an alternate location for the proposed West Kadleroshilik River Mine Site to minimize impacts to migratory birds, wetlands, fish used for subsistence purposes, and other resources. BOEM identified three feasible alternate locations based on a thorough review of existing technical and survey information.

Alternative 5C, the Duck Island Mine site, has been dismissed from analysis in this FEIS because, based on information provided by the State of Alaska, it is currently flooded and is unlikely to contain enough usable material to make it a feasible alternative (Figure ES-6 and Figure ES-7).

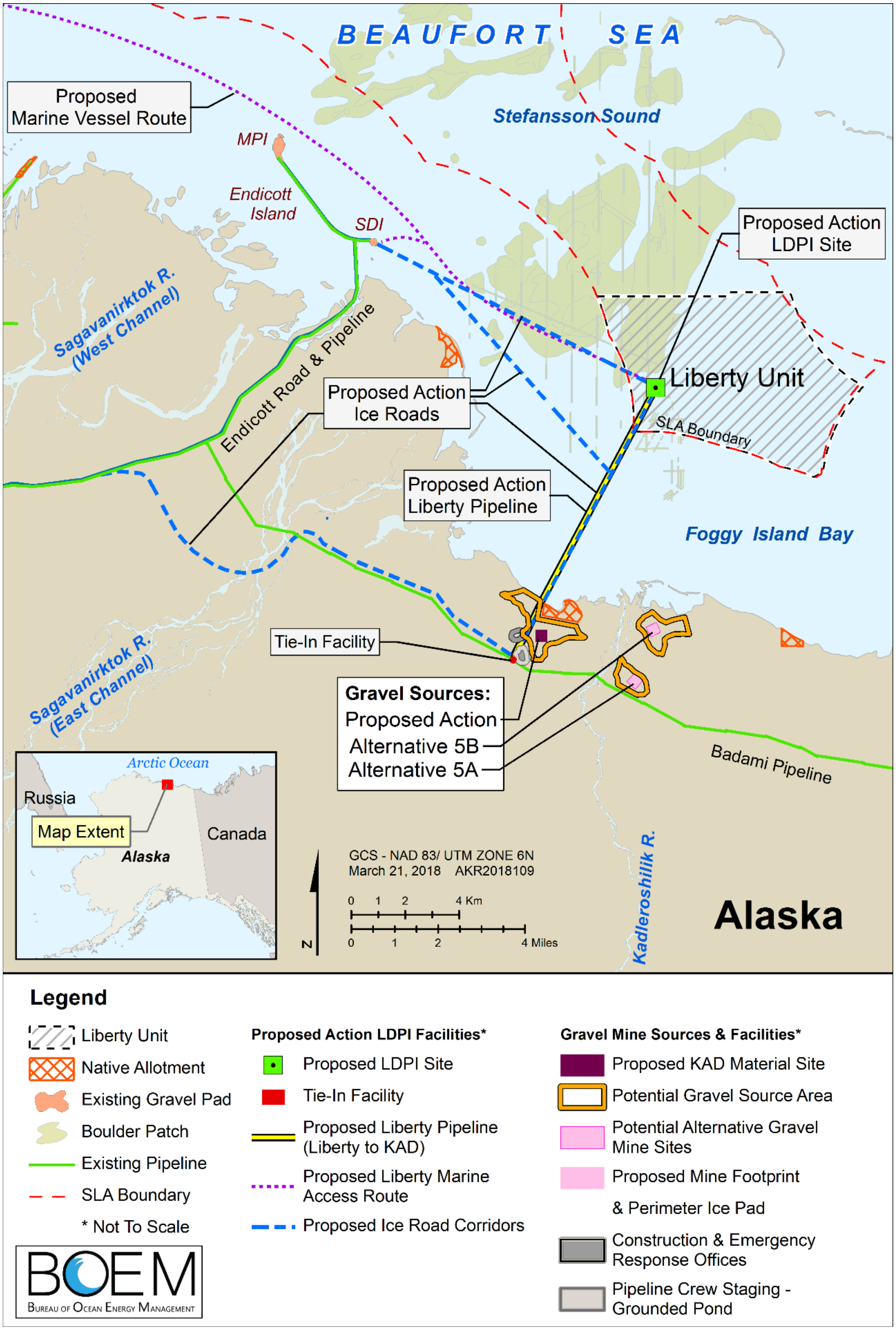

Figure ES-6 Alternative 5: Alternate Mine Site Locations, Overview

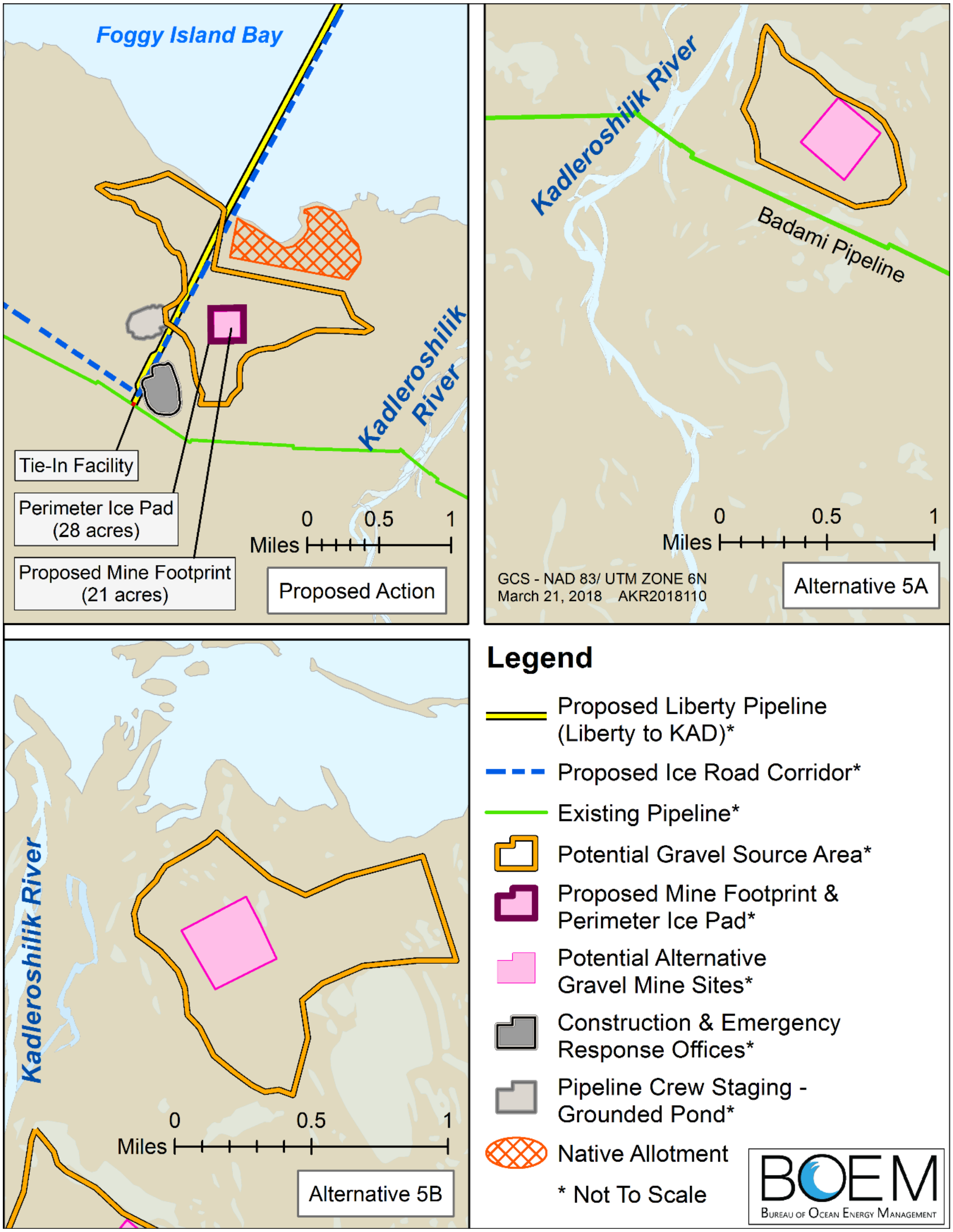

Figure ES-7 Alternative 5: Alternate Mine Site Locations, Detail

PROPOSED SOLID ICE CONDITION

In response to public comment, the FEIS considers the impacts of imposing the following mitigation measure:

Reservoir drilling is authorized only during times of solid ice conditions. For the purposes of this condition, "reservoir drilling" is defined to include initial development drilling (as opposed to workovers, recompletions, and other such well operations subsequently conducted on existing wells) beyond the shoe (base) of the last casing string above the Kekiktuk Formation (i.e. drilling that exposes the Kekiktuk Formation to an open, uncased wellbore). 'Solid ice conditions' is defined as at least 18 inches of ice in all areas within 500 feet of the LDPI.

ALTERNATIVES CONSIDERED BUT NOT CARRIED FORWARD FOR FURTHER ANALYSIS

Several potential alternatives suggested during scoping are not considered for detailed analysis in the EIS because they are not reasonable alternatives as defined under NEPA. These included:

Ultra Extended Reach Drilling (uERD) from shore to the Liberty Reservoir. This alternative is not technically feasible because it would involve drilling a uERD well that would extend almost a mile beyond the existing world record of 40,602 feet for the longest wellbore.

Horizontal Directional Drilling (HDD) the pipeline landfall. An HDD of this type would be a project not based on or in accordance with typical HDD projects; shore approaches using HDD are more complex than typical surface-to-surface HDD installations. This alternative would be the largest HDD project ever attempted in Alaska and is not technically feasible.

Seabed Gravel Mine. An alternative suggested during public scoping was to use gravel mined from the Federal OCS seabed to construct the LDPI during the open-water season. The technical and economic feasibility of this alternative is speculative; it is unknown whether the Beaufort Sea OCS (or other portions of the Alaska OCS) features a suitable gravel source. Additionally, the costs and environmental impacts of dredging and barging this gravel to the LDPI site would far exceed those from mining and trucking gravel from the proposed onshore mine located less than 10 miles away. Further, prior analyses have indicated that this alternative would likely create unacceptable environmental and social impacts.

AFFECTED ENVIRONMENT

The Affected Environment section (Chapter 3) of the Draft EIS describes the physical and biological environment, socioeconomic and sociocultural systems, oil and gas, and related infrastructure of the Alaska Beaufort Sea shelf and Foggy Island Bay that could be affected by the Proposed Action.

ENVIRONMENTAL CONSEQUENCES

Impacts to each resource category were rated as negligible, minor, moderate, or major using impact scale definitions based on the context and intensity of impact. Separate ratings were produced for routine activities, small spills (less than 1,000 barrels [bbl]), and a large spill (greater than or equal to 1,000 bbl).

Potential impacts to environmental resource categories from the Proposed Action are summarized in Table ES-1. Potential impacts to environmental resource categories from the various Alternatives are summarized in Table ES-2.

Table ES-1 Potential Impacts of the Proposed Action by Resource

Resource	Proposed Action Impacts
Oil and Gas Geology	BOEM's independent reservoir model and reservoir simulation studies using Hilcorp's development plan indicate that the Liberty Field reservoir would recover from 41% to 48% of the 180 million barrels of oil (MMBO) originally in place. These studies indicate a peak production rate of approximately 60,000-70,000 barrels of oil per day (BOPD) within the first two years of production with an estimated Proposed Action life of 22 years.
Water Quality	Overall impacts to water quality caused by water extraction, construction of ice roads and pads, gravel mining, onshore gravel pad construction, construction of the LDPI, and placement of the subsea pipeline would be negligible to minor.
Air Quality	Routine activities under the Proposed Action would result in low to medium intensity impacts to Air Quality due to one of the modeled pollutants being estimated at >50% but <100% of the NAAQS. Impacts would be temporary and localized over the 25-year lifetime of the Proposed Action and overall impacts to Air Quality would be minor.
Climate Change	The activities under the Proposed Action and its alternatives would produce GHG emissions, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). These GHG emissions would contribute to climate change.
Lower Trophic Organisms	Impacts to the Boulder Patch from construction activities are expected to be moderate, though mostly short-term and localized. Impacts from routine activities associated with the Proposed Action on resources outside of the Boulder Patch would be minor.
Fish	While the presence of the LDPI would be long-tem, impacts to fish from the Proposed Action would be short-term and localized, and thus minor.
Birds	The level of impact of the Proposed Action would be minor for most avian species. Some vulnerable (i.e., declining and limited) populations and listed spectacled eiders could experience long-lasting and widespread, and therefore moderate, impacts.
Marine Mammals	The level of effects from the Proposed Action on marine mammals would range from negligible to minor with impacts caused primarily by activities occurring during the open-water season.
Terrestrial Mammals	The level of effects to terrestrial mammals from the onshore components of the Proposed Action would be negligible.
Vegetation and Wetlands	The amount of wetlands/WOUS lost due to the Proposed Action would be approximately 3 – 5 acres filled for onshore pads, and approximately 21 acres excavated for the gravel mine. The types of wetlands that would be lost are common in the area. The impacts of Proposed Action to wetlands and vegetation would be minor.
Economy	The Proposed Action is expected to have a negligible positive impact on the State economy and a negligible to moderate positive impact on the NSB economy.
Subsistence-Harvest Patterns	Potential adverse effects to Cross Island subsistence whalers from routine activities are expected to be moderate to major for the duration of the Proposed Action. LDPI slope protection work at the Proposed Action Area is expected to have minor impacts on seal hunting for Nuiqsut and Kaktovik and negligible impacts on seal hunting for Utqiaġvik. Other routine activities associated with the Proposed Action are not expected to have adverse effects on seal hunting for any North Slope community. BOEM expects negligible impacts to subsistence caribou hunting for Nuiqsut, Kaktovik, and Utqiaġvik from routine activities associated with the Proposed Action. For Nuiqsut, Kaktovik, and Utqiaġvik, BOEM anticipates negligible impacts to subsistence fishing from routine activities associated with the Proposed Action. BOEM anticipates negligible impacts to Nuiqsut's goose hunting season from routine activities and negligible impacts to subsistence waterfowl hunting for harvesters from Utqiaġvik.
Sociocultural Systems	Negligible impacts to the sociocultural systems for Kaktovik and Utqiaġvik are anticipated as a result of routine activities associated with the Proposed Action. Nuiqsut: Major if subsistence whaling impacted.
Public and Community Health	Factors influencing public health include potential impacts to subsistence bowhead harvests, impacts to air pollution, water quality, changes in revenue and economic growth. Overall, impacts on community health as a result of the Proposed Action are anticipated to be negligible to moderate.
Environmental Justice (EJ)	If the Proposed Action results in moderate to major impacts to Cross Island subsistence whaling, it could impact the social organization, cultural values, and local institutions of Nuiqsut, which would result in disproportionately high and adverse impacts to Nuiqsut.
Archaeological Resources	The overall impacts of the Proposed Action to archaeological resources would be negligible unless an historic property or other as yet undiscovered site were to be inadvertently damaged during normal Proposed Action activities. Impacts to archaeological resources would then be major.

Table ES-2 Comparison of Impacts to Resources by Alternative

Resource	Proposed Action	No Action	Alternative 3	Alternative 4	Alternative 5
Oil and Gas Geology	41-48% recovery	No resource recovery	3A/B- Increased technical difficulty/increased risk compared to PA	4A/4B-Similar to PA	Same as PA
Water Quality	Negligible to minor	No impact	3A/B-Negligible to moderate	4A/B-Same as PA	5A/B-Same as PA
Air Quality	Minor	No impact	3A-Moderate; 3B-Moderate to major	4A/B-Same as PA	5A/B-Same as PA
Climate Change	GHG emissions, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) would contribute to climate change	No additional GHG emissions	GHG emissions, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) would contribute to climate change	GHG emissions, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) would contribute to climate change	GHG emissions, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) would contribute to climate change
Lower Trophic Organisms	Minor to Moderate (for Boulder Patch)	No impact	3A/3B-Same as PA	4A/B-Same as PA	5A/B-Same as PA
Fish	Minor	No impact	3A/B- Same as PA	4A/B-Same as PA	5A/B-Same as PA
Birds	Minor to Moderate	No impact	3A/B- Same as PA	4A-same as PA/ 4B -Moderate	5A/B-Same as PA
Marine Mammals	Negligible to Minor	No impact	3A/B- Same as PA	4A/4B-Same as PA	5A/B-Same as PA
Terrestrial Mammals	Negligible	No impact	3A/B- Same as PA	4A-Same as PA; 4B-Moderate	5A/B-Same as PA
Vegetation and Wetlands	Minor	No impact	3A/B- Same as PA	4A-Same as PA; 4B-Moderate	5A/B-Same as PA
Economy	Negligible to Moderate	Negligible	3A/B- Same as PA	4A/B-Same as PA	5A/B-Same as PA
Subsistence-Harvest Patterns	Cross Island subsistence whalers- moderate to major; Minor impacts- seal hunting, Nuiqsut and Kaktovik; negligible impacts- seal hunting, Utqiaġvik; negligible impacts- caribou hunting and fishing, Nuiqsut, Kaktovik, and Utqiaġvik; minor impacts- waterfowl hunting, Nuiqsut, Kaktovik; negligible impacts- waterfowl hunting for Utqiaġvik	No impact	3A-Moderate to Major; 3B-Minor to moderate	4A/B-Minor to moderate	5A/B-Same as PA
Sociocultural Systems	Negligible to Major	No impact	3A/Same as PA; 3B-Negligible to moderate	4A/B-Negligible to Moderate	5A/B-Same as PA
Public and Community Health	Negligible to moderate	No impact	3A-Moderate to major; 3B-minor to moderate	4A/B-Minor	5A/B-Negligible to moderate
Environmental Justice (EJ)	Negligible to Major If major effects to subsistence/sociocultural, then disproportionately high and adverse impacts to the Nuiqsut	No impact	3A-Same as PA; 3B-Negligible to Moderate, Not expected to have disproportionately high and adverse impacts	4A/B-Negligible to Moderate , Not expected to have disproportionately high and adverse impacts	5A/B- Same as PA
Archaeological Resources	Negligible, unless an historic property or undiscovered site inadvertently damaged-- then major	No impact	3A/B-Same as PA	4A/B-Same as PA	5A/B- Same as PA

VERY LARGE OIL SPILL SCENARIO AND EFFECTS

A Very Large Oil Spill (VLOS) is not estimated to occur during the life of the Proposed Action and would be considered well outside the normal range of probability, despite the inherent hazards of oil development related activities. The FEIS references a hypothetical VLOS volume of 4.6 MMbbl, which is based on Hilcorp's estimate of a worst case discharge (WCD) volume which was independently verified by BOEM. The hypothetical VLOS discharge quantity is "conditioned" upon the assumption that all of the necessary chain of events required to create the VLOS actually occur (appropriate geology, operational failures, escaping confinement measures, the spill reaching the environment, etc.). In the unlikely event that a VLOS were to occur in the Beaufort Sea, the potential for significant effects on all resource categories would be high. Significant adverse impacts could potentially occur to components (e.g., species) within all examined environmental resource categories.

CUMULATIVE EFFECTS

Cumulative effects are assessed by determining the incremental impact of an action when added to the impacts of past, present, and reasonably foreseeable future actions in the vicinity of the Proposed Action. Actions considered in the cumulative effects analysis include other oil and gas activities, community development, recreation and tourism, marine vessel traffic, aircraft traffic, subsistence activities, research and survey activities, mining projects, and military activities. The analysis also considers climate change and its ongoing role in the changing Arctic ecosystem.

The incremental contribution from the Proposed Action (including accidental small oil spills) to the cumulative effects would likely be negligible to minor for all analyzed resources.

An accidental large oil spill, should one occur, would contribute additional cumulative effects. The resources with the greatest potential to experience cumulative effects include marine mammals, birds, coastal and estuarine habitats, subsistence harvesting patterns, and sociocultural systems.

CONSULTATION AND COORDINATION

BOEM consulted with several Federal regulatory agencies, federally recognized tribes, and ANCSA corporations regarding the Liberty DPP. Below is a brief summary of how BOEM has satisfied, or will satisfy, its consultation requirements with respect to the Liberty DPP (the Proposed Action):

Executive Order 13175 – Tribal Consultation. BOEM held consultations with potentially affected tribal governments and ANCSA Corporations at multiple steps in the decision-making process. This information was used to inform the alternatives development process, Liberty Baseline Human Health Summary analyses, subsistence impact analyses, and cumulative impacts analyses.

Endangered Species Act – Section 7 Consultation. BOEM consulted with NMFS and FWS concerning potential impacts to endangered and threatened species and their designated critical habitat. NMFS and USFWS issued Biological Opinions in August 2018 and July 2018, respectively. Both Biological Opinions included reasonable and prudent measures, and implementing terms and conditions, to help reduce potential take of listed species. These measures, terms, and conditions would be included as requirements or conditions of approval for the Proposed Action.

Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Consultation. BOEM provided an Essential Fish Habitat (EFH) assessment to NMFS regarding the potential effects on EFH for all five species of Pacific salmon, as well as Arctic cod and saffron cod. NMFS responded on December 15, 2017 with conservation recommendations. BOEM incorporated analysis of these measures into the EIS. NMFS responded in an email dated January 25, 2018 that EFH consultation had been satisfied.

National Historic Preservation Act – Section 106 Consultation. On June 2, 2017, BOEM transmitted a "no effects" determination to the Alaska State Historic Preservation Office (AK SHPO) through a letter detailing the Liberty Development and Production Plan (Proposed Action) and all Action Alternatives (Alternatives 3 through 5). On July 6, 2017, BOEM received a concurrence from the AK SHPO of no historic properties affected by the Proposed Action or Action Alternatives.

APPENDICES

Appendix A. Accidental Oil Spills and Gas Releases: posted at https://www.boem.gov/liberty

Appendix A discusses the technical information used to estimate numbers and volumes of oil spills and natural gas releases assumed to occur over the life of the Proposed Action. The rationale for these assumptions is a mixture of Proposed Action-specific information, modeling results, statistical analysis, three decades of experience modelling hypothetical oil spills, and professional judgment.

Appendix B. Response to Comments

Appendix B presents summaries of public comments received on the Draft EIS, sorted by subject category, along with BOEM's responses.

Appendix C. Mitigation Measures

Appendix C discusses in greater detail the various design features and mitigation measures which are expected to reduce potential impacts from the Proposed Action to the resources analyzed in this FEIS. These mitigation measures include Lease Stipulations, typical mitigation measures incorporated into Marine Mammal Protection Act take authorizations, and typical mitigation measures incorporated into Biological Opinions issued pursuant to Section 7 of the Endangered Species Act. Appendix C also contains proposed mitigation measures that were developed as a result of scoping comments or through impacts analysis.

OTHER PERTINENT DOCUMENTS (posted at https://www.boem.gov/liberty)

Air Quality Analysis Methodology

Data, assumptions, and emission factors used in analyzing air quality effects in this FEIS.

Liberty Baseline Human Health Summary

An overview of the current health status of the communities within the North Slope Borough (NSB). This baseline health summary included Anaktuvuk Pass, Atqasuk, Kaktovik, Nuiqsut, Point Hope, Point Lay, Utqiaġvik (formerly known as Barrow), and Wainwright. This baseline health summary refers to these communities as potentially affected communities in accordance with the Health Impact Assessment Toolkit (ADHSS, 2015). The summary focused on Nuiqsut because it is the closest potentially affected community to the Proposed Action.

Wetlands Delineation Report

The Wetlands and Waters of the United States (WOUS) Delineation Report supports HAK's Liberty Development Program, east of Deadhorse, Alaska. The report discusses the location and extent of wetlands and other WOUS in the Proposed Action Area which are potentially subject to the jurisdiction of the USACE under Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act.

Lease Stipulations

Lease stipulations that apply to each of the Liberty Unit constituent lease sales. Narrative translations of obsolete terminology and the current authorizing regulations is provided as necessary within this FEIS and appendices.

Marine Mammal Emergency Response Standards

Archaeology Resources

Background information about the history of people in Alaska.

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Chapter 1

Proposed Action

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CHAPTER 1. PROPOSED ACTION

The Liberty prospect has been subject to several proposed project designs and National Environmental Policy Act (NEPA) reviews since its discovery over 30 years ago. A brief history of the project is described below to provide context for this current DPP EIS.

1.1 Background

This chapter describes the Proposed Action, the Purpose and Need for the Proposed Action, and the Federal regulatory and administrative context for preparing this Alaska Outer Continental Shelf (OCS) Beaufort Sea Liberty Development and Production Plan (DPP) Environmental Impact Statement (EIS).

The Liberty Unit, for which Hilcorp Alaska, LLC (HAK) is the designated operator, was formed in 2003 to include OCS-Y-1650 and OCS-Y-1585. In 2016, the Bureau of Safety and Environmental Enforcement (BSEE) approved the expansion of the unit to include OCS-Y-1886; this is a small sliver (2.7 acres of OCS acreage) which arose following the mapping conversion from North American Datum—NAD— 1927 to NAD 1983. These leases were obtained under Lease Sales 124 in 1991, 144 in 1996, and 202 in 2007.

Exploration wells are shown along with lease boundaries and offset wells in Figure 1-1.

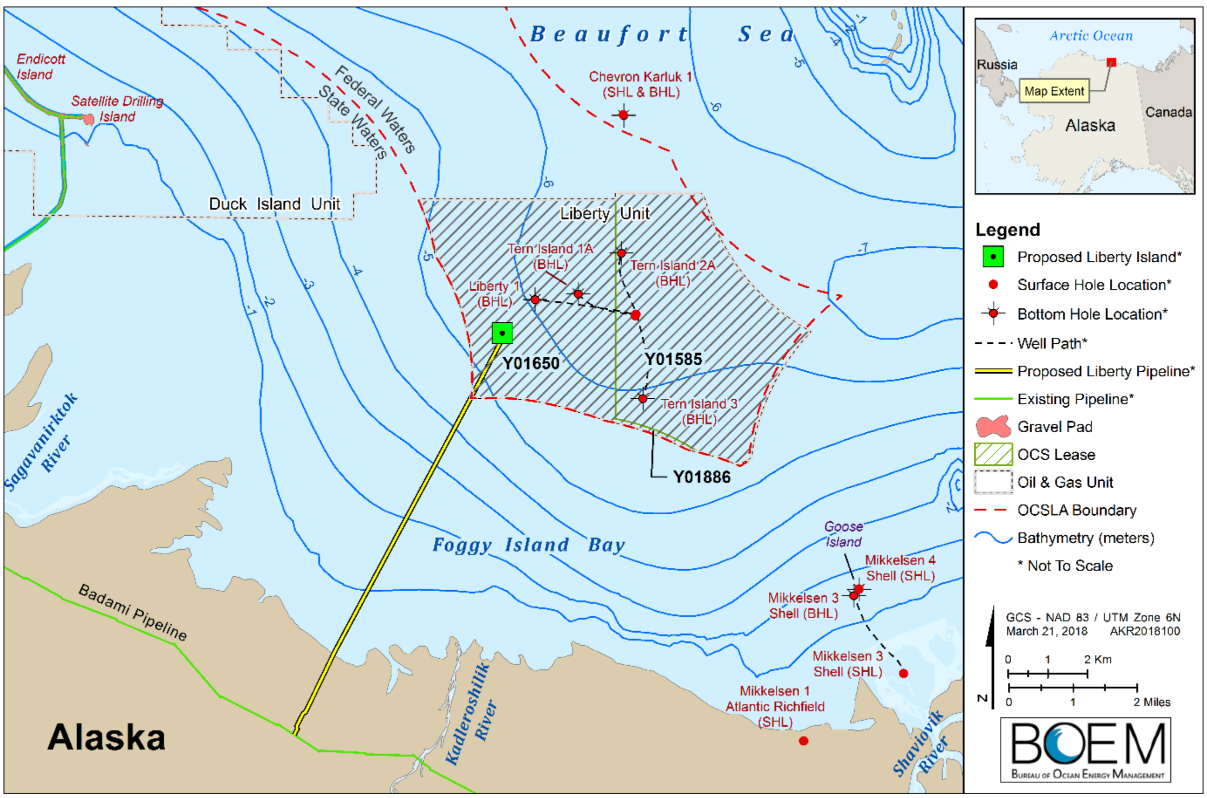

Figure 1-1 Existing Liberty Exploration Wells

The Liberty Reservoir was first discovered by Shell Oil Company. Shell drilled three wells between 1982 and 1987 to evaluate the potential of the Kekiktuk Formation in Foggy Island Bay. Tern Island wells 1A, 2A and 3 were drilled from Tern Island, with two of the wells penetrating older areas of the Kekiktuk Formation that holds the Liberty Reservoir. Later, in September 1996, BP Exploration Alaska (BPXA) acquired Tract OCS-Y-1650 in OCS Lease Sale 144, and initiated exploration permitting activity for the Liberty No. 1 Exploration Well. The surface location for this well was a gravel and ice structure situated on top of the abandoned Tern Island on Lease OCS-Y-1585 (Lease Sale 124), with the bottom-hole location (bottom of the drilled well) in Lease OCS-Y-l650.

BPXA began drilling the Liberty No. 1 well in February 1997, followed by well testing in March 1997 and demobilization in April 1997. Based on interpretations of geologic data, seismic data, and well tests, BPXA confirmed the discovery of an estimated 120 million barrels (MMbbl) of recoverable reserves from the Liberty prospect on May 1, 1997. Tern Island is currently abandoned and eroding. Since then, plans to develop the field have progressed through three stages, as described below.

1.1.1 1998 BPXA DPP

BPXA initiated conceptual engineering in 1996. This effort was based on assumed exploratory success and focused on identification and screening of project development alternatives. Factors considered in the evaluation of different approaches included reservoir development and recovery, environmental impacts, costs, technical complexity, and logistical practicalities. On February 17, 1998, BPXA submitted a DPP to the Minerals Management Service (MMS). This project included a man-made gravel island, on-island processing facilities, and a buried, single-wall subsea pipeline to shore and tie-in to the Badami pipeline. MMS initiated a regulatory review process and commenced preparation of an EIS. However, prior to a final MMS decision on the DPP, BPXA requested that the project be placed on hold. BPXA requested a Suspension of Production (SOP) on July 10, 2001, which MMS granted on July 19, 2001. MMS issued a final EIS (FEIS) concerning this DPP in May of 2002, but did not issue a Record of Decision.

1.1.2 2007 BPXA DPP

From 2002 to 2005, BPXA evaluated alternative ways to develop the oil accumulation at the Liberty site.

In August 2005, BPXA announced that it would pursue use of ultra extended-reach drilling (uERD) from an onshore location to the existing satellite drilling island (SDI) on the Endicott causeway. The proposed land-based project was intended to eliminate the gravel island and subsea pipeline components of the prior DPP, for the stated purpose of mitigating impacts related to the Boulder Patch, marine mammals, and concerns related to subsistence whaling. It also made issues related to construction impacts and risk of an offshore pipeline design immaterial. This project was described in the April 2007 Liberty DPP. BOEM prepared an Environmental Assessment (EA) of the impacts of this DPP and issued a Finding of No Significant Impact (FONSI) in November 2007.

Following approval of this plan, BPXA expanded the Endicott SDI and constructed and positioned a drilling rig to drill the proposed wells. However, BPXA cancelled the uERD project in 2012 due to technical difficulties. BPXA requested another SOP in December 2012. BSEE granted the SOP under the condition that BPXA submit an actionable DPP to BOEM by December 31, 2014.

1.1.3 2015 HAK DPP

In 2012, BPXA began re-evaluating ways to develop the reservoir with an island over the reservoir and conventional drilling technology.

In April 2014, BPXA announced the sale of several North Slope assets to HAK including Northstar, Endicott, Milne Point, and Liberty. In the case of Liberty, 50 percent ownership and full operatorship of the field was to be transferred from BPXA to HAK upon closing the sale in late 2014.

HAK incorporated many of the concepts of the plan outlined in the 1998 BPXA DPP into its December 30, 2014, DPP.

Hilcorp submitted the Liberty DPP to the Bureau of Ocean Energy Management (BOEM) on December 30, 2014. BOEM made several requests for additional information on the DPP throughout 2015. HAK responded to these requests with an amended DPP on September 8, 2015. BOEM deemed the DPP submitted (i.e., complete) on September 18, 2015.

1.2 Proposed Action

The Proposed Action is to approve the Liberty DPP and thereby authorize Hilcorp to proceed with the oil development and production activities described therein. Subsequent portions of this EIS use the term "Proposed Action" to directly refer to the development and production activities described in Hilcorp's DPP.

For a complete description of the Proposed Action, see Chapter 2 of this FEIS.

1.2.1 Land Status

The land adjacent to the U.S. Beaufort Sea is within the North Slope Borough (NSB), a political subdivision of the State of Alaska. Land-ownership in the NSB is complex. The Federal Government is the predominant land owner of onshore lands, with more than half of the Borough's land area encompassed by the National Petroleum Reserve in Alaska (NPR-A) and the Arctic National Wildlife Refuge (ANWR). Other major landholders include the State of Alaska, Arctic Slope Regional Corporation (ASRC), Kaktovik Iñupiat Corporation, and Kuukpik Corporation.

1.3 Purpose and Need for the Proposed Action

The purpose of the Proposed Action is to recover and process oil from the Liberty oil field and transport sales-quality oil to market. The need for this action is established by the Department of the Interior's (DOI's) responsibility under the Outer Continental Shelf Lands Act (OCSLA) to make OCS lands available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs. The OCSLA also specifies the submittal and review processes for proposed DPPs, and establishes the circumstances under which proposed DPPs are to be approved, modified, or disapproved.

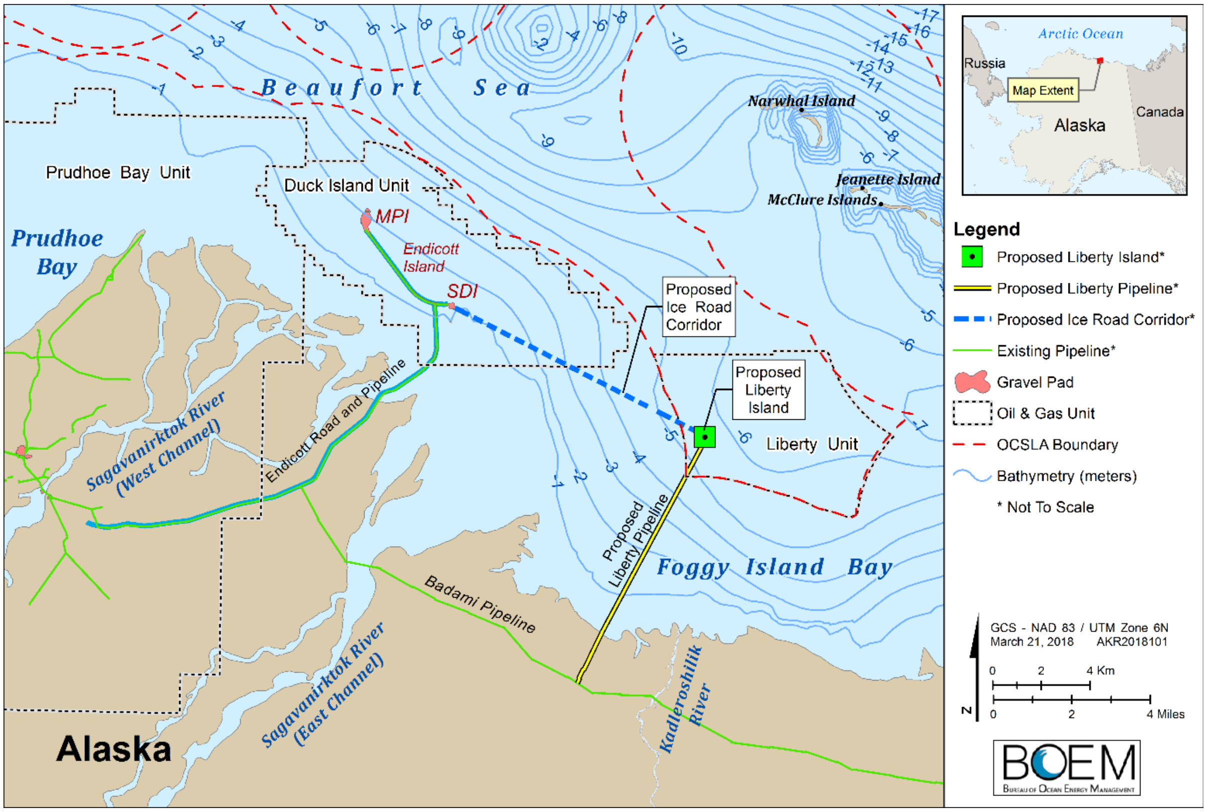

Figure 1-2 **Proposed Liberty Island Development and Production Area**
Figure shows the locations of the proposed production island, pipeline, and ice road route from Hilcorp's Satellite Drilling Island.

The DOI has delegated its OCSLA authority to several bureaus, including BOEM. BOEM is responsible for managing the mineral and energy resources located on the Nation's OCS in an environmentally sound and safe manner. To these ends, BOEM has promulgated regulations implementing certain provisions of OCSLA.

BOEM regulations pertaining to review of proposed DPPs are codified at 30 Code of Federal Regulations (CFR) Part 550, where BOEM establishes requirements for the submittal of the DPP, the DPP review process, and performance standards that the DPP must meet in order to be approved.

1.4 Regulatory and Administrative Framework

A number of other Federal agencies also have regulatory authority over aspects of the Proposed Action and are using this EIS to inform their respective regulatory reviews. The BSEE, the Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (USACE), and the National Marine Fisheries Service (NMFS) intend to adopt the Final EIS in order to satisfy the NEPA requirements associated with their pending regulatory decisions. The U.S. Fish and Wildlife Service (USFWS) and the Pipeline and Hazardous Materials Safety Administration (PHMSA) are using the environmental analysis contained herein to inform their various permitting and regulatory actions connected to the Proposed Action. This EIS contains more detailed regulatory and permitting information about the agencies that intend to adopt the Final EIS.

The State of Alaska Department of Natural Resources (ADNR) also has regulatory authority over aspects of the Proposed Action and intends to use the EIS to help inform its regulatory review.

Relevant regulatory and administrative authorities, requirements, and obligations for each Federal and State agency, as well as the individual permitting requirements connected to the Proposed Action, are described below.

Although several of the regulatory authorities described below apply to multiple federal agencies, they are described only once.

1.4.1 BOEM Regulatory Authorities

1.4.1.1 Outer Continental Shelf Lands Act

Federal laws establish the OCS leasing program and the plan-specific review processes. Under OCSLA, the DOI is required to manage the orderly leasing, exploration, development, production, and decommissioning of oil and gas resources on the Federal OCS while simultaneously ensuring protection of the human, marine, and coastal environments and assuring receipt of fair market value for the lands leased and the rights conveyed by the Federal government. OCSLA also requires coordination with states and local governments affected by OCS development activities.

OCSLA creates a four-stage process for planning, leasing, exploration, and production of oil and gas resources in Federal waters (Figure 1-3). OCSLA's four-stage oil and gas review process gives the Secretary a "continuing opportunity for making informed adjustments" in developing OCS energy resources to ensure all activities are conducted in an environmentally sound manner (Sierra Club v. Morton, 510 F.2d 813, 828 [5th Cir. 1975]). In the first stage, the Secretary (through BOEM) prepares a five-year leasing program to identify the size, timing, and location of proposed lease sales. In the second stage, BOEM conducts individual lease sales, which entail prelease processes, sealed-bid auctions, bid opening and evaluation for fair market value, and lease issuance. The third stage involves exploration of the leased blocks. Prior to any exploratory drilling, a lessee must submit an Exploration Plan (EP) to BOEM for review and approval. The fourth stage, development and production, is reached if a lessee finds a commercially viable oil and/or gas discovery. For this stage, HAK has submitted a detailed DPP to BOEM. Statutory requirements for the submittal and review of proposed DPPs are provided in Section 25 of OCSLA (43 U.S. Code [USC] 1351). BOEM's implementing regulations pertaining to review of proposed DPPs are codified at 30 CFR Part 550. There, BOEM establishes the requirements for submitting DPPs, the process by which BOEM reviews DPPs, and performance standards that the DPP must meet in order to be approved. These performance standards, codified at 30 CFR 550.202, require that the operator's DPP demonstrate that it has planned and is prepared to conduct its proposed activities in a manner that:

- Conforms to OCSLA as amended, applicable implementing regulations, lease provisions and stipulations, and other Federal laws;
- Is safe;
- Conforms to sound conservation practices and protects the rights of the lessor;
- Does not unreasonably interfere with other users of the OCS, including those involved in National security or defense; and
- Does not cause undue or serious harm or damage to the human, marine, or coastal environment.

Pursuant to 43 USC 1351 and 30 CFR 550.270-.271, BOEM would approve the DPP if it complies with all applicable requirements. Conversely, BOEM would require modification of the DPP if it fails to make adequate provisions for safety, environmental protection, or conservation of natural resources or otherwise does not comply with the lease, OCSLA, the regulations prescribed under OCSLA, or other Federal laws. BOEM would disapprove the DPP if the operator failed to demonstrate that it can comply with applicable requirements, or if any of several other specified circumstances apply.

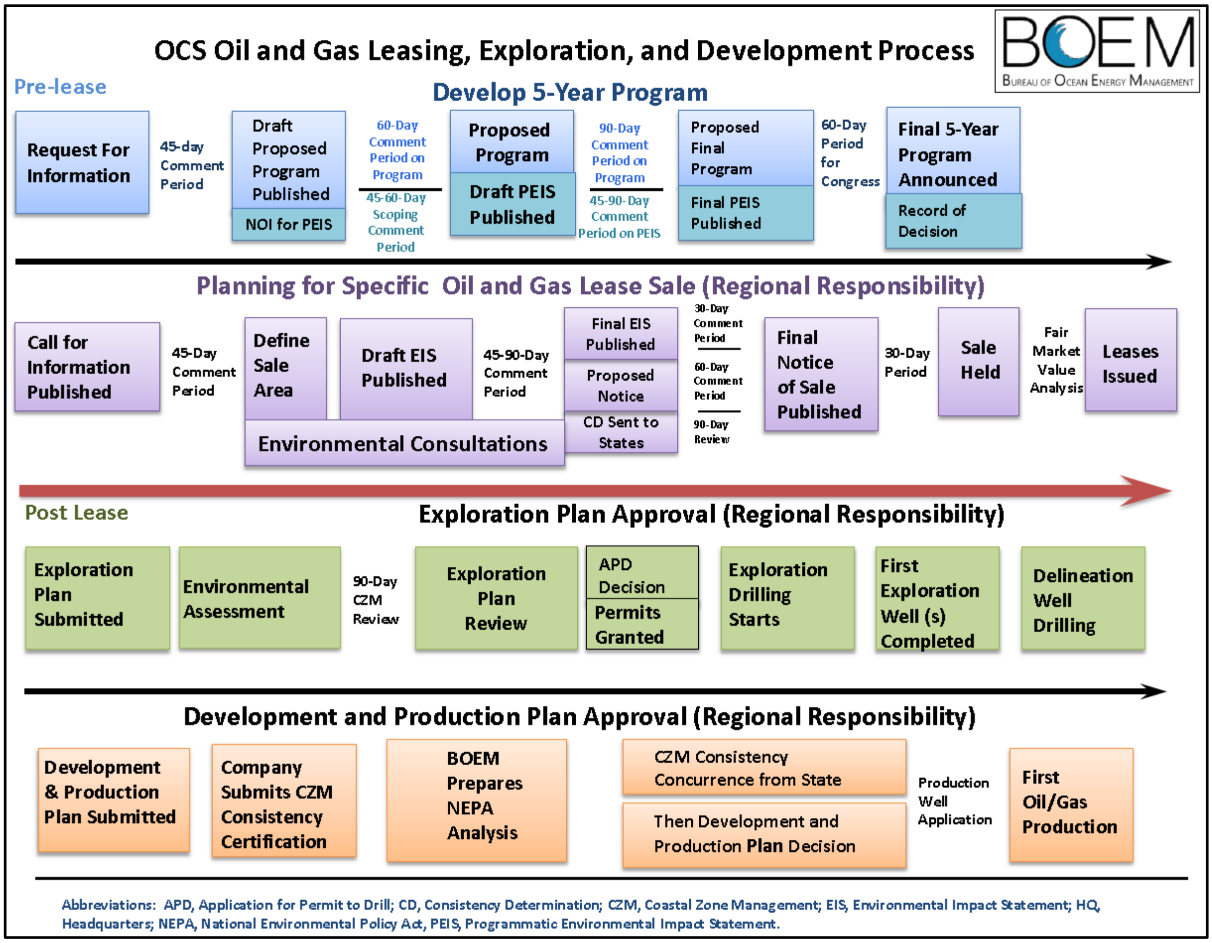

Figure 1-3 Four Stages of the OCSLA Oil and Gas Process

1.4.1.2 Lease Stipulations

HAK must abide by the requirements of lease stipulations associated with the three Federal leases which make up the Liberty Unit. These leases were issued under three separate lease sales: Beaufort Sea Planning Area Lease Sale 124 (Lease OCS-Y-1585) (USDOI, MMS, 1990), Beaufort Sea Planning Area Lease Sale 144 (Lease OCS-Y-1650) (USDOI, MMS, 1996) and Beaufort Sea Planning Area Lease Sale 202 (Lease OCS-Y-1886) (USDOI, MMS, 2003; 2006). In general, the stipulations for the three lease sales are the same. See Appendix C for further detail on Lease Sale 124, 144, and 202 stipulations.

1.4.1.3 NEPA

NEPA (42 USC 4321 et seq.) requires Federal agencies to use a systematic, interdisciplinary approach to analyzing the environmental impact of major Federal Actions. This approach ensures integration of natural and social sciences in any planning and decision-making that may have an impact on the environment. In furtherance of these policies, NEPA also requires Federal agencies to prepare a detailed EIS on any major Federal action that may have a significant impact on the environment. An EIS must analyze any adverse environmental effects that cannot be avoided or mitigated, alternatives including the Proposed Action, the relationship between short-term uses and long-term productivity of the environment, and any irreversible and irretrievable commitments of resources. In 1979, the Council on Environmental Quality established uniform procedures for implementing NEPA. These regulations (40 CFR Section 1500–1508) provide for the use of the NEPA process to identify and assess the alternatives to proposed actions that avoid and minimize adverse effects on the human environment. The USDOI regulations implementing NEPA are at 43 CFR Part 46.

All of BOEM's cooperating Federal agencies—including BSEE, EPA, USACE, NMFS, and USFWS—are also bound by NEPA.

1.4.2 EPA Regulatory Authorities

1.4.2.1 Clean Water Act (CWA)

Section 301(a) of the of the CWA provides that the discharge of pollutants to surface waters of the United States is prohibited except in accordance with a National Pollutant Discharge Elimination System (NPDES) permit. Section 402 of the Clean Water Act and the regulations at 40 CFR Parts 122, 124, and 125 establish the NPDES permit program, which provides the EPA and the authorized states the authority to control and limit the discharge of pollutants into waters of the United States. HAK has applied for a NPDES permit for the discharge of waste streams associated with the Liberty Development and Production Island (LDPI). The LDPI is located 4.78 nautical miles offshore in Federal waters of the OCS; therefore the EPA is the NPDES permitting authority.

1.4.2.1.1 Ocean Discharge Criteria Evaluation

In addition, Section 403(c) of the CWA requires that NPDES permits authorizing discharges into the territorial seas, the contiguous zones, and the oceans, including the outer continental shelf, comply with EPA's Ocean Discharge Criteria (40 CFR Part 125, Subpart M). The purpose of the Ocean Discharge Criteria Evaluation (ODCE) is to assess the discharges authorized under the NPDES permit and to evaluate the potential for unreasonable degradation of the marine environment based on the consideration of ten specific criteria.

The ten criteria are specified at 40 CFR Part 125.122, Determination of Unreasonable Degradation of the Marine Environment. The Director shall determine whether a discharge will cause unreasonable degradation of the marine environment based on consideration of:

- The quantities, composition, and potential for bioaccumulation or persistence of the pollutants to be discharged;
- The potential transport of such pollutants by biological, physical or chemical processes;
- The composition and vulnerability of the biological communities which may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain;
- The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions or critical stages in the life cycle of an organism;
- The existence of special aquatic sites including, but not limited to marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas and coral reefs;
- The potential impacts on human health through direct and indirect pathways.
- Existing or potential recreational and commercial fishing, including finfishing and shellfishing;
- Any applicable requirements of an approved Coastal Zone Management plan;
- Such other factors relating to the effects of the discharge as may be appropriate; and
- Marine water quality criteria developed pursuant to section 304(a)(1).

New Source Performance Standards

Discharges to surface waters of the United States associated with the oil and gas extraction point source category are regulated under 40 CFR Part 435, Subparts A-D, which were promulgated in 1979. Effluent limitation guidelines and new source performance standards for the offshore subcategory of the oil and gas extraction point source category were amended on January 15, 1993 and became effective on March 4, 1993 (40 CFR 435, Subpart A; 58 FR 12454). New oil and gas development and production operations where construction commenced after the effective date of applicable new source performance standards (NSPS) are considered new sources.

40 CFR Section 122.2 defines "new source" as follows:

> New Source means any building, structure, facility or installation from which there is or may be a "discharge of pollutants," the construction of which is commenced:
>
> a. After promulgation of standards of performance under Section 306 of the CWA which are applicable to such source, or
> b. After proposal of standards of performance in accordance with Section 306 of the CWA which are applicable to such source, but only if the standards are promulgated in accordance with Section 306 within 120 days of their proposal.

The regulations at 40 CFR Section 122.29(b)(4) define what constitutes "construction" of a new source, stating that:

> "Construction has commenced if the owner or operator has:
>
> (i) Begun, or caused to begin as part of a continuous on-site construction program:
>
> (A) Any placement assembly, or installation of facilities or equipment; or
>
> (B) Significant site preparation work including clearing, excavation or removal of existing buildings, structures, or facilities which is necessary for placement, assembly, or installation of new source facilities or equipment; or
>
> (ii) Entered into a binding contractual obligation for the purchase of facilities or equipment intended to be used in its operation with a reasonable time."

Chapter 2 provides a more detailed discussion of EPA's regulatory authority for the Proposed Action and the Alternatives.

1.4.3 USACE Regulatory Authorities

The proposed project requires Federal Action (i.e., a permit) under three USACE regulatory authorities, in addition to Section 4(f) of OCSLA, which addresses construction of artificial islands on the seabed to the seaward limit of the outer continental shelf. USACE jurisdiction over an artificial island in OCS on "lands" under mineral lease from MMS (now BOEM) is limited to the evaluation of impacts to navigation and national security, 33 CFR Section 322.5(f).

1.4.3.1 CWA

Section 404 (b) of the Clean Water Act contains the guidelines for specification of disposal sites for dredged or fill material into waters of the United States (33 USC Sections 1344 and 1362) (pipeline in territorial sea, gravel material site in wetlands, vertical support members [VSMs] and gravel pads supporting pipeline construction in wetlands). In summary, dredge or fill material shall not be permitted if it violates any applicable State water quality standard; violates any applicable toxic effluent standard; jeopardizes the continued existence of species listed as threatened or endangered; or violates any marine sanctuary protection requirements.

1.4.3.2 Rivers and Harbors Act (RHA) of 1899

Section 10 of the RHA (commonly referred to as the Rivers and Harbors Act) addresses the construction or modification of structures in navigable waters, or the accomplishment of any other work affecting the course, location, condition, or physical capacity of navigable waters (33 USC Section 403).

Section 10 of the RHA would also apply to the construction of the pipeline in water on the OCS and in territorial seas.

1.4.3.3 Marine Protection, Research, and Sanctuaries Act of 1972 (as amended)

Section 103 of the Marine Protection, Research, and Sanctuaries Act addresses the transport of dredged material for the purpose of ocean disposal (33 USC Section 1413). This would be applicable if the applicant proposes to discharge materials excavated for the construction of the pipeline in the territorial seas, elsewhere in the territorial seas.

1.4.4 NMFS Regulatory Authorities

1.4.4.1 Marine Mammal Protection Act (MMPA)

Under the MMPA (16 USC Section 1361 *et seq.*), the taking of marine mammals without a permit or exception is prohibited. The term, "take" under the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The MMPA defines "harassment" as "any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment]".

In order to obtain an exemption from the MMPA's prohibition on taking marine mammals, a citizen of the U.S. who engages in a specified activity (other than commercial fishing) within a specified geographic region must obtain an Incidental Take Authorization (ITA) under Section 101(a)(5)(A) or (D) of the MMPA. An ITA shall be granted if NMFS finds that the taking of small numbers of marine mammals of a species or stock by such citizen will have a negligible impact on the affected species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for taking for subsistence uses. NMFS or USFWS must base its findings on the best scientific information available (50 CFR Part 216.102(a)). NMFS or USFWS shall also prescribe, where applicable, the permissible methods of taking and other means of affecting the least practicable adverse impact on the species or stock and its habitat (i.e. mitigation, monitoring and reporting of such takings). ITAs may be issued as either (1) regulations and associated Letters of Authorization (LOAs) or (2) Incidental Harassment Authorizations (IHAs). IHAs can be issued only when there is no potential for serious injury and/or mortality or where any such potential can be negated through required mitigation measures. If the analysis of a specific proposal indicates the potential for death or serious injury of marine mammals and that potential cannot be negated through the inclusion of mitigation measures, then NMFS would not issue an IHA and would consider issuing regulations and associated LOA, which allow for "take" of marine mammals by serious injury or mortality.

NMFS has defined "negligible impact" in 50 CFR § 216.103 as "... an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival." Additionally, NMFS has defined "unmitigable adverse impact" in 50 CFR Section 216.103 as:

> …an impact resulting from the specified activity: (1) That is likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: (i) Causing the marine mammals to abandon or avoid hunting areas; (ii) Directly displacing subsistence users; or (iii) Placing physical barriers between the marine mammals and the subsistence hunters; and (2) That cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met.

1.4.4.2 Endangered Species Act (ESA)

Section 7 (16 USC Section 1536) of the ESA states that all Federal agencies shall, in consultation with, and with the assistance of the Secretary of the Interior or Commerce (Secretary), ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species, which is determined by the Secretary to be critical. Section 9 (16 USC Section 1538) of the ESA identifies prohibited acts related to endangered species and prohibits all persons, including all Federal, state and local governments, from taking listed species of fish and wildlife, except as specified under provisions for exemption (16 USC Sections 1535(g)(2) and 1539). Generally, the USFWS manages land and freshwater species while NMFS manages marine species, including anadromous salmon. However, the USFWS has responsibility for some marine animals such as nesting sea turtles, walrus, polar bears, sea otters, and manatees.

For actions that may result in prohibited "take" of a listed species, Federal agencies must obtain authorization for incidental take through Section 7 of the ESA's formal consultation process. Under the ESA, "take" means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct" to species listed as threatened or endangered in 16 USC Section 1532(19). NMFS has further defined harm as follows: "harm" is "…an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering" (50 CFR 222.102). NMFS has not defined the term "harass" under the ESA.

Under Section 7 of the ESA, Federal agencies consult with the USFWS and/or NMFS and submit a consultation package for proposed actions that may affect listed species or critical habitat. If a listed species or critical habitat is likely to be affected by a proposed Federal action, the Federal agency must provide the USFWS and NMFS with an evaluation whether or not the effect on the listed species or critical habitat is likely to be adverse. The USFWS and/or NMFS uses this documentation along with any other available information to determine if a formal consultation or a conference is necessary for actions likely to result in adverse effects to a listed species or its designated critical habitat. If a Federal action is likely to adversely affect endangered or threatened species or designated critical habitat, then USFWS and/or NMFS prepares a Biological Opinion (BO), which makes a determination as to whether the action is likely to jeopardize an endangered or threatened species. If take is anticipated, the USFWS and/or NMFS must also issue an Incidental Take Statement, which includes terms and conditions and reasonable and prudent measures which must be followed.

1.4.4.3 Magnuson-Stevens Fishery Conservation and Management Act

Federal agencies are required to consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect essential fish habitat identified under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).

1.4.5 USFWS Regulatory Authorities

USFWS has authority under ESA and MMPA similar to that described above for NMFS. Generally, the USFWS manages land and freshwater species, and NMFS manages marine species, although there are some exceptions as described above. The USFWS also has authority under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to regulate and/or permit, if appropriate, the take or destruction of bird nests, eggs, and nestlings.

1.4.6 PHMSA Statutory Authority

The Pipeline and Hazardous Materials Safety Administration, or PHMSA, is a U.S. Department of Transportation (USDOT) agency. It was created under the Norman Y. Mineta Research and Special Programs Improvement Act (P.L. 108-426) of 2004 (https://www.phmsa.dot.gov/about/faq). PHMSA Regulations pertaining to pipeline safety are specified in 49 CFR Parts 190-199.

1.4.7 SOA Regulatory Requirements

The State of Alaska has regulatory, statutory, and permitting authority over waters and lands on the North Slope, (including submerged lands of the Beaufort Sea), other than those that are part of native allotments. The SOA would have permitting authority over several actions associated with the Liberty Development that would occur subsequent to BOEM’s approval of Proposed Action or one of the Alternatives analyzed in this EIS. These actions include, but are not limited to, the construction of onshore ice roads and ice pads, gravel use, and any construction associated with the trench and pipeline in State waters. The State would coordinate the approval of these actions across its agencies and determine whether to approve or deny permits and leases for use of State land. As part of this process, the State will apply additional mitigation measures for the protection of wildlife, air and water quality, and subsistence practices. The State would also participate in reviews of any other necessary plans or authorizations required by the project.

1.4.8 BSEE Regulatory Authorities

BSEE is responsible for regulating and monitoring oil and gas operations on the Federal OCS, promoting safety, and protecting the environment. BSEE Regulations applicable to oil, gas, and sulfur lease operations on the OCS are specified in 30 CFR Part 250. Oil spill preparedness and response rules are specified in 30 CFR Part 254.

The following subsections briefly describe several means through which BOEM and BSEE regulate OCS activities.

1.4.9 BSEE Permitting Responsibilities and Oversight

1.4.9.1 Pipelines

Regulatory authority over pipelines on the OCS and in coastal areas is shared by several Federal agencies, including USDOI (which includes BOEM and BSEE), the USDOT, the Federal Energy Regulatory Commission (FERC), and the U.S. Coast Guard (USCG). The State of Alaska (SOA) has regulatory authority for pipelines shoreward of 3 nautical miles. SOA standards and regulations would also be applicable when OCS pipelines tie into shore-based facilities, pump stations, or other pipelines when facilities, pump stations, or other pipelines are located in state-owned waters or tidelands within the 3 nautical mile state boundary. For the Liberty project, the primary pipeline oversight will be provided by USDOT and SOA.

1.4.9.2 Best Available and Safest Technology Requirements

To ensure all oil and gas exploration, development, production, and decommissioning activities on the OCS are conducted in a safe and environmentally responsible manner, OCSLA requires that all OCS technologies and operations use the best available and safest technology that the Secretary determines to be economically feasible. These include, but are not limited to, requirements for:

- State-of-the-art drilling technology
- Production-safety systems
- Well control
- Completion of oil and gas wells
- Oil spill response plans (OSRPs)
- Pollution control equipment
- Specifications for platform/structure designs

1.4.9.3 Technical and Safety Review

The lessee must design, fabricate, install, use, inspect, and maintain all platforms and structures on the OCS to ensure their structural integrity for the safe conduct of operations at specific locations. Applications for platform design and installation are filed with BSEE for review and approval.

Production-safety equipment used on the OCS must be designed, installed, used, maintained, and tested in a manner that ensures the safety and protection of the human, marine, and coastal environments. All tubing installations open to hydrocarbon-bearing zones below the surface must be equipped with safety devices that would shut off the flow from the well in the event of an emergency, unless the well is incapable of flowing. “Incapable of flowing” means that in order to produce hydrocarbons from the well, artificial means would be required using mechanical pumps. All surface production facilities must be designed, installed, and maintained in a manner that provides for efficiency, safety of operations, and protection of the environment.

BSEE will provide for the inspection and oversight of the design and drilling of all wells for the Liberty project. Each well will need to have an approved Application for Permit to Drill (APD) in order for Hilcorp to initiate the drilling of each individual well. BSEE’s review will determine whether the well design meets BSEE regulatory requirements as well as what special requirements or conditions may be necessary while drilling takes place. Once drilling begins, BSEE will conduct appropriate inspections and oversight of the operation both onsite as well as through review of daily reporting by the operator.

1.4.9.4 Pollution Prevention and Oil Spill Response

Safety and prevention of pollution, including accidental oil spills, is the primary focus of BSEE OCS operating regulations. Pollution-prevention regulatory requirements for oil, gas, and sulphur operations in the OCS are in 30 CFR 250, Subpart C – Pollution Prevention and Control. These regulations require operators that engage in activities such as exploration, development, production, and transportation of oil and gas to prevent unauthorized discharge of pollutants into offshore waters. Operators shall not create conditions that would pose unreasonable risks to public health, life, property, aquatic life, wildlife, recreation, navigation, commercial fishing, or other uses of the ocean. These regulations further mandate that the operator conduct daily inspections of drilling and production facilities to determine if pollution is occurring. If problems are detected, maintenance or repairs must be made immediately.

In compliance with 30 CFR Part 254, all owners and operators of oil handling, oil storage, or oil transportation facilities located seaward of the coastline must submit an OSRP to BSEE for approval, and maintain the OSRP until the facility is physically removed or dismantled. Owners or operators of offshore pipelines are required to submit a plan for any pipeline that carries oil, condensate that has been injected into the pipeline, or gas with naturally occurring condensate. Pipelines carrying essentially dry gas do not require a plan. A response plan must be submitted before an owner/operator may use a facility. To continue operations, the facility must be operated in compliance with the approved plan. As a general rule, OSRPs must be updated and re-submitted for BSEE approval every two years. Revisions to a response plan must be submitted to BSEE within 15 days whenever any of the following occur:

- A change occurs that significantly reduces an owner/operator's response capabilities
- A significant change occurs in the worst-case discharge scenario or in the type of oil being handled, stored, or transported at the facility
- There is a change in the name or capabilities of the oil spill removal organizations cited in the plan
- There is a significant change in the appropriate area contingency plans

To ensure plan holder readiness, BSEE will conduct routine inspections of the operator's response resources to ensure that the identified spill response equipment is readily available and in the quantities and condition described in the OSRP. BSEE also will conduct government initiated unannounced exercises (GIUE) to test the operator's ability to carry out the provisions of the OSRP. Additional information about oil spill response and exercise requirements can be found in Chapter 4 (Section 4.1.1.2).

1.4.9.5 Inspection Program

Under the direction of the BSEE Alaska OCS Region, the BSEE inspection program provides review and inspection of oil and gas operations. BSEE conducts on-site inspections to ensure compliance with lease terms, Notices to Lessees, approved plans, and to ensure that safety and pollution-prevention requirements of regulations are met. These inspections involve items of safety and environmental concern. Further information on the baseline for the inspection of lessee operations and facilities is in the National Office Potential Incident of Noncompliance (PINC) List (USDOI, BSEE, 2013a).

The purpose of the inspection program is to ensure that an oil and gas facility complies with the regulations and that the lessee is conducting operations in accordance with the regulations and approved permits. For the Liberty project, BSEE will tailor its inspection strategy to the scope and nature of the activities described in the Development and Production Plan. BSEE Alaska OCS Region conducts inspections of existing OCS development and production facilities several times a year. BSEE conducts on-site inspections of many critical operations such as testing of blowout preventer (BOP) equipment, testing of various well stages of well installation, installation and testing of production systems, and many other items. The BSEE Alaska OCS Region has the authority and will issue an Incident of Non-Compliance (INC) (a documented and recordable action) when a violation is found, and may shut-in (deactivate a piece of equipment or shut-down the offshore facility) any activity that is not in compliance with regulations or the approved permit. BSEE has a range of enforcement mechanisms to address regulatory violations, most notably issuing Incidents of Noncompliance, levying civil penalties, and shutting in components or facilities.

1.4.9.6 Structure Removal and Site Clearance

Lessees/operators have one year from the time a lease is terminated to plug and abandon all wells and remove all structures from a leased area (30 CFR 250.1700 through 250.1754). BSEE requires lessees to submit a procedural plan for site-clearance verification. Lessees must ensure all objects related to their activities are removed following termination of their lease. All surface equipment to a depth of 15 feet below mudline will be removed.

1.4.9.7 Training Requirements for Offshore Personnel

Proper training is important for ensuring that OCS oil and gas operations are carried out in a manner that emphasizes operational safety and minimizes the risk of environmental damage. Industry offshore personnel are required to have well control and production safety training, though training is job dependent and not everyone on the platform may have training in all aspects of the work conducted at the facility (30 CFR 250.1500-1510).

1.4.9.8 Safety and Environmental Management Systems (SEMS)

BSEE requires companies to develop, implement, and maintain a Safety and Environmental Management System (SEMS) program to promote safety and environmental protection. This program identifies, addresses, and manages safety, environmental hazards, and impacts during the design, construction, start up and operations to be conducted on the Outer Continental Shelf. The program also ensures that all personnel involved with the program receive appropriate training to perform their assigned duties. See 30 CFR 250 subpart S for more information.

Proposed Action and Alternatives

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CHAPTER 2. PROPOSED ACTION AND ALTERNATIVES

This chapter describes the Proposed Action and Alternatives analyzed in this Final Environmental Impact Statement (FEIS) and identifies BOEM's Preferred Alternative.

This chapter also includes a discussion of Alternatives that were considered but not analyzed in detail and concludes with a proposed mitigation measure that would apply to all action Alternatives.

Table 2-5 through Table 2-9 compare aspects of the Proposed Action and Alternatives described in this chapter.

2.1 Proposed Action

HAK's proposed Liberty DPP provides the basis of the Proposed Action analyzed in this EIS. HAK proposes to construct the Liberty Development and Production Island (LDPI) to recover petroleum reserves from three Federal leases (OCS-Y-1650, OCS-Y-1585, and OCS-Y-1886) in Foggy Island Bay in the Beaufort Sea, northeast of the Prudhoe Bay Unit and east of the Duck Island Unit.

The schedule for the Liberty Project is described below. Multiple activities occur concurrently and would use the same access vehicles/vessels. The type of equipment used for island construction and support activities, such as ice road construction and pipeline installation, is described in Appendix B of a document entitled "Underwater and Airborne Noise Modelling" (SLR, 2017), which was provided by HAK.

Table 2-1 Liberty Timeline[1]

CONSTRUCTION OPERATIONS (Year 1 – Year 4)	
Activity	**Timing**
Summer & Winter Access	Year 1 – Year 4
Ice Road[2]	Year 1 – Year 4, December – May[4]
Hovercraft & Amphibious Vehicles	Year 2 – Year 4, January - December
Sea-going Barges	Year 2 – Year 4, June - November
Small Marine Vessels	Year 2 – Year 4, June - November
Gravel Mine Site Development & Island Construction[2]	Year 2, January – September
	Year 3, January – September[4]
Pile Driving	Year 2, March – August
Facilities Construction	Year 2, January – Year 4, May
Pipeline Construction (onshore and offshore)	Year 3, January – May
DRILLING OPERATIONS (Year 3 – Year 6)[4]	
Activity	**Timing**
Summer & Winter Access	Year 3 – Year 6
Annual Ice Road (#1)[2,7]	Year 3 – Year 6, January – May, *additional lanes*
Hovercraft & Amphibious Vehicles	Year 3 – Year 6, January – December
Sea-going Barges	Year 3 – Year 6, June – November
Small Marine Vessels	Year 3 – Year 6, June – November
Drilling Operations	Year 3 – Year 6
Rig Mobilization	Year 3, July – August
Rig Support Mobilization	Year 3, August – September/October

Rig Installation, Commissioning	Year 3, August – November
Drilling Operations[5]	Year 3 – 6, January – December
First Oil/Commissioning	Year 5, January
PRODUCTION OPERATIONS (Year 5 – 23)	
Activity	**Timing**
Production Operations	Year 5 – Year 23
Summer & Winter Access	Year 5 – Year 23
Annual Ice Road (#1)[2]	Year 5 – Year 23, December – May[4]
Hovercraft & Amphibious Vehicles	Year 5 – Year 23, January – December
Sea-going Barges[7]	Year 5 – Year 23, June – November, *about once every 5 years*
Small Marine Vessels	Year 5 – Year 23, June – November
Drilling Operations[5]	Year 6 – 23, January – December
DECOMMISSIONING (Year 24 – 25)	
Activity	**Timing**
Summer & Winter Access	Year 24 – Year 25
Ice Roads (#1,2,4)[2]	Year 24 – Year 25, December – May
Hovercraft & Amphibious Vehicles	Year 24 – Year 25, January – December
Sea-going Barges	Year 24 – Year 25, June – November
Small Marine Vessels	Year 24 – Year 25, June – November
Island, Pipeline and Facilities Removal	Year 24 – Year 25
Pile Removal	Year 25, January – December

Notes: 1. Dates in BOEM’s project schedule do not align with HAK’s DPP because BOEM does not distinguish between “Evaluate” and “Execute” years as HAK does.
2. Date ranges include construction, maintenance and general use of the ice roads.
3. Island construction includes gravel deposition (limited to periods when ice-road is intact), slope shaping and armament installation.
4. Liberty Drilling and Production Island construction may occur over two winter seasons, as ice conditions allow.
5. BOEM assumes 10 (disposal, injection and production) wells will be drilled during this time.
6. BOEM assumes up to 6 (disposal, injection and production) wells will be drilled during this time, as necessary.
7. Additional information is noted in Italics.

Details about the proposed LDPI:

- Located approximately 5 miles north of the Kadleroshilik River and 7.3 miles southeast of the existing Endicott Satellite Drilling Island (SDI).
- Built in approximately 19 feet of water with the elevation of the top of the LDPI +15 feet above Mean Lower Low Water (MLLW) level.
- Work surface of approximately 9.3 acres.
- Seabed footprint would be approximately 24 acres.
- Design life and associated infrastructure is approximately 25 years, as shown in Table 2-1.

The proposed LDPI location is shown in Figure 2-1.

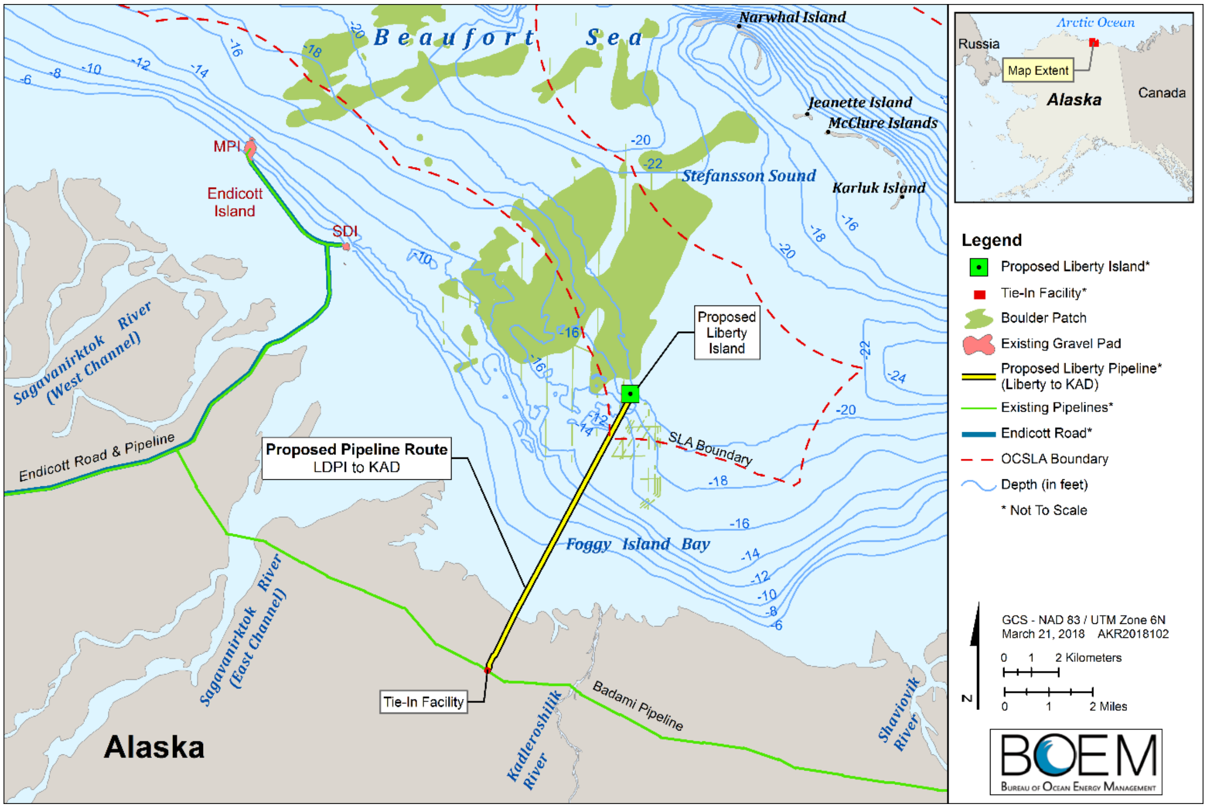

Figure 2-1 Proposed Action Area

Associated onshore facilities and activities to support the project would include construction and development of:

- Ice roads;
- Gravel pads;
- Ice pads;
- A hovercraft shelter and small boat dock; and
- A gravel mine site west of the Kadleroshilik River.

Existing North Slope infrastructure, including the Deadhorse Airport, West Dock, the Trans-Alaska Pipeline System (TAPS), and the Dalton Highway would be used to support this project.

General project information is available in Section 2 of the DPP. Additional information on the project schedule is available in the DPP, Section 3.2, Project Execution Phase.

2.1.1 Winter and Summer Access

2.1.1.1 Ice Road Construction

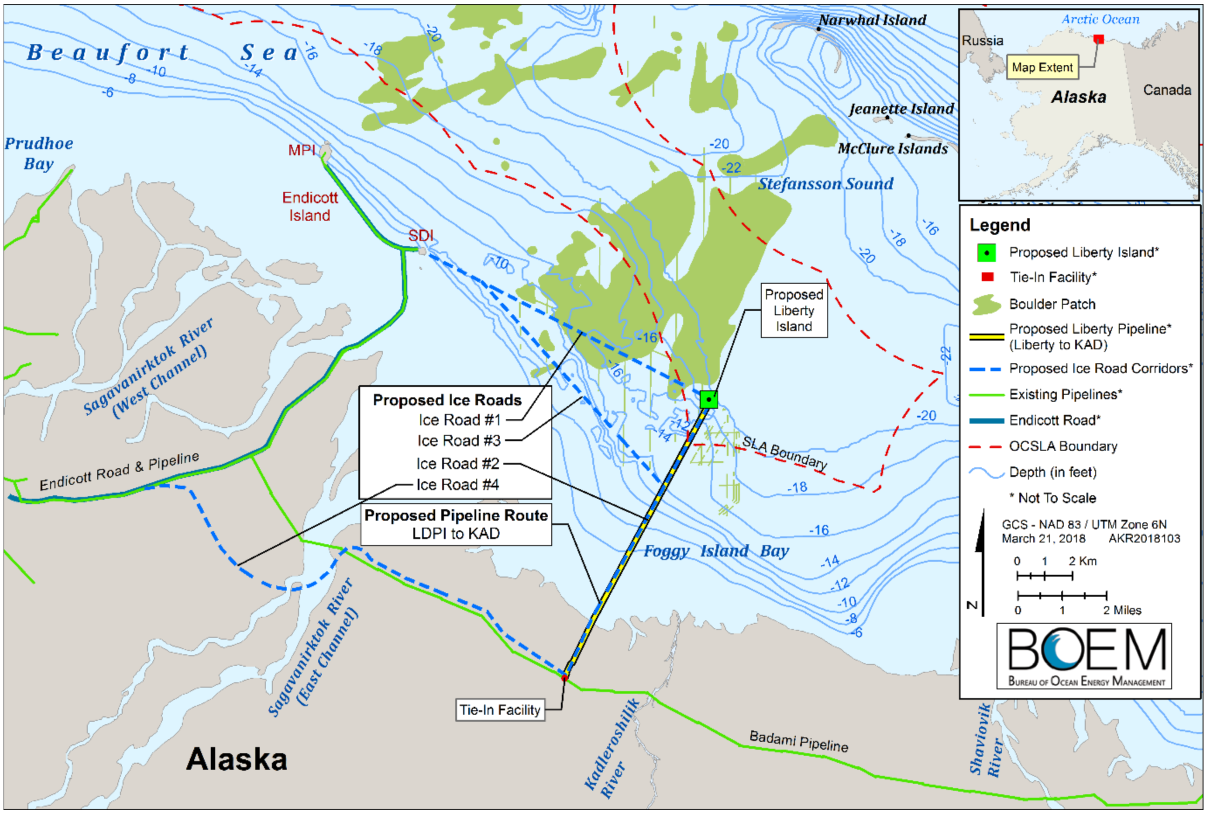

Figure 2-2 Proposed Ice Road Routes

HAK proposes to construct four ice roads to support construction operations (Figure 2-2):

Ice road #1 (annual ice road between Endicott SDI and LDPI):

- Approximately 7 miles long
- Approximately 120 feet wide with a driving lane width of 40 feet
- Between 70 inches and 96 inches thick
- Would cover approximately 160 acres of sea ice in total

Ice road #2 (connecting the LDPI to the mine site and Badami Ice Road juncture):

- Approximately 7 miles long
- Approximately 50 feet wide
- Approximately 6 inches thick onshore

Ice road #3 (midpoint access road built on grounded sea ice):

- Approximately 6 miles long
- Approximately 40 feet wide
- Between 70 inches and 96 inches (8 feet) thick

Ice road #4 (Badami ice road):

- Approximately 12 miles long
- Approximately 30 feet wide
- Approximately 6 inches thick

Typically, ice roads constructed on the tundra to access water sources would be approximately 6 inches thick with a traveled surface width of approximately 30 feet. The actual width and depth of the ice in a given year would be based upon that year's activities and the required loads.

Ice roads (#1, #2 and #4) would be constructed in Year 1 and Year 2 to support transportation from existing North Slope roads to the proposed gravel mine site, and from the mine site to the proposed LDPI location in the Beaufort Sea.

Ice roads (#1 through #4) would be reconstructed in Year 2 and Year 3 to support the pipeline installation, including the offshore section from the shore crossing to LDPI, and the onshore portion that includes the tie-in to the Badami pipeline. Both sections of the pipeline would require access via an ice road system for construction.

Additional ice roads (along #1 corridor) from Endicott SDI would be constructed in Years 2 through 5 to allow additional materials and equipment to be mobilized to support LDPI, pipeline, and facility construction activities.

An ice road (#1) connecting Endicott SDI to the LDPI is expected to be constructed annually to support production operations in Years 6 through 23 for LDPI resupply and personnel transport.

The State of Alaska is responsible for permitting winter travel, ice road construction, temporary water withdrawal from existing (rehabilitated) mine sites and tundra ponds for onshore ice road construction, and the water discharge to create ice roads.

HAK currently holds a general permit (#LAS 29963) for ice road and ice pad construction on all State owned lands on the Alaska North Slope bordered by the Canning River to the east, the Colville River to the west, and the Brooks Range to the south. To maintain this permit, HAK must submit an annual application that includes ice road location, anticipated schedule of operations, and a list of vehicles/equipment used for travel. The Bureau of Ocean Energy Management (BOEM) assumes that ice road and ice pads would be constructed under this (or similar) permit regulated by the State of Alaska.

HAK does not anticipate mechanized on-ice travel without the use of ice roads. For the purpose of this analysis, BOEM assumes that there would be no travel across shorefast ice or tundra without the use of ice roads.

HAK proposes to construct approximately 32 miles of ice roads during the construction phase. Ice roads are best constructed when weather is -20ºF to -30ºF, but temperatures below 0ºF are considered adequate for ice road construction. Ice road construction can typically be initiated in mid- to late-December and roads maintained until mid-May. At the end of the season, ice roads will be barricaded by snow berm and/or slotted at the entrance to prevent access and allowed to melt naturally.

HAK proposes to use seawater to construct the offshore ice roads. Construction would follow these steps:

- Clear away snow
- Smooth/grade ice (surface rubble ice would be incorporated into or moved outside the expected road surface, approximately 200 feet either side of the center line)

- Pump seawater from holes drilled through floating ice
- Flood the ice road

Flooding techniques are dependent on the conditions of the sea ice; grounded ice typically requires limited flooding with fresh water to either cap or repair cracks. Floating ice requires flooding with seawater until the desired thickness is achieved (determined by the required strength and integrity of the ice). Once this thickness is achieved, floating ice roads may then be flooded with fresh water to either cap or repair cracks. This technique minimizes the usage of fresh water.

Ice roads across tundra are constructed after the soil is frozen and there is adequate snow cover. Ice rubble is knocked down into the planned road path and rough areas are flooded as needed to allow tracked vehicles and rolligons to travel the road.

Ice road construction would be done in accordance with the applicable Mitigation Measures in Appendix C. More information on ice roads is available in the DPP in Section 5.1.2, Ice Roads, Section 5.1.5, Surface Transportation, and Section 5.2, Access by Project Phase.

2.1.1.1.1 Ice Pad Construction

Three ice pads are proposed to support construction activities. These would be used to support LDPI, pipeline, (including pipe stringing and two stockpile/disposal areas) and facilities construction. A fourth staging area ice pad (approximately 350 feet by 700 feet) would be built on the sea ice on the west side of the LDPI during production well drilling operations.

More information on ice pads is available in the DPP in Section 10.1, Ice Roads.

2.1.1.2 Winter Transportation Estimates

HAK would utilize ground vehicles (heavy duty diesel trucks, light duty diesel pickup trucks, trimmers, tractors, loaders, and excavators, etc.) during periods when ice roads can be constructed and used. Surface transportation to the onshore pipeline would be via ice roads in winter and by approved tundra travel vehicles in summer (Table 2-2). The largest volume of traffic is anticipated to occur during gravel hauls to create the LDPI.

Table 2-2 Projected Surface Vehicle Traffic

Estimated Fuel Capacity (Gallons) / Vehicle	Island, Pipeline & Facilities Construction [Years 1 – 4] (Trips)	Drilling & Production Operations [Years 2 – 6] (Trips)	Production Operations [Years 6 – 23] (Trips)	Decommissioning [~Years 24-25]
80	21,000 per season	400 per season	100 per season	21,000 per season

2.1.1.3 Summer Transportation Estimates

HAK proposes to use barges, hovercraft, or small vessels to transport equipment, personnel and supplies to the LDPI from West Dock or Endicott SDI during the open water season. Large barges and tugs, transiting through Dutch Harbor to the LDPI, or, alternatively, from West Dock or Endicott SDI to the LDPI, would be used to transport large equipment (i.e. drilling rig) and supplies. Most construction materials would be transported via barge from West Dock or Endicott SDI to the LDPI.

Hovercraft would transport personnel and small loads during shoulder seasons when ice roads and open-water vessel support are not available. Amphibious vehicles would be used for emergency evacuation from the LDPI.

The marine transit route from West Dock to LDPI is approximately 25 miles. Endicott SDI to LDPI is approximately 8 miles.

Table 2-3 provides descriptions of the types of offshore vessels that are anticipated to be used within 25 miles of the LDPI during construction, drilling and production operations. Figure 2-3 and Figure 2-4 illustrate the general marine traffic routes described in this section.

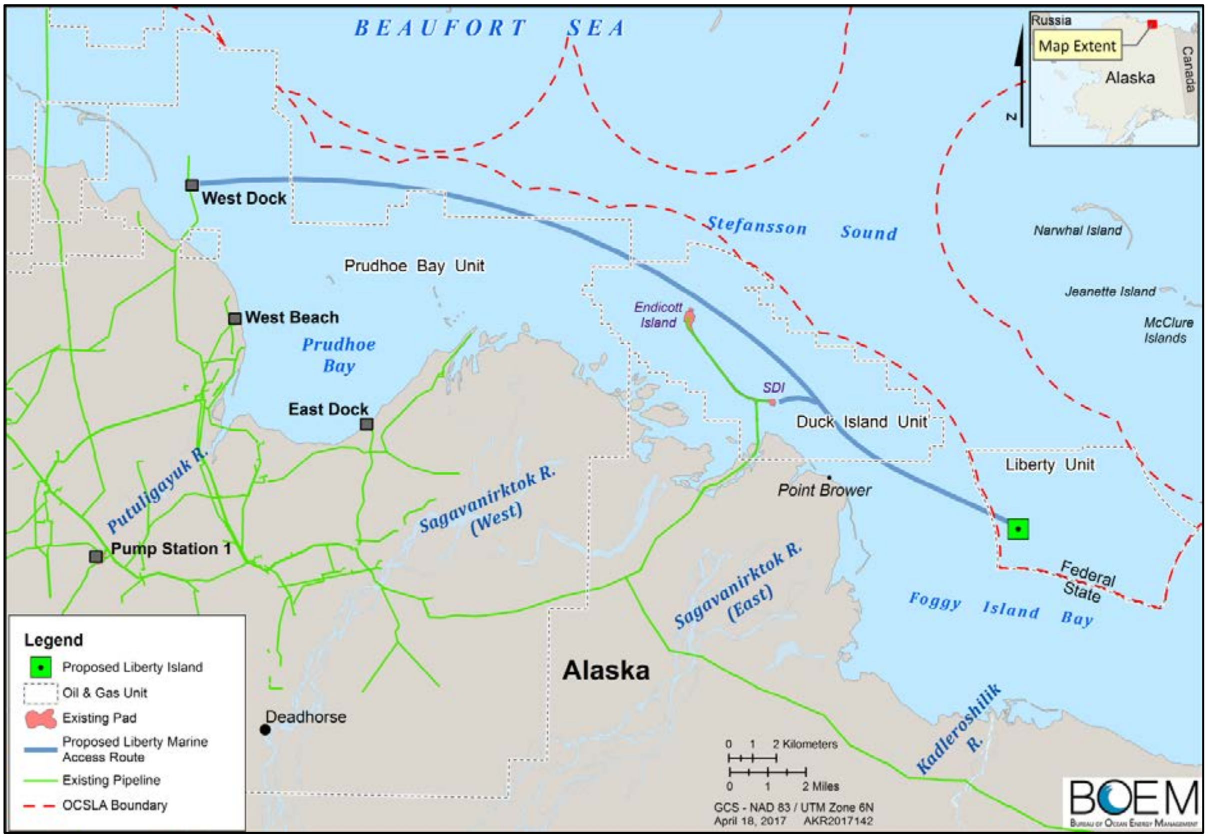

Figure 2-3 Marine Traffic Route, West Dock and Endicott SDI to LDPI

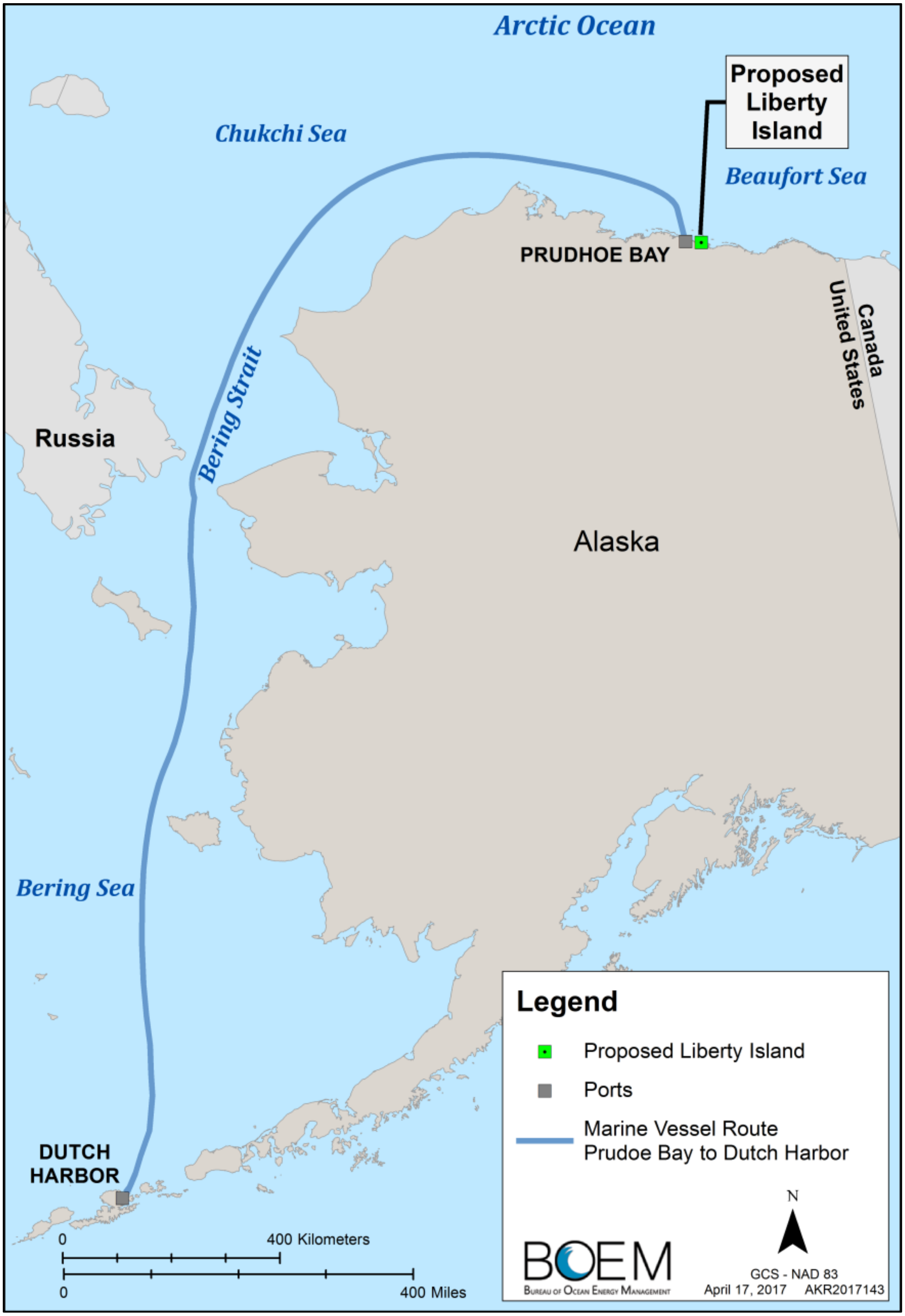

Figure 2-4 Marine Traffic Route, Dutch Harbor to LDPI

Table 2-3 Marine Traffic and Vessel Types

Mode	Number of Vessels	Estimated Fuel Capacity (Gallons)	Island, Pipeline & Facilities Construction [Years 1 – 4] (Trips)	Drilling & Production Operations [Years 3 – 6] (Trips)	Production Operations [Years 6 – 23] (Trips)
Seagoing Barge	1 to 2	Not Applicable	2-5/year	1/ 5 years	1/ 5 years
Ocean Class Tug	1 to 2	252,000	2-5/year	1/ 5 years	1/ 5 years
Coastal Barge	1 to 2	700	3/day	20/year	10/year
Assist Tug	1 to 2	22,000	3/day	20/year	10/year
Crew Boat	1 to 2	300	12/day	2/day	90/year
Bathymetry Vessel (Ancillary Activity)	1	300	1 survey	1/year	1/year
Hovercraft	1	250	3/day	2/day	2/day
Amphibious Vehicles	2	--0	--0	As needed	As needed

HAK plans to use helicopters year round (weather/visibility conditions permitting) to access the LDPI. Helicopters would also be used for pipeline surveillance, personnel transport, resupply during the broken ice seasons, and maintenance and inspection of the onshore pipeline system (Table 2-4).

Table 2-4 Projected Helicopter Traffic

Estimated Fuel Capacity (Gallons)	Pre-Construction Data Gathering	Island, Pipeline & Facilities Construction [Years 1 – 4] (Trips)	Drilling & Production Operations [Years 3 – 6] (Trips)	Production Operations [Years 6 – 23] (Trips)
400	1/week	1-2/day	2/day	1-2/day

Note: Fixed-wing aircraft use, while not part of the Proposed Action, may occur over the life of the project for the purpose of pipeline monitoring, marine mammal monitoring, or in the event of an oil spill. Impacts of fixed wing aircraft to marine and terrestrial mammals are discussed in Sections 4.3.4 through 4.3.5.

2.1.2 Gravel Mine Site Development

Two government agencies regulate development and/or operation of the gravel mine site. The U.S. Army Corps of Engineers (USACE) regulates the placement of dredged or fill material in wetlands (as described in Chapter 1). Details of the USACE's possible regulatory actions for the gravel mine site or other aspects of the project are available for each alternative in sections titled "USACE Permitting." The Alaska Department of Natural Resources Division of Mining, Land and Water also regulates the extraction of gravel from state lands.

The proposed gravel mine site (West Kadleroshilik Site #1) is located approximately 6.2 miles south of the proposed LDPI and 1.5 miles west of the Kadleroshilik River (Figure 2-5). Transport of gravel from the mine site to the proposed LDPI would require approximately 24 trucks working for 70 days.

Mine site development includes removal of snow and ice, removal and stockpiling of unusable overburden material, blasting, pit excavation, gravel hauling, and backfill of unusable material into the pit. Once the mine is no longer needed, the pit would be flooded and reclaimed.

Details about the proposed mine site:

- Excavated area of about 25 acres
- Additional ice pad (which would not result in ground disturbance) of approximately 250 square feet surrounding the pit. This ice pad boundary area brings the total mine site area to 49 acres
- Approximately 46 to 60 feet deep
- A first lift (mining cycle) would remove about 20 feet of overburden, (although this may be variable once excavation work begins). The second and third lifts would remove material at 20 feet depth intervals.

The gravel source is high quality, exhibiting fines content (percent passing the #200 sieve) of less than 10 percent (mean value of about 4 percent). The percent of gravel in each core ranges from 15 to 55 percent, with a mean value of about 35 percent.

Diagrams are included below to illustrate the mine site plan view (Figure 2-5) and mine site cross-section (Figure 2-6); reclamation figures for the mine site are in Section 2.1.8, Decommissioning.

About 1,337,000 cubic yards (cy) of gravel could be excavated to support construction activities on the LDPI. BOEM used the largest potential estimated values based on the May 2017 DPP, in case more gravel is necessary. This includes:

- About 929,000 cy for the LDPI;
- About 3,500 cy for the Badami tie-in pad;
- About 1,500 cy for the Badami ice road crossing; and,
- About 5,000 cy for the pipeline landfall.

The remaining yardage (408,000 cy) would be used for pipeline select backfill, maintenance, and contingency needs. BOEM conservatively assumed the remaining yardage would be the same for all alternatives. As stated above, ice roads and ice pads would be constructed to support mining and gravel hauling during construction.

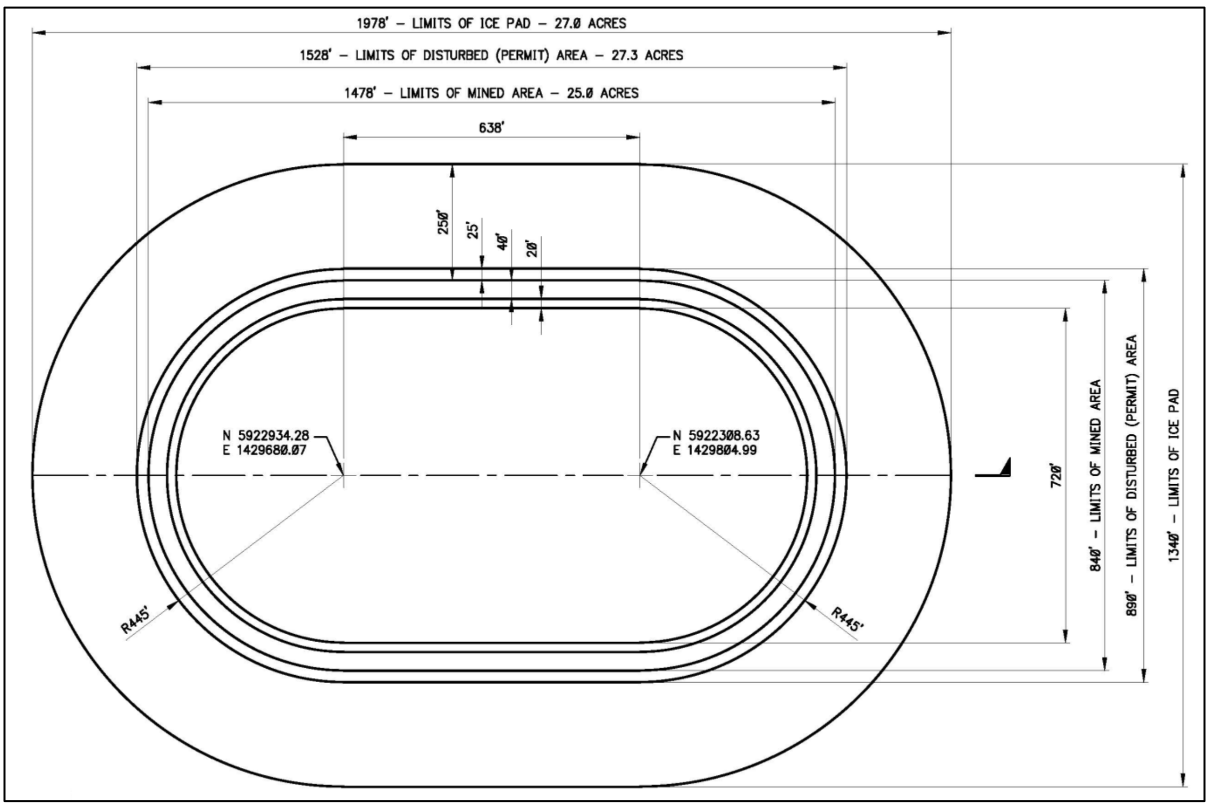

Figure 2-5 Proposed Action Generalized Mine Site View (for Analysis Purposes)

HAK proposes a single year mining program, with a second year contingency option in case of poor offshore ice conditions that restrict gravel transport to the LDPI site. If the second winter season is necessary, HAK would store the overburden material within the mine site.

More information on ice pads is available in the DPP, in Section 3.2.3, Mine Site Development and Section 10.3, Gravel Sources.

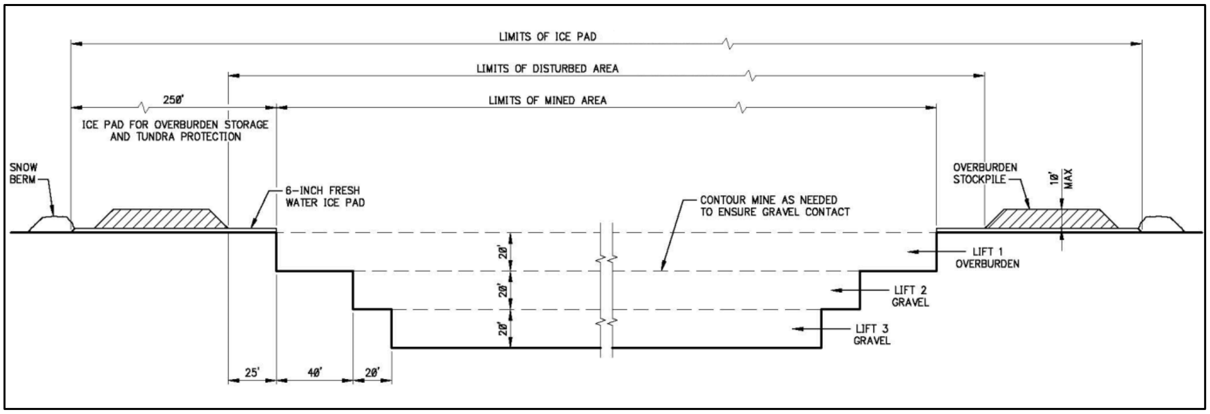

Figure 2-6 Proposed Action Mine Site Cross Section

2.1.3 Liberty Development and Production Island Construction

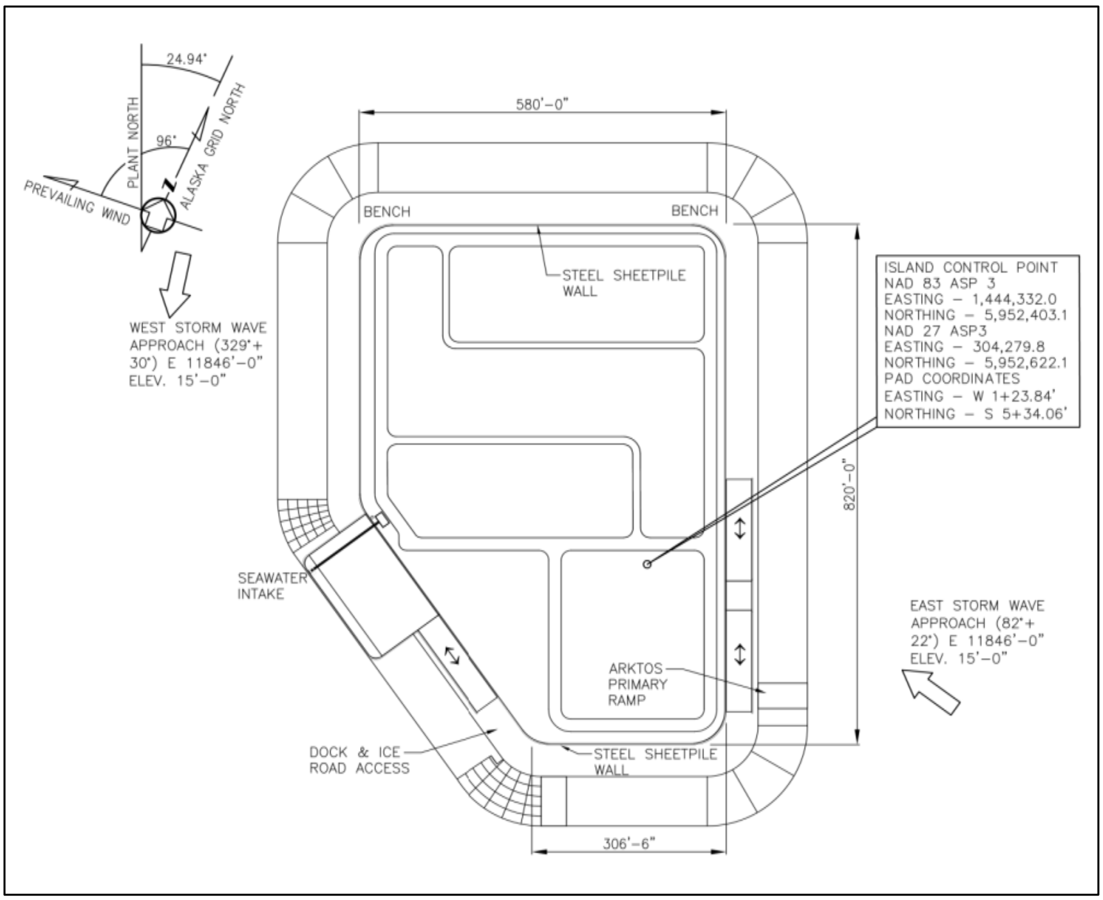

Figure 2-7 Liberty Development and Production Island (LDPI) (Preliminary)

The LDPI would be constructed during the first two winter seasons of the project. Island construction would commence as soon as the ice road from the gravel mine site to the LDPI construction site is completed. Figure 2-1, Figure 2-7, and Figure 2-8 show the location, preliminary island schematic, and a conceptual rendering of the island.

Gravel hauling over the ice road to the LDPI construction site would initiate in December of Year 1, continue for 50 to 70 days, and conclude mid-April or earlier depending on road conditions. Once gravel haul is complete and before ice breakup, protective armament (interlocking concrete mats) and sheet pile (island perimeter) installation would occur. Well conductor and foundation piles would be installed in this same time frame.

A detailed description of pile driving is discussed in HAK's acoustic model for this project (SLR, 2017). Mitigation measures for this activity are discussed in Appendix C.

Figure 2-8 Conceptual 3-D Rendering of Proposed LDPI

The LDPI slopes would be protected from erosion due to winds and waves by a combination of interlocking concrete mats and sheet piling, and potentially gravel bags or large boulders as a secondary measure. Comparatively, on Northstar Island, which is outside the protection of the barrier islands, HAK replaces about 25 of 18,000 (0.0014 percent) concrete mats annually, and about 200 of 18,000 (0.011 percent) every 5 years on a routine island repair cycle.

The work surface of the proposed LDPI would be about 9.3 acres, and the seabed footprint would be roughly 24 acres. Construction of the proposed LDPI would require approximately 929,000 cy of gravel. The design life of the LDPI and associated infrastructure is approximately 25 years.

BOEM notes that the DPP does not provide detailed engineering descriptions of the island construction. Prior to construction, Hilcorp would be required to submit this information to the Bureau of Safety and Environmental Enforcement (BSEE) under the Platform Verification Program. Plans to be submitted include a design verification plan, a fabrication verification plan, and an installation verification plan. These plans would be vetted by an independent third party entity. A description of the proposed island construction is available in Chapter 6 of the DPP.

2.1.4 Pipeline Construction

HAK proposes a pipe-in-pipe (PIP) subsea pipeline consisting of a 12-inch diameter inner pipe and 16-inch diameter outer pipe. The production pipeline would be bundled with a nominal 4-inch coiled utility line, along with an armored fiber optic cable. The utility line would be installed as a contingency for possible future use as a fuel gas delivery line or to allow for a circulation loop with the 12-inch export line for upset conditions (when the pipeline is not functioning appropriately) (Figure 2-9).

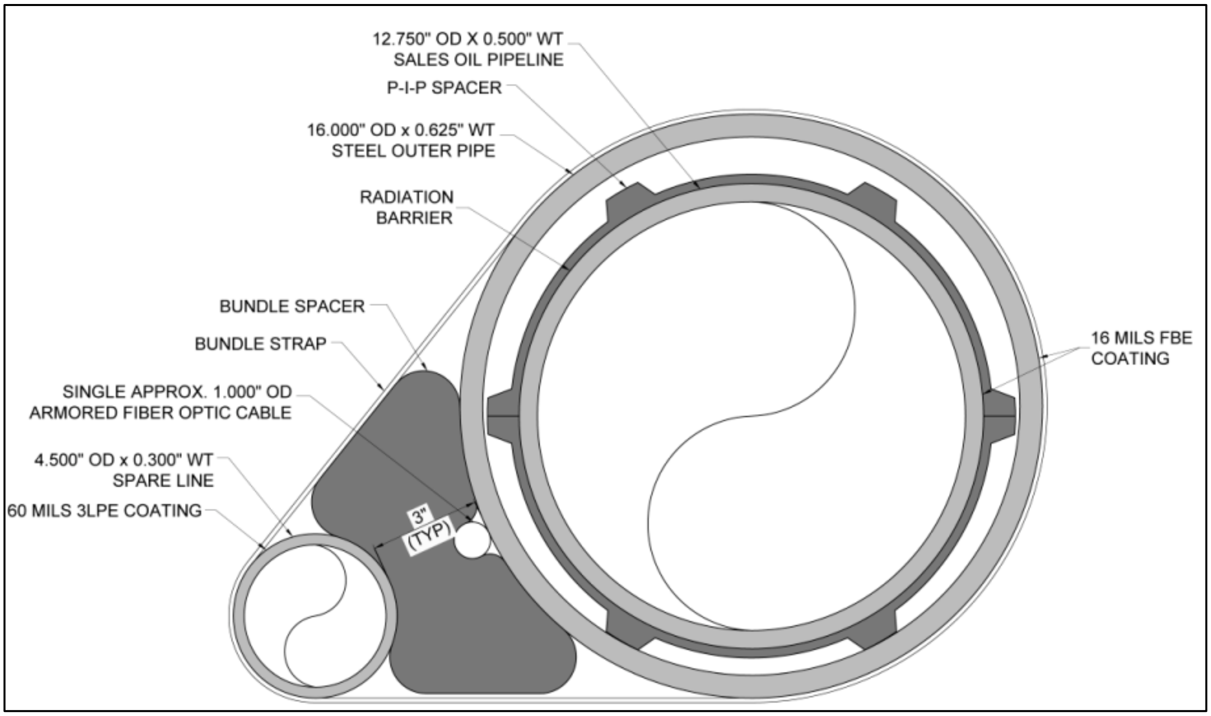

Figure 2-9 Liberty Pipeline Schematic

Pipeline construction is planned for the winter following LDPI construction. The offshore and onshore pipeline segments would be installed within the same time frame, with two separate construction spreads of equipment and manpower.

The pipeline would extend from the LDPI to a tie-in with the Badami Pipeline system. Two onshore gravel pads would be constructed in close proximity starting at the tie-in. The Badami ice road crossing (over the Liberty pipeline) pad would require up to 1,500 cy of gravel and would have a footprint of approximately 0.15 acres. The pipeline would be buried in the gravel pad at this crossing point. A section and plan view of the pad is shown in Figure 2-10 and Figure 2-11.

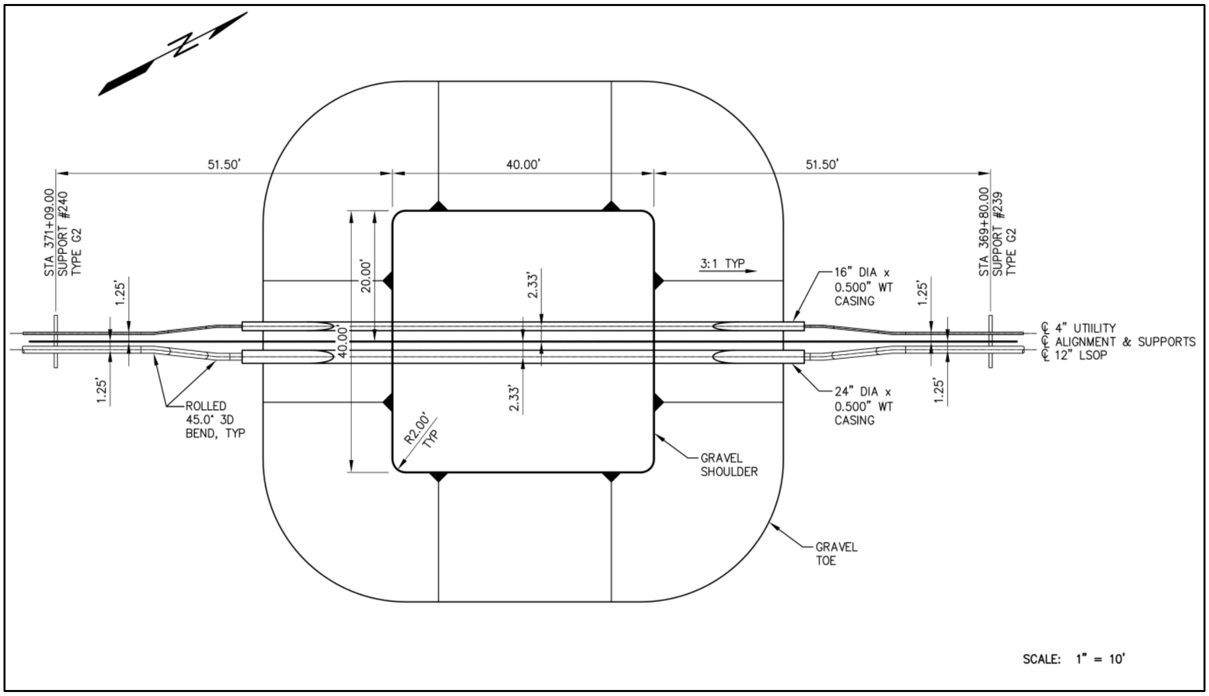

Figure 2-10 Badami Ice Road Crossing Pad, Plan View

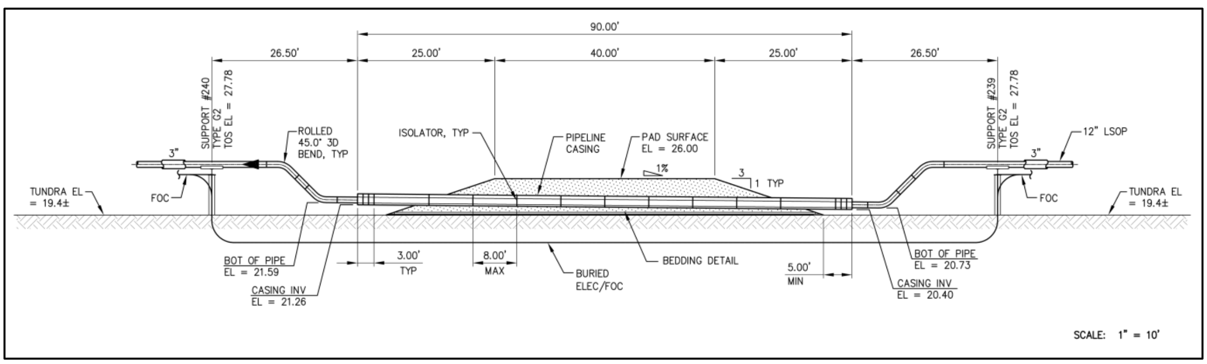

Figure 2-11 Badami Ice Road Crossing Pad, Section View

An approximately 0.7-acre gravel pad would be required where the Liberty Pipeline and Badami Pipeline join (Badami tie-in pad). This would require roughly 3,500 cy of gravel (Figure 2-12 and Figure 2-13, below).

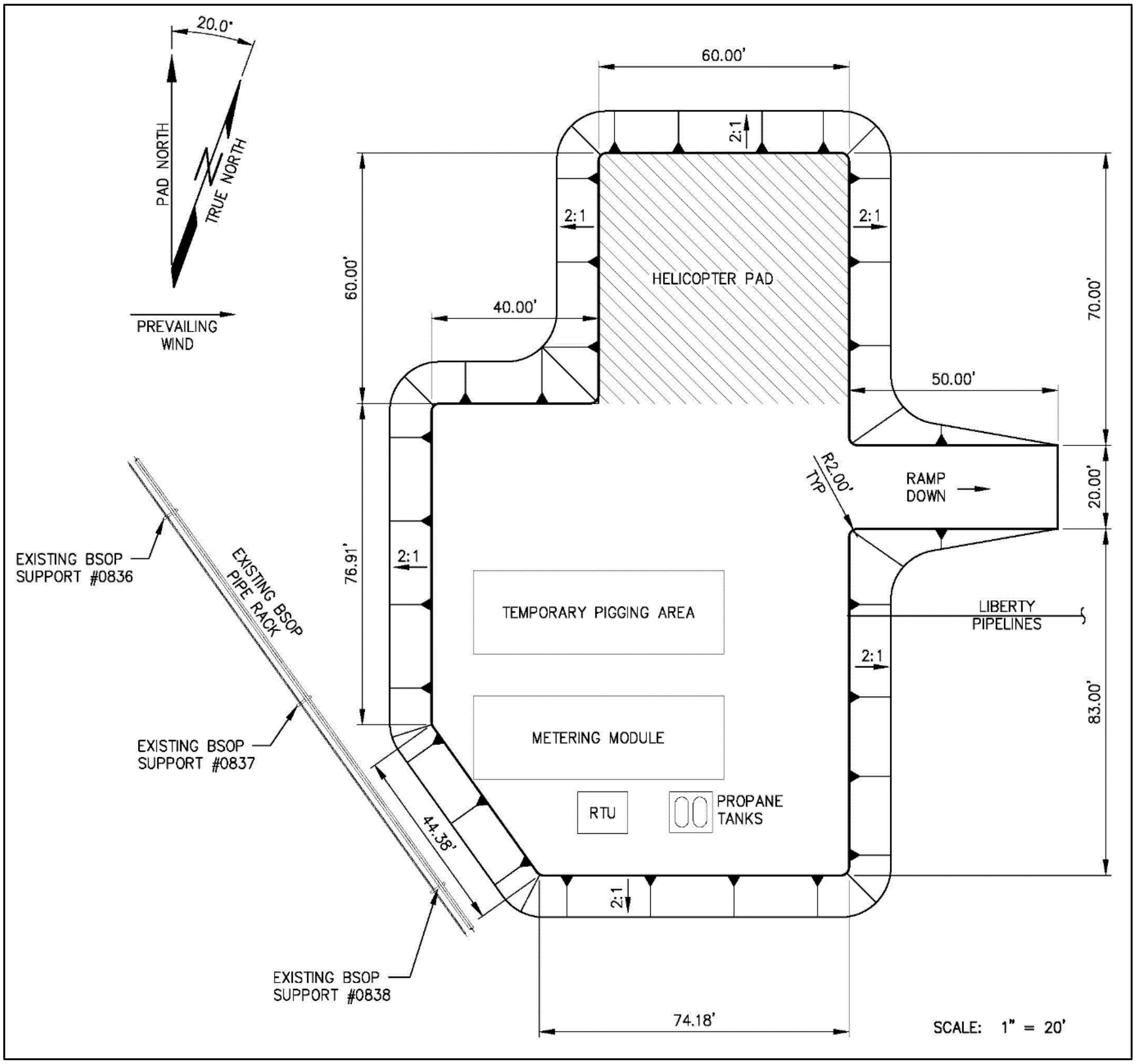

Figure 2-12 Onshore Tie-In Pad, Plan View

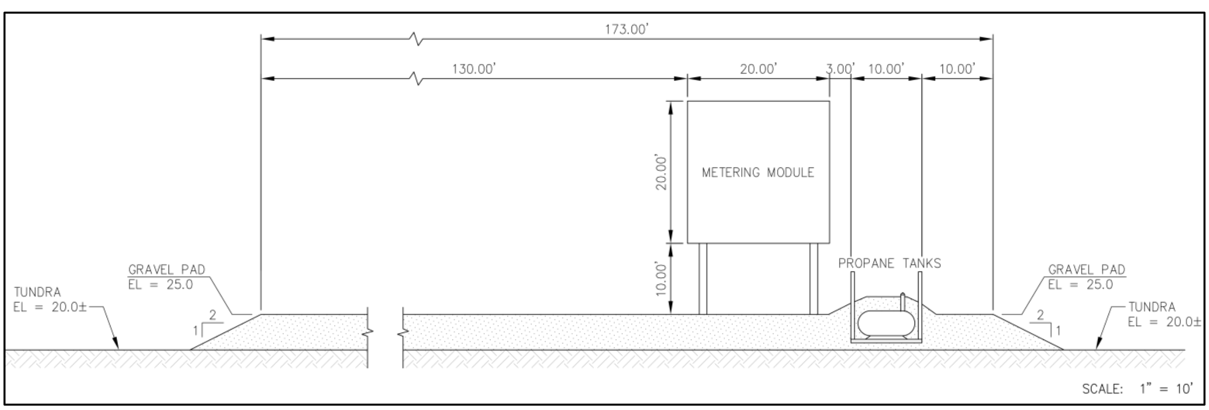

Figure 2-13 Onshore Tie-In Pad, Section View

The proposed onshore pipeline would cross the tundra for almost 1.5 miles. The single wall 12-inch pipeline would rest on 150 to 170 Vertical Support Members (VSMs), spaced approximately 51 feet apart to provide the pipeline a minimum 7-foot clearance above the tundra. Pipeline expansion loops would be required roughly every 1,300 feet. See Section 7.5 of the DPP for additional detail.

The VSMs would be installed and the pipeline placed before the installation of the pigging facilities at the Badami tie-in pad (a ‘pig’ is a device that is forced through a pipeline by pipeline internal pressure for the purposes of displacing or separating fluids and cleaning or inspecting the line).

At the pipeline landfall (where the pipeline transitions from onshore to offshore), HAK would construct an approximately 1.4-acre trench to accommodate the installation of thermosiphons (heat pipes which circulate fluid based on natural convection to maintain or cool ambient ground temperature) along the pipeline and to protect against coastal erosion along the pipeline corridor. Approximately 5,000 cy of gravel would be used at the landfall site as thaw-stable fill material. The proposed length of the onshore setback is approximately 350 feet, starting from the 4-foot elevation to the daylight of the pipeline, to account for any potential ice ride-up associated with onshore sea ice movement. HAK estimates long-term (period from 1949 to 1995) erosion rates of about 2 feet per year at the shore crossing location (Coastal Frontiers, 1996). The length of the transition (daylight) would account for the average long-term erosion rate and the maximum expected short-term erosion rate (see Figure 2-14).

More information is available in Section 7 of the DPP. A schematic for the pipeline landfall is shown below in Figure 2-14.

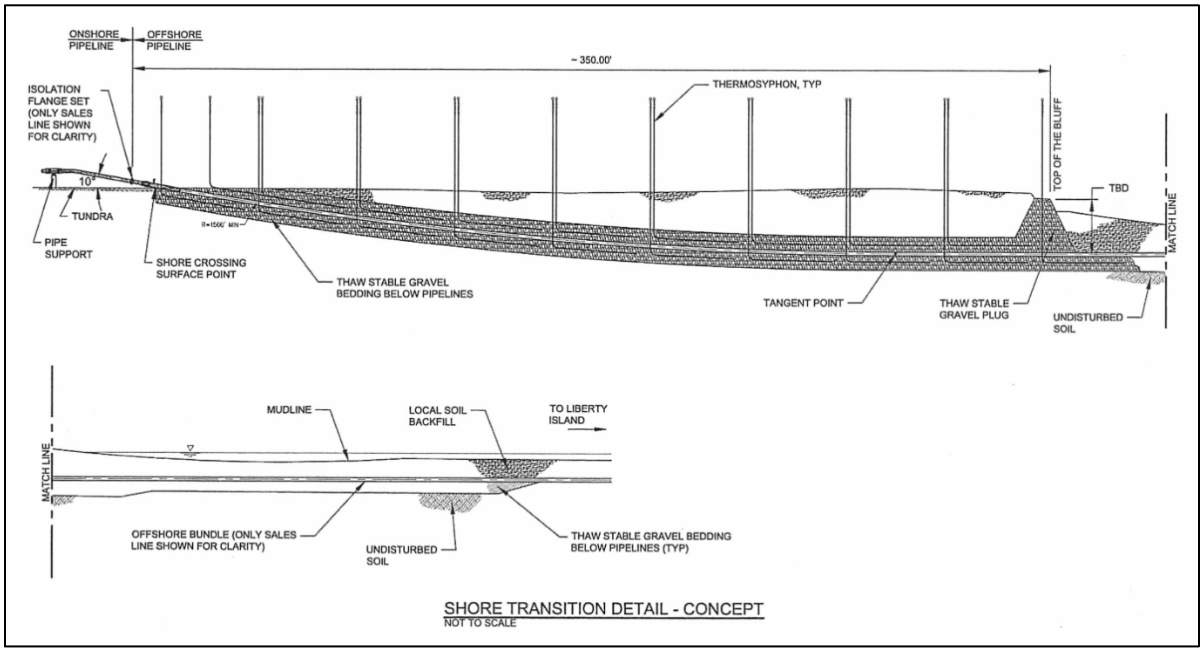

Figure 2-14 Pipeline Landfall Schematic, Section View

The subsea (offshore) section of the pipeline would be the PIP system described above, constructed within a 1,500-foot wide proposed temporary construction right-of-way (ROW) during the winter. The nearshore portion of the pipeline is expected to transit through an area having a 75 percent possibility of overflood occurrence (overflooding is the fluvial process that causes strudel scour; see Section 3.1.2.4). Overflooding increases the risk of a strudel scour event, which Hilcorp has mitigated by proposing that the minimum depth of cover over the pipeline bundle is approximately 7 feet below mudline. The target trench depth is 9 to 13 feet.

The estimated excavated trench volume for the entire route length based on the estimated slopes is approximately 491,000 cy.

Offshore pipeline construction would progress from shallower to deeper water for the approximately 5.6-mile marine portion of the pipeline, with multiple construction spreads. Construction would involve:

- Equipment, material and crew member mobilization
- Construction of the supporting ice road
- Cutting a slot through the ice, excavating a trench (including temporarily storage of excess materials)
- Preparing (welding and joining together) the pipeline bundle components
- Placement of the pipeline bundle in the trench
- Trench backfilling

The pipeline trench would be backfilled with the material removed during excavation using conventional equipment (backhoes, dump trucks, etc.). Some gravel or gravel bags may also be used as backfill for the transition trench.

More information is available in Section 7.8, Offshore Pipeline Installation, of the DPP.

BOEM notes that the pipeline ROW, design, construction, installation, monitoring and maintenance are regulated by the U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (USDOT PHMSA) and/or the State of Alaska, State Pipeline Coordinator Services.

2.1.4.1 Disposal of Pipeline Trench Materials

HAK plans to place all dredged material back in the pipeline trench. Based on the estimated pipeline trench depth and the soil composition along the proposed pipeline alignment, all material would be suitable for backfilling the trench excavation. Due to thaw settlement along the pipeline corridor, excess material is assumed to be minimal.

2.1.5 Facilities Construction

The LDPI layout includes areas for drilling, production, production support, utilities, a camp, camp utility area, and a relief well area. Permanent structures on the LDPI would be supported by driven steel piles and/or slab on grade foundations. Rig mats (portable platforms used to support equipment used in construction and other resource-based activities) may be used in some areas (e.g., storage containers).

The LDPI would have a helicopter landing pad and one dock to accommodate barges, hovercraft, and small boats. It would also have ramps for amphibious vehicle access. Offshore ice road transitions would occur around the LDPI bench perimeter.

The LDPI design includes a seawater treatment plant, a sanitary wastewater facility, and a potable water treatment plant. Wastewater would receive secondary treatment. Remaining sewage solids would be incinerated on-island or stored in enclosed tanks prior to shipment to the North Slope Borough (NSB) treatment plant in Deadhorse. Please refer to Section 2.1.9 of the DPP for additional description of the wastewater treatment operations and discharges.

Power for the camp and utilities during construction would be generated by two diesel-fired generators for a maximum power output of 1.25 megawatts each. A redundant generator would be available for backup power generation. Chemicals stored on the LDPI would include diesel fuel, methanol, and other chemicals to support drilling and production.

The LDPI production facilities and camp would be powered by fuel gas-fired turbines once the third well has been completed. The diesel-fired engines that were located on the LDPI during construction would remain on the LDPI to provide power to the facilities in the event of a power disruption from the fuel gas-fired turbines. The LDPI production facilities would include three gas-fired compressors.

HAK plans to truck most modules, buildings, and material for on-site construction to the Alaska North Slope (ANS) via the Dalton Highway, to be staged at West Dock, Endicott SDI, or in Deadhorse. HAK may contract sea-going barges during Year 2 through Year 6 that would transit through Dutch Harbor to the LDPI to support construction and drilling operations. HAK estimates that one to two barges, making two to five trips annually, would be needed during this phase. Barges transiting between Dutch Harbor and the LDPI would occur throughout the life of the project; HAK estimates one trip every 5 years would be required. Barges transiting between West Dock or Endicott SDI to LDPI would also occur throughout the project life. Construction workers and materials may be based at Endicott SDI; a hovercraft ramp and hangar would be installed there, and HAK may create a ramp to facilitate winter ice road access across the sea ice to the LDPI.

Other onshore facilities would include a gravel pad for pipeline support at the tie-in location to the Badami Pipeline, as described previously. A plan view and section view of these pads are shown in Section 2.1.4. Additional onshore support, mentioned above, would include use of water sources for ice roads and ice pad construction and development of a gravel mine site west of the Kadleroshilik River.

2.1.6 Drilling Operations

The drilling unit and associated equipment would be transferred by barge through Dutch Harbor or from West Dock to the LDPI in Year 2. Drilling is scheduled to begin in early Year 3. HAK proposes 16 well slots. The initial 10 wells would be drilled in Year 3 through Year 6; additional well slots would be available as backups or for potential in-fill drilling throughout the project life. HAK would drill 5 to 8 producing wells (to include any additional future completions), 4 to 6 water and/or gas injection wells, and up to 2 disposal wells with a surface wellhead spacing of 15 feet between well slots.

The first well drilled would be a disposal well for cuttings re-injection and waste mud. HAK plans to power the drill rig, grind and inject facility, and other drilling operations exclusively by diesel-fired equipment while the first three wells are being completed. Rock cuttings and excess drilling mud from this well would be stored on site until the disposal well is completed and the grind and inject facility is commissioned. Alternatively, cuttings and drilling muds may be transported to an existing onshore site for disposal.

The next well drilled would be a gas injector, which would be used to re-inject produced gas into the reservoir. Produced gas would be used as fuel gas and lift gas (i.e., reinjected gas used to increase fluid pressure).

The third well drilled would be a producer. This well would be completed and connected to the processing facilities to allow the plant to start up. Once this occurs, the LDPI drill rig, grind and inject facility, and production facilities would be powered by fuel gas-fired equipment with diesel-fired units available as backups in case the gas processing plant shuts down. Drilling would continue as described in the project schedule (see DPP, Figure 8-1).

Seawater, treated and comingled with produced water, would be used for injection into the Liberty Reservoir in a process called waterflooding. Waterflooding, unlike fracking, does not fracture the reservoir to increase production. Instead, water is transferred to the reservoir from the surface down an injector well with the intention of pushing oil towards the producing well, enhancing oil production. This process maintains the pressure within the reservoir by filling pore space left vacant by initial oil production. The treated seawater would also be used to create potable water and utility water used at the proposed LDPI.

Each spring and fall, prior to soft/broken ice seasons, sufficient drilling consumables (i.e., drilling fluid, additives, lubricants, etc.) would be stockpiled on the LDPI to allow drilling through the periods when re-supply is limited to personnel, groceries, and small loads via helicopter or hovercraft.

A more detailed discussion of the sequence of drilling activities, including drilling unit mobilization and drilling operations, is provided in Section 8 of the DPP.

2.1.7 Production Operations

Production would commence once the initial facilities are constructed and the first three wells are drilled. Production, drilling, and facility installation activities would occur simultaneously until all the wells are drilled and in service. First oil is anticipated in first quarter of Year 4.

The initial production rate is expected to be in the range of 10,000 to 15,000 barrels of oil per day (BOPD). As additional wells are brought online, the production rate is expected to peak at a rate between 60,000 and 70,000 BOPD. HAK anticipates it would take approximately 2 years from first oil to reach peak flow rate from the reservoir.

HAK estimates the economic life of the field at approximately 15 to 20 years, so the facilities and pipeline are designed for an operational life of 25 years based on design criteria appropriate to Arctic conditions (e.g., wave, ice, storm, seismic conditions, etc.). HAK plans to upgrade facilities (i.e., replacing equipment and/or piping) if the operational life of the Liberty Field exceeds 25 years.

More information about the Liberty reservoir is available in Section 3.1.3 of this FEIS, and Section 4 of the DPP. Production operations are discussed in Section 11 of the DPP.

2.1.7.1 Ancillary Activities

HAK may conduct annual ancillary activities to identify conditions at or below the seafloor or along the island perimeter that are potentially hazardous. These ancillary activities could include geohazard and geophysical surveys or aerial reconnaissance surveys. The National Marine Fisheries Service (NMFS), in their Effects of Oil and Gas Activities in the Arctic Ocean EIS (NMFS, 2016a), describes the noise characteristics associated with the typical types of equipment for geohazard surveys as:

- Single Beam Echosounders: 180 to 205 dB_{RMS} (decibel root mean square) at 1 meter (m) between 3.5 and 1,000 kilohertz (kHz)
- Multibeam Echosounders: 216 to 242 dB_{RMS} at 1 m between 180 kHz and 500 kHz
- Sidescan Sonar: 194 to 249 dB_{RMS} at 1 m between 100 and 1,600 kHz
- Subbottom Profilers And Single Channel Seismic: 200 to 250 dB_{RMS} at 1 m between 0.2 kHz and 200 kHz
- Multichannel Seismic: 196 to 217 dB_{RMS} at 1 m between 0 and 200 Hz.

HAK plans to complete annual geohazard surveys, using geophysical (primary sidescan sonar) or visual surveys, over the pipeline corridor and/or along the island perimeter to assess trends associated with strudel scour impacts, ice events or erosion. HAK would implement mitigation measures based on these surveys, such as filling in strudel scours, controlling shoreline or island erosion.

Additional monitoring (via remote operated vehicle or sidescan sonar) may occur if aerial reconnaissance surveys or other monitoring instrumentation indicates that the pipeline has been exposed due to a strudel scour event.

The U.S. Environmental Protection Agency (EPA) and the Alaska Department of Environmental Conservation (ADEC) have issued general permits that would provide discharge authorization for geotechnical surveys and related activities, which would result in disturbance and mobilization of seafloor sediments (e.g. sand, rock, sediments, muds, etc.) Those permits are as follows:

- EPA General National Pollutant Discharge Elimination System (NPDES) General Permit #AKG-28-4300, Oil and Gas Geotechnical Surveys and Related Activities in Federal Waters of the Beaufort and Chukchi Seas; Effective Dates: March 2, 2015 – March 1, 2020.
- ADEC Alaska Pollutant Discharge Elimination System (APDES), General Permit AKG283100, Geotechnical Surveys in State Waters of the Beaufort and Chukchi Seas, Effective Dates: May 1, 2015 – April 30, 2020.

2.1.7.2 Monitoring Activities

HAK would monitor various physical features of the Liberty Development including ice conditions, bathymetry, and trench conditions. More information is available in the DPP, Section 12.5 Environmental Monitoring, in Appendix C of this FEIS.

2.1.8 Decommissioning

When HAK determines the project is no longer economically viable for it to continue operations, HAK would either begin abandonment procedures according to the permit conditions and regulations in force at that time, or enter into negotiations to transfer ownership of the project to another entity. If HAK transfers ownership, the new operator would be required to abide by all terms and conditions that BOEM imposes upon HAK, assuming the project is approved.

The estimation of the end of economic field life depends upon predictions of future oil and gas prices and operating costs. The expected producing life of the Liberty field is 15 to 20 years. The project operational life, which includes construction and decommissioning time, is estimated to be 25 years. See Section 19 of the DPP for more information on decommissioning.

2.1.8.1 Winter and Summer Access

During the project life, including during decommissioning, onshore ice roads used to connect the mine site, construction areas, and LDPI would melt at breakup; stream and river crossings would be slotted to facilitate stream flow. Onshore ice road routes would be inspected the following summer for tundra damage and remediated as needed. Abandonment and rehabilitation of the onshore gravel pads would be completed according to applicable regulatory requirements. BOEM assumes that Ice Roads #1 through #3 would be constructed in Year 24 through Year 25 to support decommissioning.

As a conservative estimate, BOEM assumes that all summer (open water) transits for decommissioning would be equal to the vessel types and transits used during construction.

2.1.8.2 Gravel Mine

Abandonment and rehabilitation of the gravel mine site for Liberty would be described in a Mining and Rehabilitation Plan submitted for approval to the ADNR and USACE. A proposed mine site reclamation section view has been included below.

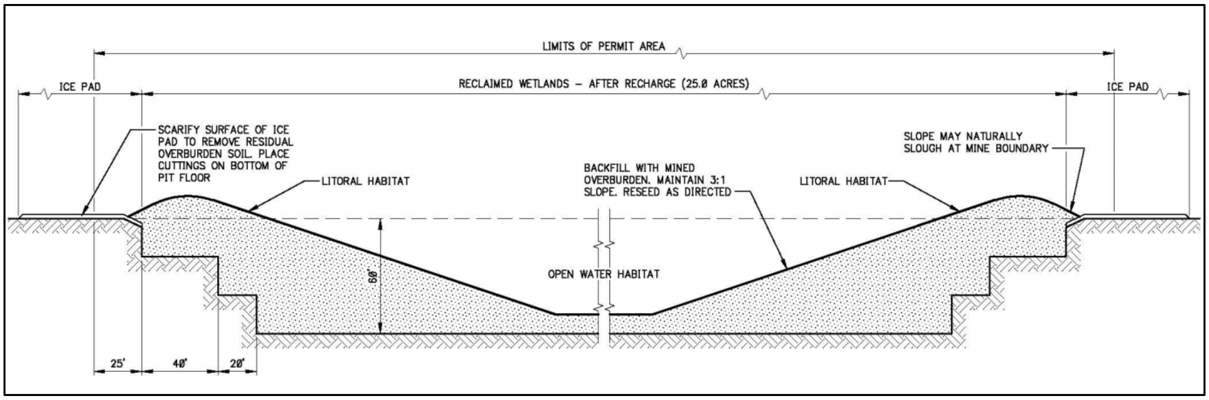

Figure 2-15 Proposed Mine Site Reclamation, Section View

2.1.8.3 Island and Wells

While in the Production Operations phase, infill drilling or possible delineation success could extend the service life of the LDPI, production facilities, and pipeline system. BOEM conservatively assumes that in Year 23, HAK would initiate activities to modify and/or update the existing Liberty infrastructure to ensure safe continued use of the LDPI (and wells), production facilities, and pipeline system.

If this does not occur, HAK proposes to begin abandonment procedures when the project ceases to be economically viable, predicted to be Year 24 of the project life. The LDPI would be decommissioned at the end of field life (EOFL) and cessation of production, as defined by operating agreements, permits, and regulations. Removal of facilities and abandonment of the wells is expected to require two winter seasons over a span of 18 months (Year 24 through Year 25).

The procedure described below was used for Tern Island, which is located about 1.5 miles from the proposed LDPI, and other exploration gravel islands built in the 1980s and 1990s to explore State and Federal acreage in the Beaufort Sea. Abandonment procedures have involved plugging and abandoning the wells, then removing wellheads, pilings, and other structures to below the mudline. Subsequently, the armoring and sheet piles are removed, followed by testing the island for any contamination, remediating any contamination, and then allowing natural wave, ice, and current forces to erode the island.

The removed armor from the LDPI may be used to enhance hard bottom habitat, or removed from the project area and recycled to another use or disposed of in an approved manner. Special consideration would be given to any Boulder Patch communities that may have colonized the lower portions of the concrete slope armor. HAK would obtain approval of its decommissioning plan by submitting applications pursuant to regulations in effect at that time. Title 30 Code of Federal Regulations (CFR) 250.1703(a) and 30 CFR 250.1704 currently require the application be submitted to BSEE and meet the applicable requirements of 30 CFR Subpart Q, Decommissioning Activities. BSEE regulations provide specific requirements for well abandonment, but those are not prescriptive for gravel island abandonment. Removal is subject to the approval of the Regional Supervisor.

Laws and regulations pertaining to ADNR and USACE approvals for this project also provide for discretion in termination and abandonment procedures.

2.1.8.4 Pipeline

At the end of the project life, decommissioning of the pipeline would be subject to both State of Alaska and DOT PHMSA regulations. The State would consider closure plans in the future rather than determining the fate of infrastructure at this time. The following information describes a reasonable decommissioning process under the agencies' jurisdictions. All lines would be de-energized and flushed prior to removal. The processes and standards for flushing are expected to be site-specific and would be incorporated into the final decommissioning plan. Site clearance work on State land would likely require removal of all materials, supplies, structures, VSMs, and installations from the location.

The buried subsea portion of the pipeline would likely be abandoned in place or continued for use by HAK or another entity after Liberty is depleted, after which time it would be abandoned in place. Following flushing, HAK would verify that all hydrocarbons or other contaminants have been removed, cut the ends of the pipeline off at the appropriate elevation, and permanently seal the ends. Marine lines would be identified to the U.S. Coast Guard for proper chart designations or aid to navigation marking, as appropriate. Additional details of decommissioning the subsea buried pipeline would be determined in the permitting and/or decommissioning approval process.

If the pipeline is not decommissioned in Year 24 through Year 25, the pipeline system could be operated as a common carrier. This would allow for HAK and/or another entity to use the pipeline for other future purposes after the Liberty reservoir has been depleted.

2.1.8.5 Facilities

Surface facilities include all equipment and structures associated with drilling, development, and production of the Liberty petroleum reserves. All modules, structures, pipelines, and supports are considered surface facilities.

All installed surface facilities associated with the Liberty Development would be removed. Surface facilities would be de-energized, flushed of any oil and chemical residues if necessary (not all the lines carry oil), and removed. Modules would be removed in a reverse process from installation and transported to an offsite location to be reused, recycled or disposed. Other installations would likely be removed by dismantlement.

2.1.9 EPA Permitting

The Proposed Action would require a NPDES permit from EPA for the discharge of waste streams associated with the LDPI.

Section 301(a) of the Clean Water Act (CWA) provides that the discharge of pollutants to surface waters of the United States is prohibited except in accordance with a NPDES permit. Section 402 of the CWA establishes the NPDES permit program, which provides the EPA and the authorized states the authority to control and limit the discharge of pollutants into waters of the United States. HAK has applied for an NPDES permit for the discharge of waste streams associated with the LDPI. The LDPI is located 4.78 nautical miles offshore in Federal waters of the Outer Continental Shelf (OCS); therefore, the EPA is the NPDES permitting authority.

2.1.9.1 Ocean Discharge Criteria Evaluation

Section 403(c) of the CWA requires that the NPDES permits authorizing discharges into the territorial seas, the contiguous zones, and the oceans, including the outer continental shelf, comply with EPA's Ocean Discharge Criteria (40 CFR Part 125, Subpart M). The purpose of the Ocean Discharge Criteria Evaluation (ODCE) is to assess the discharges authorized under the NPDES permit and to evaluate the potential for unreasonable degradation of the marine environment based on the consideration of ten specific criteria.

The 10 criteria are specified at 40 CFR Part 125.122, Determination of Unreasonable Degradation of the Marine Environment. The Director shall determine whether a discharge would cause unreasonable degradation of the marine environment based on consideration of:

1. The quantities, composition and potential for bioaccumulation or persistence of the pollutants to be discharged;
2. The potential transport of such pollutants by biological, physical or chemical processes;
3. The composition and vulnerability of the biological communities which may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain;
4. The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions or critical stages in the life cycle of an organism;
5. The existence of special aquatic sites including, but not limited to, marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas and coral reefs;
6. The potential impacts on human health through direct and indirect pathways;
7. Existing or potential recreational and commercial fishing, including fin-fishing and shell-fishing;
8. Any applicable requirements of an approved Coastal Zone Management Plan;
9. Such other factors relating to the effects of the discharge as may be appropriate; and
10. Marine water quality criteria developed pursuant to section 304(a)(1).

2.1.9.2 New Source Performance Standards

Discharges to surface waters of the United States associated with the oil and gas extraction point source category are regulated under 40 CFR Part 435, Subparts A-D, which were promulgated in 1979. Effluent limitation guidelines and new source performance standards for the offshore subcategory of the oil and gas extraction point source category were amended on January 15, 1993, and became effective on March 4, 1993 (40 CFR 435, Subpart A; 58 FR 12454). New oil and gas development and production operations where construction commenced after the effective date of applicable new source performance standards (NSPS) are considered new sources.

40 CFR Section 122.2 defines “new source” as follows:

> “New Source means any building, structure, facility or installation from which there is or may be a “discharge of pollutants,” the construction of which is commenced:
>
> a. After promulgation of standards of performance under Section 306 of CWA which are applicable to such source, or
> b. After proposal of standards of performance in accordance with Section 306 of CWA which are applicable to such source, but only if the standards are promulgated in accordance with Section 306 within 120 days of their proposal.”

The regulations at 40 CFR Section 122.29(b)(4) defines what constitutes “construction” of a new source, stating that:

> “Construction has commenced if the owner or operator has:
>
> (i) Begun, or caused to begin as part of a continuous on-site construction program:
>
> (A) Any placement assembly, or installation of facilities or equipment; or

(B) Significant site preparation work including clearing, excavation or removal of existing buildings, structures, or facilities which is necessary for placement, assembly, or installation of new source facilities or equipment; or

(ii) Entered into a binding contractual obligation for the purchase of facilities or equipment intended to be used in its operation with a reasonable time."

EPA has determined the LDPI is a new source because construction would commence after the promulgation of new source performance standards in 1993.

In accordance with Section 511(c)(1) of the CWA and the EPA's regulations for implementing the procedural provisions of NEPA at 40 CFR Part 6, issuance of NPDES permits for new sources are considered major federal actions subject to National Environmental Policy Act (NEPA) review.

In order to satisfy their NEPA compliance obligations associated with the issuance of an NPDES permit for the LDPI, the EPA has agreed to assist in the preparation of this FEIS as a cooperating agency pursuant to 40 CFR 1501.6.

NPDES permits would be required to implement the Proposed Action or any of the other Alternatives considered in the EIS that fall under EPA authority, except for the No Action Alternative. EPA has identified the following alternatives for its own NPDES permitting action:

- **EPA's Action:** Issue an individual NPDES permit to HAK for requested waste streams associated with the Liberty Project, in accordance with the statutory/regulatory-based requirements described below.
- **EPA's No Action:** Do not issue an NPDES permit to HAK for requested waste streams associated with the Liberty Project.

2.1.9.3 Wastewater Discharges under the Proposed Action

All permitted waste streams would be discharged from the LDPI into Stefansson Sound in the Beaufort Sea. A description of the requested waste streams and treatment processes is provided below.

2.1.9.3.1 Sanitary and Domestic Wastewater (Outfall 001a; Contingency Discharge)

Sanitary wastes from offshore oil and gas facilities are comprised of the human body waste discharged from toilets and urinals. Domestic waste, or graywater, originates from sinks, showers, laundries, safety showers, eye-wash stations, hand-wash stations, food preparation areas, galleys, and other domestic sources that do not include wastes from toilets, urinals, hospitals, and cargo spaces.

HAK intends to use a membrane bioreactor (MBR) with ultraviolet (UV) disinfection to treat the sanitary and domestic wastewater at LDPI. The MBR treatment process consists of screening, a suspended growth biological reactor (similar to conventional activated sludge systems), membrane filtration to separate and confine solid particles, and disinfection (US EPA, 2007). MBRs have demonstrated high removal efficiencies for contaminants such as nitrogen, phosphorus, bacteria (e.g. fecal coliform), biological oxygen demand, and total suspended solids. HAK has indicated an average daily flow of approximately 5,000 gallons per day (gpd) and a maximum daily flow of approximately 20,000 gpd.

HAK has indicated this would be a contingency discharge. During the first two years of construction, prior to completion of a disposal well, sanitary and domestic wastewater would be hauled offsite to an onshore disposal facility. Once the disposal well is available at the LDPI, HAK intends to discharge the sanitary and domestic wastewater through injection into the disposal well. HAK has requested this contingency discharge for those times when the disposal well is not operational due to maintenance or other issues.

2.1.9.3.2 Potable Water Treatment Reject Wastes (Outfall 001b; Contingency Discharge)

Potable water reject waste is the residual high-concentration brine produced during the distillation of seawater. It has a chemical composition and ratio of major ions similar to the influent seawater, but with significantly higher concentrations.

HAK intends to use vapor-compression/distillation technology to produce potable water at the LDPI. Seawater is boiled inside a bank of enhanced surface tubes located on one side of the heat transfer surface. The excess feed water that does not evaporate (blowdown) contains concentrated dissolved solids and salts (brine) which are nearly twice the concentration of ambient seawater. A continuous injection of maintenance chemicals would be added during the process. Periodic injection of an acid and/or descaler would be used to remove mineral buildup in the system. HAK has indicated an average daily flow of approximately 5,000 gpd and a maximum daily flow of approximately 20,000 gpd.

HAK's NPDES permit application (December 3, 2016) states that the potable water reject waste discharge would be a contingency discharge. During the first 2 years of project construction, prior to Liberty facility installation, potable water would be hauled to the project location from an existing onshore source. Once the disposal well is available at the LDPI, HAK anticipates comingling the sanitary and domestic wastewater effluent with the potable water treatment plant effluent, and discharging both waste streams into the disposal well. HAK has requested this contingency discharge for those times when the disposal well is not operational due to maintenance or other issues.

2.1.9.3.3 Seawater Treatment Plant Wastewater (Outfall 002; Ongoing Discharge)

The overall purpose of the seawater treatment plant (STP) is to provide treated seawater for injection into the petroleum reservoir to maintain formation pressures and allow secondary oil recovery from production wells. The STP unit operations consist of a desander, coarse strainer, fine media filters, and a continuous seawater dump that allows seawater to pass through or be shunted for use in backwashing operations. The operation of the STP results in one continuous discharge through Outfall 002, which consists of the residual high-concentration brine and filter backwash produced during the treatment processes at the seawater treatment plant and a small volume of seawater to transport the solids to the disposal point. It has a chemical composition and ratio of major ions similar to seawater, but with significantly higher concentrations.

The proposed system has been designed to minimize the discharge of residual chemicals. There would be an amount (yet to be determined) of sodium hypochlorite discharged directly to the receiving water during backwash of the coarse and fine filters and some residual coagulant chemicals that may be used during periods of high suspended sediment load that occur during spring break-up and during summer storm events. The use of dechlorination is being considered to reduce the amount of total residual chlorine being discharged to the marine environment. Other chemicals used during the treatment process such as biocides, oxygen scavengers, scale/corrosion inhibitors, etc. would be utilized downstream of the filter backwash processes and, therefore, would not be introduced to the marine discharge, but would be injected as part of the enhanced oil recovery process.

HAK has indicated that the daily maximum discharge from the STP would be approximately 1.1 Million Gallons per Day (MGD) with an average daily discharge rate of 0.94 MGD. The unit operations have been designed to minimize the frequency of backwashing/flushing, however, the ultimate frequency for backwash is a function of the solids loading in the feed to the system. If there is a high solids loading due to sand being sucked into the pump pit (e.g., storm conditions) or there is a high concentration of organic material (e.g., algal bloom) the backwash frequency may increase and the discharge rate and concentration of total suspended solids (TSS) may also increase.

Based on the available background TSS data, the observed spatial and temporal variability, it is reasonable to assume that average background TSS concentrations near the STP influent pipe may be approximately 30 mg/L. Furthermore, if it is assumed that all of the incoming seawater solids are removed, and the average daily discharge rate is 0.94 MGD, then the total combined average effluent TSS concentration is expected to be approximately 140 milligrams per liter (mg/L). However, given the potential for variable concentrations of TSS in the receiving water environment due to naturally occurring seasonal events (e.g. algal blooms, ice break-up, large and sudden sediment loading from nearby freshwater rivers, and storm surges) and based on limited data from comparable facilities operating and discharging to the Beaufort Sea, HAK estimates that the average daily TSS concentration would be 250 mg/L and the maximum daily TSS concentration would be 1,000 mg/L (Hilcorp, December 2016 NPDES Permit Application).

The STP facility installation on the LDPI would not begin until late in second year or early in the third year of the project construction, therefore, there would be no discharge of STP effluent until that time.

2.1.9.3.4 Construction Dewatering Wastewater (Outfall 003; Contingency Discharge)

Construction dewatering is the removal of water from excavated areas where precipitation and/or snowmelt water accumulates and hinders the construction activity. Construction dewatering is primarily related to trenching activities while installing or repairing utilities and pipelines, but may also be related to other activities such as foundation or vertical support member installations. The most common methods for dewatering include submersible pumps, wells, well points, and vacuum trucks for small volumes.

While no flow volume has been specified for construction dewatering activities located at LDPI, HAK has indicated construction dewatering discharges would be minimal due to the majority of the project construction occurring during the winter. Construction dewatering may be required on the island if construction activities such as land farming or facility installation are occurring during the spring thaw, approximately May to June. When the disposal well is completed, in approximately Year 3 of project development, construction dewatering effluent would be injected. Therefore, discharges from construction dewatering activities are expected to occur intermittently during Year 1 through Year 3, at which point the waste stream would be injected into the disposal well.

2.1.9.3.5 Secondary Containment Dewatering Wastewater (Outfall 004; Contingency Discharge)

Secondary containment areas are diked or bermed areas around hydrocarbon tanks, tank farms, fuel transfer stations, tanker truck loading racks, and for the storage of non-petroleum chemicals, which provide an emergency storage area and help to prevent accidental spills from reaching the environment or nearby receiving waters. These areas are susceptible to rain or snowmelt accumulation.

HAK has requested authorization to discharge storm water (rainfall and snowmelt) accumulated in areas of secondary containment (i.e., diked or bermed areas) surrounding tanks and other areas utilizing secondary containment structures. No flow volume has been specified, but HAK has indicated that, as with construction dewatering, secondary containment dewatering would be required primarily during the spring thaw, approximately May to June. Discharge of secondary containment dewatering may occur during the first two years of construction. Once the disposal well is completed, in approximately Year 3 of project construction, secondary containment dewatering generated on the island would be injected. Therefore, discharges from secondary containment dewatering activities are expected to occur intermittently during Year 1 through Year 3, at which point the waste stream would be injected into the disposal well.

2.1.10 USACE Permitting

The following proposed activities would require a permit from under Section 404 of the Clean Water Act:

- Development of a 25-acre gravel mine site (discharge of fill into jurisdictional wetlands);
- Construction of the tie-in pad, totaling 0.7 acres (discharge of fill into jurisdictional wetlands);
- Construction of ice road crossing pad, totaling 0.15 acres (discharge of fill into jurisdictional wetlands);
- Construction of VSMs (footprints) to support the elevated onshore pipeline over 1.5 miles, totaling 0.03 acres (discharge of fill into jurisdictional wetlands);
- Construction of the pipeline landfall trench, totaling 1.4 acres (discharge of fill into jurisdictional wetlands); and,
- Construction of the portion of pipeline located within the territorial seas, totaling 4.5 miles and 33 acres, the discharge of fill below mean high tide in navigable waters (the Beaufort Sea).

The construction of the 4.5-mile portion (33 acres) of pipeline within the territorial seas is subject to not only Section 404 of the Clean Water Act jurisdiction, but also to Section 10 of the Rivers and Harbors Act (RHA).

A Department of the Army permit under Section 10 of the RHA (as extended by section 4(f) of the Outer Continental Shelf Lands Act of 1953 as amended (43 U.S.C. 1333(e)) would also be required for the construction of the 24-acre artificial island and 1.1 miles of the pipeline on the OCS. This work would not be subject to Section 404 of the CWA.

Therefore, the Proposed Action would result in 27.28 acres of impacts subject to Section 404 only (onshore impacts), 33 acres subject to both Section 404 and Section 10 (territorial seas impacts), and 32 acres subject to Section 10 only (OCS impacts). An Individual Permit would be issued under Section 404 and Section 10 authorities.

2.1.11 NMFS Permitting

In 1972, Congress enacted the Marine Mammal Protection Act (MMPA), which puts a prohibition on the take of marine mammals, with certain exceptions; one of which is the issuance of Incidental Take Authorizations (ITAs) (16 USC 1371, 50 CFR Subpart 1).

Under the MMPA, the 'taking' of marine mammals, incidental or otherwise, without a permit or exemption is prohibited. Among the activities exempt from the MMPA's moratorium on the take of marine mammals is subsistence hunting of marine mammals by Alaska Natives [Section 101(b)]. Among the exceptions allowed to the moratorium on marine mammal takes [as stated in Sections 101(a)(5)(A) and (D)] is for the incidental, but not intentional, "taking," by U.S. citizens, while engaging in an activity (other than commercial fishing) of small numbers of marine mammals within a specified geographical region. The MMPA directs the Secretary of Commerce to authorize the take of small numbers of marine mammals provided that the taking would have a negligible impact on such species or stock, would not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses, and the permissible methods of taking and requirements pertaining to mitigation, monitoring, and reporting are set forth. Additionally, pursuant to Section 101(a)(5)(D) of the MMPA monitoring plans are required to be independently peer reviewed where the proposed activity may affect the availability of a species or stock for taking for subsistence uses.

The term "take" under the MMPA means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The MMPA further defines "harassment" as "any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment)."

Given the widespread presence of several species of marine mammals in the Beaufort Sea and the nature of oil and gas production facility construction and, potentially, operational activities, there is the potential that some activities associated with HAK's LDPI may result in the take of marine mammals incidental to the introduction of noise into the marine environment and ice road construction activities. Because of the potential for these activities to "take" marine mammals, HAK has submitted an Incidental Take Authorization (ITA) application to NMFS.

In order to satisfy their NEPA compliance obligations associated with the issuance of an MMPA ITA for the Liberty DPP, if issued, NMFS has agreed to assist in the preparation of this FEIS as a cooperating agency pursuant to 40 CFR 1501.6.

NMFS has identified the following alternatives for its own MMPA ITA action:

- **NMFS' Action:** Issuance of ITAs under Sections 101(a)(5)(A) or (D) of the MMPA for the incidental taking of marine mammals during construction and potentially operation of the LDPI.
- **NMFS' No Action:** NMFS would neither promulgate requested regulations nor issue authorizations under the MMPA relating to the potential taking of marine mammals incidental to construction and/or operation of the LDPI.

2.2 Alternatives

2.2.1 Alternatives Selection Process

BOEM developed Alternatives by considering public scoping comments, input from Cooperating Agencies, tribal and ANCSA corporation consultations, previous BOEM (formerly Minerals Management Service [MMS]) NEPA documents, and current conditions (existing infrastructure and operations) in North Slope oil and gas development. BOEM evaluated each suggested alternative for its ability to meet the Purpose and Need, and for technical and economic feasibility. Alternatives which were "screened out" are described in Section 2.4, Alternatives Considered but Not Carried Forward for Further Analysis.

The Cooperating Agencies that assisted in the development, screening, and selection of alternatives for analysis include:

- Bureau of Land Management (BLM)
- Bureau of Safety and Environmental Enforcement (BSEE)
- Environmental Protection Agency (EPA)
- National Marine Fisheries Service (NMFS)
- North Slope Borough (NSB)
- Pipeline and Hazardous Materials Safety Administration (PHMSA)
- State of Alaska (SOA)
- U.S. Army Corps of Engineers (USACE)

- U.S. Coast Guard (USCG)
- U.S. Fish and Wildlife Service (USFWS)
- Inupiat Community of the Arctic Slope (ICAS)

Existing NEPA analyses evaluating North Slope development since the original MMS 2001 Liberty EIS include the 2012 Point Thomson EIS, NOAA's 2016 Programmatic EIS concerning Effects of Oil and Gas Activities in the Arctic Ocean, the 2012 BLM National Petroleum Reserve-Alaska (NPR-A) EIS, and multiple Environmental Assessments (EAs) for ancillary activities in the Beaufort Sea.

Public Input on Alternatives includes public scoping meetings in Anchorage, Fairbanks, Utqiaġvik (previously Barrow), Kaktovik, and Nuiqsut in November 2015. Comments were also received by BOEM through www.regulations.gov from September 2015 through March 2016.

BOEM also took public comments on the DEIS during meetings held in Anchorage, Fairbanks, Utqiaġvik, and Nuiqsut during October 2017. BOEM was unable to visit Kaktovik due to poor weather conditions. Comments were also collected through www.regulations.gov from August 2017 through December 2017.

A comparison of the alternatives is found in Table 2-5 through Table 2-9.

2.2.2 Alternative 1 (Proposed Action)

Under this alternative, BOEM would approve the proposed DPP and authorize HAK to proceed with the Liberty Project as described in Section 2-1. The Liberty Project would be a self-contained offshore drilling and production facility located on an artificial gravel island called the LDPI with a pipeline to shore. Figure 2-16 illustrates the Proposed Action Area.

2.2.3 Alternative 2 (No Action)

Under this Alternative, the Proposed Action would not be approved and the actions described in the Liberty DPP would not take place. No oil and gas resources would be extracted from the Liberty unit at this time, and none of the negative or positive impacts that would be attributable to the Proposed Action would be realized.

Implementation of this alternative would not require any regulatory authorizations or permits from any of the Cooperating Agencies on this EIS.

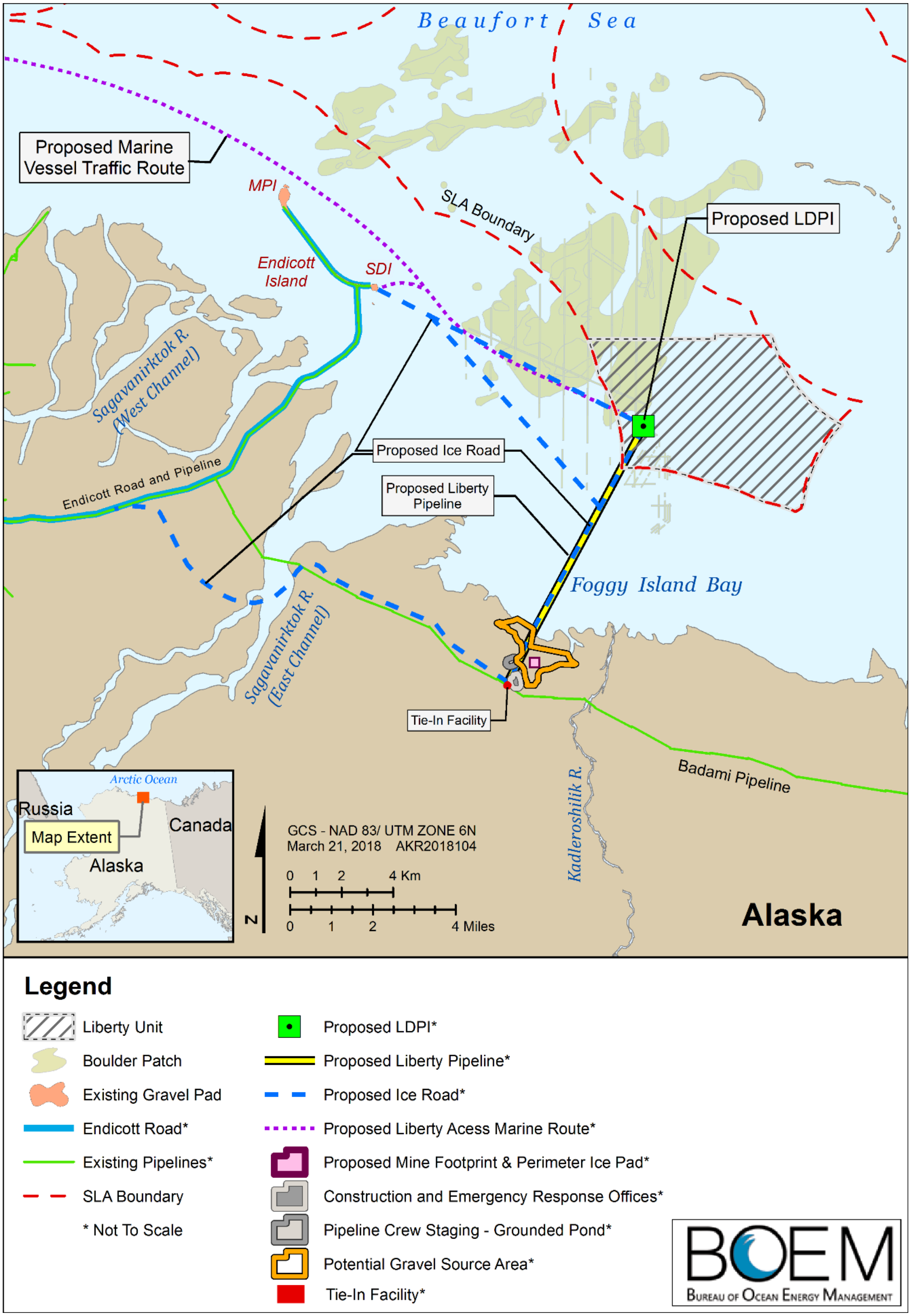

Figure 2-16 Proposed Action Area

2.2.4 Alternative 3 (Alternate LDPI Locations)

During scoping, BOEM received public comments suggesting the LDPI be relocated in order to avoid or reduce impacts to Boulder Patch communities. Based upon this input, BOEM requested that HAK identify possible alternate island locations that maintain the technical feasibility of the project and either:

1. Minimize impacts to the Boulder Patch from turbidity and sedimentation associated with construction activities, and/or
2. Move the LDPI and other project components as far from the densest areas of known Boulder Patch habitat as practicable.

Based on these public comments, responses from HAK, and independent review by BOEM geologists and petroleum engineers, BOEM developed two sub-alternatives.

The first, Alternative 3A, would relocate the LDPI to a site about 1 mile to the east, which would put the island approximately one mile further away from the densest areas of the Boulder Patch.

Alternative 3B places the LDPI approximately 1.5 miles closer to shore into State of Alaska waters. This location is 1.5 miles further away from the densest areas of the Boulder Patch.

For a comparison of the components of Alternative 3A and 3B with the Proposed Action, see Table 2-5 through Table 2-9.

2.2.4.1 Alternative 3A: Relocate LDPI Approximately One Mile to the East

This alternative would increase the distance of the LDPI from the densest parts of the Boulder Patch by about 1 mile.

2.2.4.1.1 Winter and Summer Access

Ice road construction activities would remain the same under Alternative 3A as for the Proposed Action, although the location and length of the ice roads would differ (shown in Figure 2-17). The ice roads would be approximately 34 miles in total. Summer access would involve the use of the same marine vessels as described in the Proposed Action. The marine transit route from West Dock to LDPI (Alternative 3A) is about 26 miles; from Endicott SDI to LDPI (Alternative 3A) is about 8.7 miles.

2.2.4.1.2 Gravel Mine Site Development

Alternative 3A would require more gravel than described in the Proposed Action to construct the Liberty infrastructure because the water depths at this site are deeper than at the Proposed Action site. This alternative would require about 1,398,000 cy of gravel to be mined; this would increase the size of the gravel mine (under the Proposed Action) by 1 acre, to about 26 acres total. This site is a 13-mile round trip from the proposed gravel mine site, which would require approximately 24 trucks working for 70 days; trips made per day would increase to accommodate the extra gravel transport (see Table 2-5 through Table 2-9 for full comparison of alternatives).

2.2.4.1.3 Island Construction

The LDPI would be located in deeper water, about 21 feet, compared to the Proposed Action which is in water about 19 feet deep and have a sea bottom footprint of about 24.5 acres (0.6 acres larger) to maintain the proper side slope of the island. The estimated amount of gravel needed for Alternative 3A LDPI would be about 980,000 cy instead of about 929,000 cy for the Proposed Action.

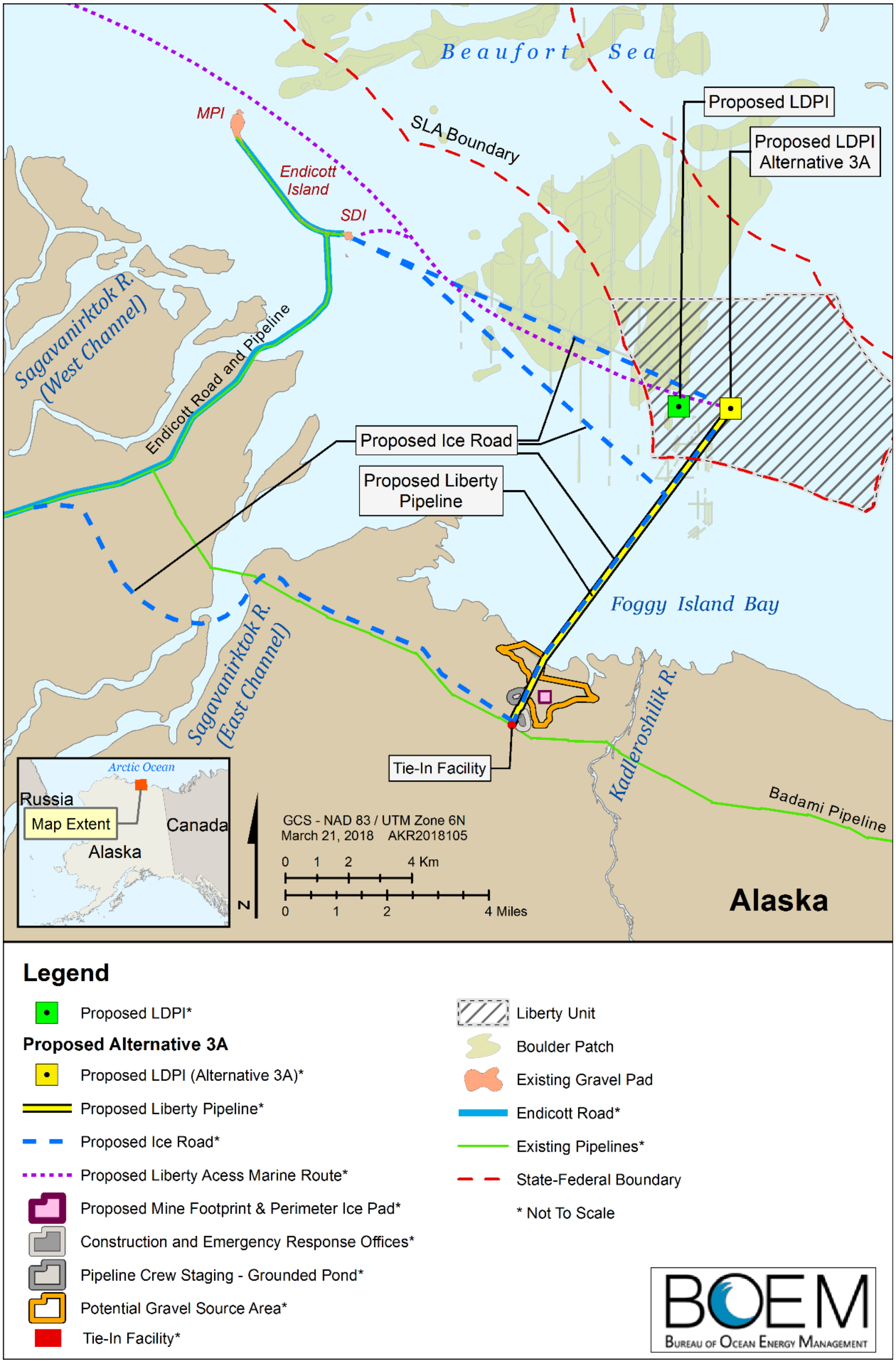

Figure 2-17 Alternative 3A: LDPI Moved Approximately 1 Mile to the East

2.2.4.1.4 Pipeline Construction

Under this alternative, the offshore portion of the pipeline would be moved 1 mile closer to the Kadleroshilik River Delta. The location of the onshore Badami pipeline tie-in would not be affected (see Figure 2-17). The pipeline in this alternative would be 7.7 miles long in total, with about 6.2 miles offshore. The resulting trench volume would be approximately 244,000 cy.

Approximately 0.25 mile of this offshore pipeline route would transverse through an area with a 100 percent possibility of overflood occurrence. Overflooding increases the risk of a strudel scour event, which could cause upheaval buckling (upward bending of the pipeline), wear, and possible pipeline rupture. Pipeline design changes would be necessary to contend with these risks. For the purpose of this analysis, BOEM assumes for Alternative 3A that the pipeline would be buried nearly 2 feet deeper than the Proposed Action pipeline to minimize potential for a strudel scour to contact the pipeline. This additional depth would require additional time spent excavating. Another potential design change to prevent strudel scour damage would be to increase the wall thickness of the pipeline to prevent upheaval buckling.

2.2.4.1.5 Facilities Construction

The surface area and the number/type of facilities located on the LDPI would remain the same as the Proposed Action.

2.2.4.1.6 Drilling Operations

This alternative would allow the Liberty Reservoir to be accessed and produced through conventional slant angle wells directionally drilled from the LDPI. The wells would be directionally drilled, with a plan view distance from the surface well head locations to bottomhole locations of no greater than a radius of 2.4 miles. The resulting borehole angles through the reservoir section would allow for standard drilling and completions, but it would increase the borehole angles and measured lengths through overlying shales and clays. The aggregate change in wellbore path length would reduce the volume of ultimately recoverable hydrocarbons by 1,152,000 barrels over the life of the field as compared to the Proposed Action owing to lengthening of producer wellbores draining the most prolific (northwest) part of the Liberty pool.

2.2.4.1.7 Production Operations and Decommissioning

Production operations and decommissioning under Alternative 3A would remain the same as in the Proposed Action.

2.2.4.2 Alternative 3B: Relocate LDPI Approximately 1.5 Miles to the Southwest

This alternative would decrease the distance between the proposed LDPI and the shore by 1.5 miles. It would also increase the distance of the LDPI from the densest parts of the Boulder Patch by 1.5 miles.

2.2.4.2.1 Winter and Summer Access

Ice road construction activities would remain the same under Alternative 3B as for the Proposed Action, although the location and length of the ice roads would differ (see Figure 2-18). The ice roads would be approximately 33 miles in total. Summer access would involve the use of the same marine vessels as described in the Proposed Action. The marine transit route from West Dock to LDPI (Alternative 3B) is about 25 miles; from Endicott SDI to LDPI (Alternative 3B) is about 7.6 miles.

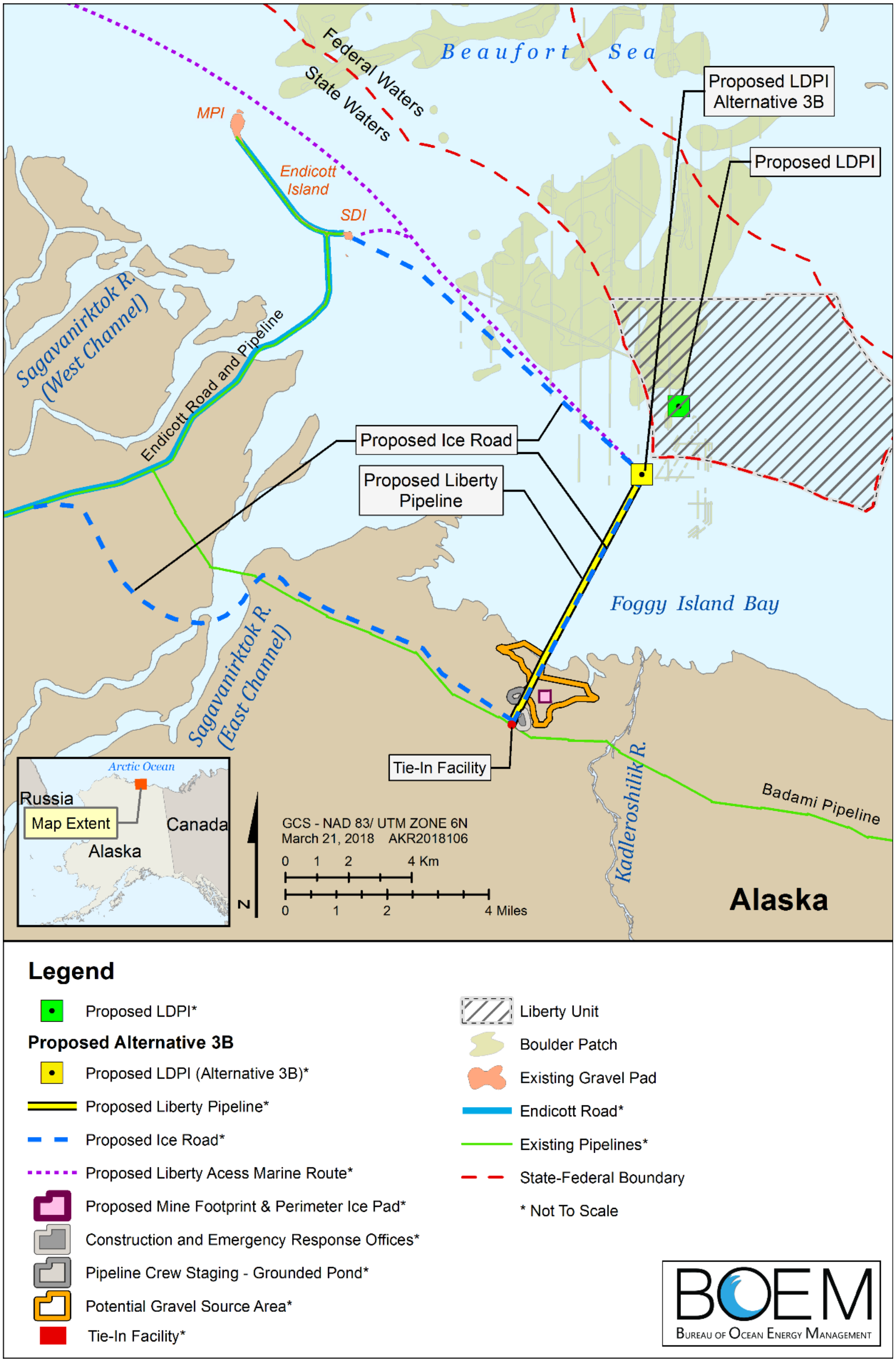

Figure 2-18 Alternative 3B: LDPI Moved Approximately 1.5 Miles to the Southwest

2.2.4.2.2 Gravel Mine Site Development

Alternative 3B would require about 1,297,000 cy of gravel to construct the Liberty infrastructure compared to about 1,337,000 cy for the Proposed Action. This could decrease the size of the mine site by about 1 acre, to 24 acres total. This site is a 10-mile round trip from the proposed gravel mine site, which would require approximately 24 trucks working for 62 days (see Table 2-5 through Table 2-9 for comparison of alternatives).

2.2.4.2.3 Island Construction

The surface area and the number/type of facilities located on the LDPI would remain the same as the Proposed Action. The LDPI would be located in shallower water than the Proposed Action 17 feet instead of 19 feet, requiring less gravel, and having a smaller sea bottom footprint, about 23.4 acres instead of 24 acres to maintain the proper side slope of the island. The estimated amount of gravel needed for Alternative 3B LDPI would be about 879,000 cy compared to about 929,000 cy for the Proposed Action.

2.2.4.2.4 Pipeline Construction

This alternative would not alter the location of the onshore Badami pipeline tie-in or the proposed pipeline route. The offshore pipeline would be 1.5 miles shorter, which would require about 20 percent less construction material (including the pipeline, cathodic bracelets, etc.) and an estimated 8-14 days less construction time. The resulting trench volume for this alternative would be 177,500 cy as compared to 491,000 cy for the Proposed Action.

2.2.4.2.5 Facilities Construction

The surface area and the number/type of facilities located on the LDPI would remain the same as the Proposed Action.

2.2.4.2.6 Drilling Operations

This alternative would increase the length of each wellbore by about 2,850 feet to an average length of approximately 17,200 feet , as compared to an average wellbore length of approximately 14,350 feet for the Proposed Action. The resulting borehole angles through the reservoir section would allow for standard drilling and completions; however, this alternative flattens wellbore angles and increases the measured lengths of open holes through unstable shale formations that are prone to wellbore collapse. The volume of ultimately recoverable hydrocarbons as compared to the Proposed Action would be reduced by 1,026,000 barrels over the life of the field owing to lengthening of producer wellbores draining the most prolific (northwest) part of the Liberty pool.

2.2.4.2.7 Production Operations and Decommissioning

Production operations and Decommissioning under Alternative 3B would remain the same as in the Proposed Action.

2.2.4.2.8 State Permitting

Under Alternative 3B, the LDPI would be located on State of Alaska submerged lands, meaning regulatory jurisdiction over certain aspects of the project would shift from the Federal government to the State of Alaska. This could include, but is not limited to, jurisdiction over air quality, oil spill response, water quality, underground injection (disposal wells), wastewater treatment, and disposal. Alternative 3B would also require the operator to acquire a Surface Use Lease from the State of Alaska prior to constructing the LDPI.

2.2.4.2.9 EPA Permitting

Under Alternative 3A, EPA's NPDES permitting requirements would be the same as those required under the Proposed Action. Although the locations of the wastewater discharges would change, the discharges would still occur to federal waters of the United States and are therefore subject to NPDES permitting requirements under the CWA. Under Alternative 3B, EPA would not have NPDES permitting authority and would not issue an NPDES permit. Discharges would occur in State waters and the Alaska Department of Environmental Conservation (ADEC) would be the permitting authority and the discharges would be subject to an Alaska Pollutant Discharge Elimination System (APDES) permit.

2.2.4.2.10 USACE Permitting

Under Alternative 3A, the following proposed activities would require a permit from USACE under Section 404 of the Clean Water Act:

- Development of a 26-acre gravel mine site (discharge of fill into jurisdictional wetlands)
- Construction of the tie-in pad, totaling 0.7 acres (discharge of fill into jurisdictional wetlands)
- Construction of ice road crossing pad, totaling 0.15 acres (discharge of fill into jurisdictional wetlands)
- Construction of VSMs (footprints) to support the elevated onshore pipeline over 1.5 miles, totaling 0.03 acres (discharge of fill into jurisdictional wetlands)
- Construction of the pipeline landfall trench, totaling 1.4 acres (discharge of fill into jurisdictional wetlands)
- Construction of the portion of pipeline located within the territorial seas (as defined under the CWA to extend 3 miles from shore), totaling 4.9 miles and 35.6 acres (the discharge of fill below mean high tide in navigable waters [the Beaufort Sea])

The construction of the 4.9 miles portion of pipeline within the territorial seas is subject to not only Section 404 of the Clean Water Act jurisdiction, but also to Section 10 of the RHA.

A Department of the Army permit under Section 10 of the RHA—as extended by Section 4(f) of the OCS Lands Act of 1953 as amended [43 U.S.C. 1333(e)]— would also be required for the construction of the 24.5-acre artificial island and 1.3 miles of the pipeline on the OCS. This work would not be subject to Section 404 of the CWA.

Therefore, Alternative 3A would result in 2.28 acres of impacts subject to Section 404 only (onshore impacts), 35.6 acres subject to both Section 404 and Section 10 (territorial seas impacts), and 34 acres subject to Section 10 only (OCS impacts). An Individual Permit would be issued under Section 404 and Section 10 authorities.

Under Alternative 3B, the following proposed activities would require a permit from USACE because they would impact waters of the U.S. (WOUS). The following activities are subject to Section 404 of the CWA:

- Development of a 24-acre gravel mine site (discharge of fill into jurisdictional wetlands)
- Construction of the tie-in pad, totaling 0.7 acres (discharge of fill into jurisdictional wetlands)
- Construction of ice road crossing pad, totaling 0.15 acres (discharge of fill into jurisdictional wetlands)
- Construction of VSMs (footprints) to support the elevated onshore pipeline over 1.5 miles, totaling 0.03 acres (discharge of fill into jurisdictional wetlands)

- Construction of the pipeline landfall trench, totaling 1.4 acres (discharge of fill into jurisdictional wetlands)
- Construction of the portion of pipeline located within the territorial seas, totaling 4.1 miles and 29.8 acres (the discharge of fill below mean high tide in navigable waters [the Beaufort Sea])
- Construction of the Alternate 3B proposed LDPI within the territorial seas, totaling 23.4 acres, (the discharge of fill below mean high tide in navigable waters [the Beaufort Sea])

The construction of the 4.1 miles portion (35.6 acres) of pipeline and the Alternate 3B proposed LDPI (23.4 acres) within the territorial seas is subject to not only Section 404 of the CWA jurisdiction, but also to Section 10 of the RHA.

Therefore, Alternative 3B would result in 26.28 acres of impacts subject to Section 404 only (onshore impacts), and 53.2 acres subject to both Section 404 and Section 10 (territorial seas impacts). An Individual Permit would be issued under Section 404 and Section 10 authorities.

2.2.5 Alternative 4 (Alternate Processing Locations)

This Alternative has 2 subalternatives. Alternative 4A would move the oil and gas processing facilities from the LDPI to the existing Endicott Main Production Island (MPI) facilities. Alternative 4B would move oil and gas processing facilities from the LDPI to a new onshore facility. Both of these subalternatives would be located in areas of existing archaeological surveys.

Both subalternatives match the Proposed Action in that the LDPI would be constructed and house wells to access the reservoir, and a pipeline would still be necessary to transport fluid to shore. They differ from the Proposed Action in that fluid transported via pipeline from the LDPI would be an unprocessed solution of oil, gas, water, and other constituents (termed “3-phase” fluid) as opposed to processed oil. For a comparison of the components of Alternative 4A and 4B with the Proposed Action, see Table 2-5 through Table 2-9.

These alternatives were developed as a result of scoping comments suggesting that onshore processing and power generation may minimize impacts to marine resources and subsistence harvest practices from on-island equipment noise and vibration.

2.2.5.1 Alternative 4A: Relocate Oil and Gas Processing to Endicott Facilities

Under this alternative, a 3-phase pipeline would route around the Boulder Patch to Endicott SDI, then transported along the Endicott Causeway in existing piping to the Endicott MPI. Processing would be carried out at the Endicott MPI facilities. Drilling activities would remain on LDPI (Figure 2-19).

2.2.5.1.1 Winter and Summer Access

Ice road construction activities would remain the same under Alternative 4A as for the Proposed Action. The ice roads would run approximately 35 miles in total. Summer access would involve the use of the same marine vessels as described in the Proposed Action.

2.2.5.1.2 Gravel Mine Site Development

In this alternative, the mine site would decrease to about 19 acres compared to the 25 acres described in the Proposed Action. About 1,040,000 cy would be extracted to support Alternative 4A compared to about 1,337,000 cy described in the Proposed Action. This site is a 13-mile round trip from the proposed gravel mine site, which would require would require 24 trucks working for 47 days.

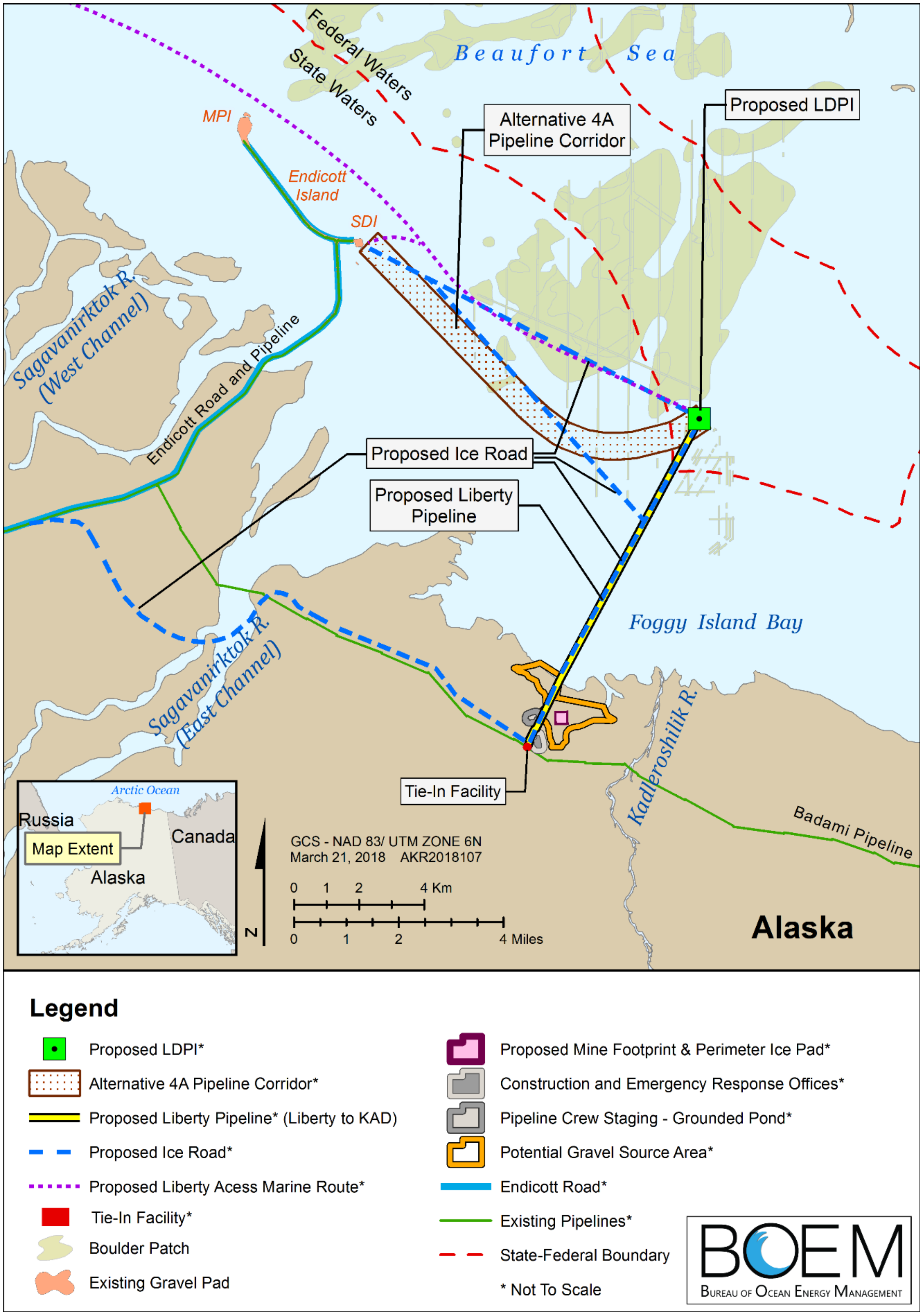

Figure 2-19 Alternative 4A: Endicott Processing and Alternate Pipeline Route

2.2.5.1.3 Island Construction

Relocating the oil and gas processing facilities to Endicott facilities would reduce the work surface area of the LDPI to 5.4 acres. The seabottom footprint would also decrease to about 17.2 acres. The LDPI for this alternative would require approximately 622,000 cy of gravel to construct (compared to about 929,000 cy). The decreased LDPI size would require roughly 18 to 20 days less to construct.

2.2.5.1.4 Pipeline Construction

In this alternative, the subsea three-phase pipeline bundle would be routed to the west of the LDPI, around the Boulder Patch, to the Endicott SDI; from that point, existing pipelines would transport the oil until it reaches the TAPS. This alternative would increase the subsea pipeline length to 7.7 miles from 5.6 miles under the Proposed Action. The pipeline materials (including the pipeline, cathodic bracelets, etc.) required would increase by approximately 250 percent.

This alternative would change the design of the pipeline bundle to include:

- A 14-inch diameter pipe-in-pipe 3-phase pipeline
- A 10-inch insulated and concrete coated treated seawater pipeline
- A 6-inch high pressure natural gas pipeline
- A shielded power cable
- A fiber-optic communications cable

Once the production was brought onto the SDI, the existing piping would be used to transport the fluid to the MPI. Transportation of natural gas and power back to the island would need the addition of appropriate means of transport.

These additions to the pipeline bundle would be necessary because natural gas and produced water would not be separated on-site, and would need to be transported back to LDPI after separation into single phases. The offshore construction time would increase by 40 to 50 days for the additional welding required to assemble the pipelines. The pipeline trench depth and trench design would require additional engineering and calculations to determine the minimum depth of cover and strain demand of the pipeline due to thaw settlement. The resulting trench volume would be about 292,000 cy.

2.2.5.1.5 Facilities Construction

Endicott was constructed in 1987 with a 25 to 30 year design life and a specific capacity, meaning that the facility was designed to last until the reservoir was depleted without tremendous changes or modifications. If Endicott were to process Liberty fluids, the design life of this facility would have to be more than doubled, as the proposed LDPI also has a proposed design life of 25 to 30 years, and first production is not expected until the early 2020's. Extensive work would have to occur at Endicott to accomplish this increase in design life, particularly in the realm of engineering design and equipment fabrication and installation. Alternative 4A would require the curtailing of production from current Endicott wells to enable the Endicott processing facilities to accept Liberty oil, water, and gas due to processing capacity restrictions at Endicott.

The additional equipment and processing load would also require 10 to 12 additional personnel at the facility. The expected operational cost (including engineering redesign, additional/modified equipment, general maintenance of an aging facility) of maintaining Endicott for the design life of Liberty is estimated to be twice the cost to build and maintain the proposed LDPI.

Endicott is the closest existing oil and gas processing facility to the Liberty reservoir. It is currently operated by HAK.

2.2.5.1.6 Drilling Operations

Drilling activities under Alternative 4A would be similar to those described for the Proposed Action. Additional decommissioning activities would occur on Endicott.

2.2.5.1.7 Production Operations

Sales Oil Conditioning

Oil, gas, and water would be carried in a single pipeline from the LDPI to Endicott SDI, then along the existing causeway piping to Endicott MPI for processing. The 3-phase fluid would be separated and treated at the existing Endicott MPI facility.

Key Changes from the Proposed Action

- Equipment such as production modules, custody transfer metering, sale oil pumps, and oil storage tanks would not be present on LDPI. Instead, additional equipment and facility upgrades would be required at Endicott to handle the additional flow from the Liberty reservoir.
- Booster pumps would need to be installed offshore to propel the 3-phase fluid to the Endicott SDI.
- Methane hydrate inhibition equipment on LDPI would need a larger volume capacity to prevent hydrate formation in the 3-phase line before reaching Endicott SDI. Hydrates form in pipelines from mixing of natural gas and water at low temperature and high pressures and can be a danger if not treated effectively. Liberty's high carbon dioxide (CO_2) content and presence of hydrogen sulfide (H_2S) may make it more susceptible to hydrate formation in a 3-phase stream. Depending on need and the inhibition methods deemed appropriate by the operator, the following may be necessary:
  - Larger capacity fuel-gas fired production heater(s) on LDPI and/or
  - Chemical treatment equipment and chemical pipeline (typically methanol) from SDI to LDPI or constant resupply of chemicals by barge.
- The 12-inch pipe-in-pipe sales oil pipeline would be changed to a 14-inch, 3-phase, pipe-in-pipe pipeline.
- If Endicott MPI does not process out CO_2 (which both Endicott and Liberty fields are rich in), the return gas have limited value as fuel gas, possibly requiring alternate power generation equipment.

Gas Compression and Treatment

Currently, the Endicott facilities do not have the capacity to support additional produced gas from Liberty. The additional equipment and processing load would also require an additional 10 to12 operators at the facility. The expected operational cost (including engineering redesign, additional/ modified equipment, general maintenance of an aging facility) of maintaining Endicott for the design life of Liberty is estimated to be twice the cost to build and maintain the proposed LDPI.

Key Changes from the Proposed Action

Gas processing equipment that would be relocated to Endicott:

- All gas compressor modules
- Vapor recovery module
- Gas dehydration unit, flare boom
- Flare and flare knock out vessel

- Associated metering
- A 6-inch high pressure natural gas pipeline would be added to the pipeline bundle

Processed natural gas from the Liberty reservoir would be used to provide reinjection gas for pressure maintenance of the reservoir. Natural gas is also used for gas lift operations, which increase and maintain maximum economic production and depletion rates.

After processing at Endicott, the produced gas would be compressed in multiple stages and transported through a high pressure pipeline back to the LDPI to be used as fuel gas, wellbore lift gas, and reservoir injection gas. The high pressure pipeline would transport approximately 120 million standard cubic feet per day (MMscfd) of natural gas at approximately 5,000 pounds per square inch gauge pressure (psig) to the LDPI. As a result of commingled 3-phase production at Endicott, some processed Liberty natural gas would be used for fuel gas and reinjection in wells at Endicott. Any Natural Gas Liquids (NGLs) formed in processing at Endicott would be sold as oil through the Badami pipeline as specified vapor pressure limits allow. Remaining NGLs are blended to become a miscible injectant that is used in miscible water-alternating-gas (MWAG) enhanced recovery operations at Endicott, and LDPI.

Seawater Treatment

The existing seawater treatment plant at Endicott would be modified or an additional plant would be constructed to allow for the additional capacity of water necessary to support Liberty production. At LDPI the treated seawater will be branched to deliver water to both the Living Quarters Utilities where it will receive additional treatment for domestic use and to the water injection pumps to support reservoir waterflooding.

Produced Water Treatment

Reservoir produced water would be separated from production fluids during processing and combined with the MWAG enhanced recovery operations at Endicott.

Power Generation

For this alternative, power for the offshore LDPI facility would be generated at Endicott. Existing facilities on Endicott would require upgrades and/or additional generators for the increased demand for the onshore and offshore power. Natural gas from the comingled (Endicott and Liberty) production fluid would be used to generate power for both Endicott and Liberty facilities, including drilling rigs and other equipment.

Key Changes from the Proposed Action

- Power generation equipment to be relocated to Endicott would include power generation units, switchgear modules, and associated cable trays.
- A shielded power cable would be added to the pipeline bundle.

2.2.5.1.8 Decommissioning

Decommissioning activities under Alternative 4A would be similar to those described for the Proposed Action.

2.2.5.2 Alternative 4B: Relocate Oil and Gas Processing to a New Onshore Facility

Under this alternative, a new onshore oil and gas processing facility would be constructed near the Badami pipeline tie-in point (Figure 2-20).

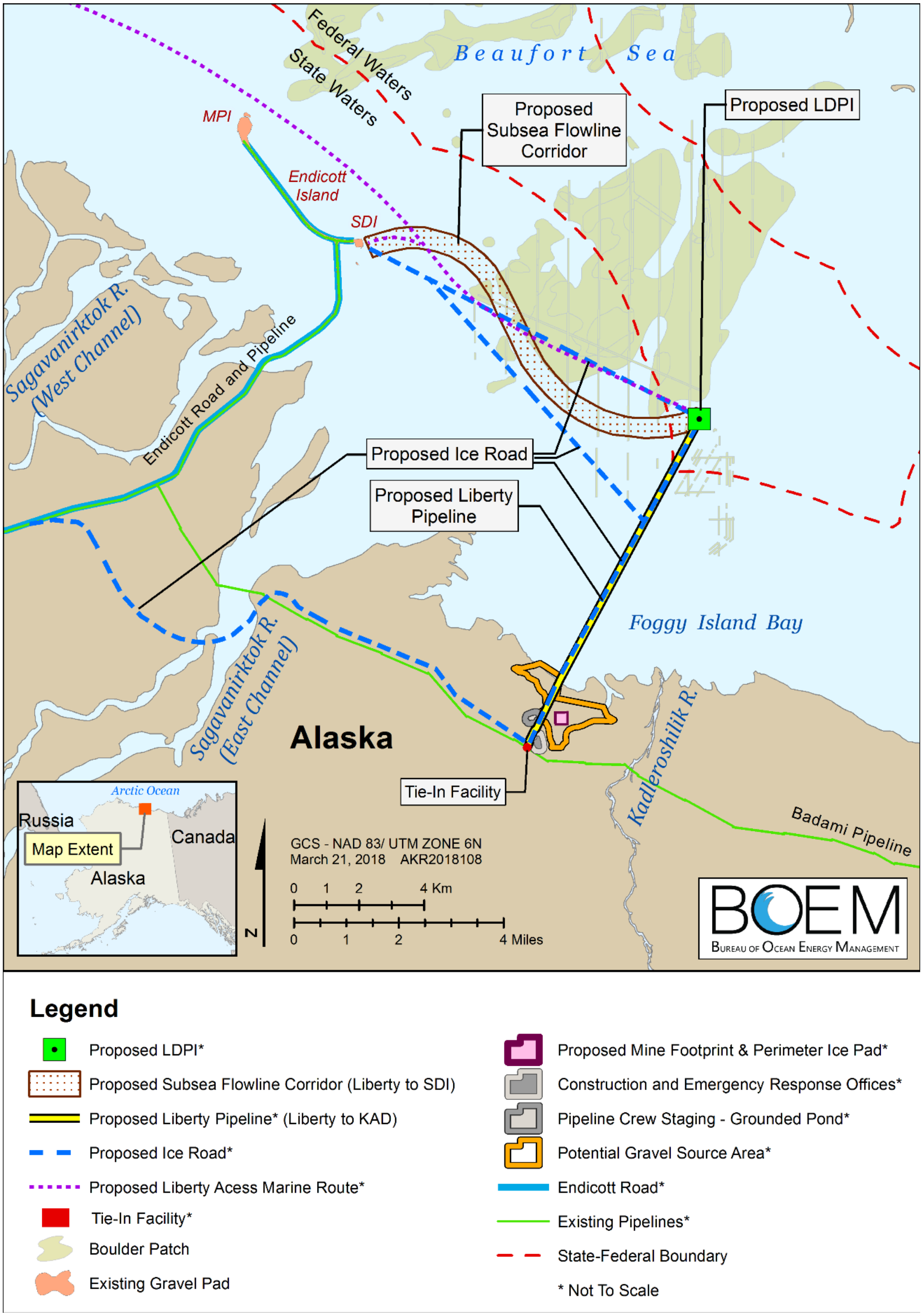

Figure 2-20 Alternative 4B: Onshore Processing

2.2.5.2.1 Winter and Summer Access

Ice road construction activities would remain the same under Alternative 4B as for the Proposed Action. Summer access would involve the use of the same marine vessels as described in the Proposed Action and a gravel road would be constructed along the Badami pipeline corridor to reach this facility.

A permanent gravel road would be constructed to support transportation between the new onshore processing facility and Endicott Road. This gravel road would be about 52 feet wide and nearly 12 miles long, requiring about 720,000 cy of gravel. Additionally, a bridge would be required to span the East Channel of the Sagavanirktok River as part of this alternative. Additional bridges would likely be required to allow floodwater passage at swales and flood channels, as well as numerous cross drainage culverts along the permanent gravel road.

2.2.5.2.2 Gravel Mine Site Development

The combined gravel requirements for the reduced LDPI and additional onshore Liberty Processing Pad would be about 1,848,800 cy. This would require expanding the gravel mine site to about 35 acres, compared to the 25 acres described in the Proposed Action.

2.2.5.2.3 Island Construction

Relocating the oil and gas processing and produced water treatment to an onshore pad would reduce the required working surface area of the proposed LDPI. Under Alternative 4B, the working surface area would be reduced from 9.3 acres for Proposed Action to 6.1 acres. The disturbance to the seafloor would be reduced from 24 acres for the Proposed Action to 18.4 acres. This island would require up to 666,000 cy of gravel to construct, as compared to about 929,000 cy for the Proposed Action. The smaller LDPI would require 15 to 20 days less time to construct.

2.2.5.2.4 Pipeline Construction

In this alternative, the subsea pipeline bundle would maintain the route of the Proposed Action.

This alternative would change the design of the pipeline bundle to include:

- A 14-inch, pipe-in-pipe, 3-phase pipeline;
- A 6-inch high pressure natural gas pipeline;
- A shielded power cable;
- A fiber-optic communications cable;
- A pipeline to return produced water to LDPI for reinjection; and
- An enlarged outer pipe to house the 14-inch inner pipe.

These changes to the pipeline bundle would increase pipeline materials cost by roughly 50 percent. The offshore construction time would increase by 10 to 15 days for the additional welding required to assemble the pipelines. The trench depth and design for this alternative would require engineering and calculations to determine the minimum depth of cover and strain demand of the pipeline due to thaw settlement.

2.2.5.2.5 Facilities Construction

In this alternative, oil and gas processing would be conducted at a new facility near the Badami Sales Oil Pipeline tie-in point. A new production pad would be constructed to host the processing and power generation equipment relocated from the LDPI. The additional onshore Liberty Processing Pad would have 3.9 acres of working surface area. The estimated gravel required for construction is 44,800 cy. This onshore Liberty Pad would require about 10 to 12 additional days for construction.

This new pad would require about 16 to 20 operations personnel in addition to the required 8 to 12 operators offshore.

2.2.5.2.6 Drilling Operations

Drilling activities under Alternative 4B would be similar to those described for the Proposed Action.

2.2.5.2.7 Production Operations

Sales Oil Conditioning

In this alternative, 3-phase production fluid would be comingled into a single pipeline for processing onshore. After transport to the onshore facility, the 3-phase fluid would be separated and treated in the same manner as described in the Proposed Action. Sales quality oil would then be metered and transported via pipeline to the Badami Sales Oil Pipeline tie-in pad where it would mix with oil from Badami and Point Thomson before entering the TAPS.

Key Changes from the Proposed Action:

- Produced fluid equipment to be located on shore includes production modules, custody transfer metering, sale oil pumps, and oil storage tanks.
- The 12-inch pipe-in-pipe sales oil pipeline would be changed to a 14-inch, 3-phase, pipe-in-pipe pipeline.

Gas Compression and Treatment

In this alternative, the produced gas would be compressed in multiple stages at the onshore facility and transported back to the offshore facility for fuel gas, wellbore lift gas, and reservoir injection gas. The high pressure pipeline would transport approximately 120 MMscfd of natural gas at approximately 5,000 psig to the LDPI. Processed natural gas from the Liberty reservoir would provide reinjection gas for pressure maintenance of the reservoir. This pressure maintenance is necessary for supporting reservoir management efforts in order to maximize the total economic recovery of available hydrocarbon liquids. Gas lift operations also require the use of natural gas to increase and maintain maximum economic production and depletion rates.

Key Changes from the Proposed Action

- Gas processing equipment to be relocated onshore: all gas compressor modules, vapor recovery module, gas dehydration unit, flare boom, flare knock out pot, and associated metering.
- A 6-inch high pressure natural gas pipeline would be added to the pipeline bundle.

Produced Water Treatment

The produced water would be treated and routed to the water injection line for reinjection at LDPI.

Key Changes from the Proposed Action

- Produced water equipment to be relocated onshore include water filtration modules, produced water pumps, and a water storage tank.

Power Generation

Power for the LDPI and the new onshore Liberty Processing Pad would be generated onshore. Natural gas from the reservoir production stream would be used to generate power for the offshore and onshore facilities, including drilling rigs and other equipment.

Key Changes from the Proposed Action

- Additional power requirements would result from duplicate systems for LDPI and the onshore Liberty Pad processing.

2.2.5.2.8 Decommissioning

Decommissioning activities under Alternative 4B would be the similar as those described for the Proposed Action. Additional decommissioning activities would occur at the onshore processing facility.

2.2.5.2.9 EPA Permitting

Under Alternative 4, certain discharges would be transported to the Endicott SDI (Alternative 4A) or a new onshore production facility (Alternative 4B), both of which are located in or would discharge to state waters. EPA's permitting requirements under Alternative 4A would include providing NPDES permit coverage for the following waste streams discharged from the LDPI into Federal waters:

- Sanitary and domestic wastewater (Outfalls 001a)
- Potable water treatment reject (Outfall 001b)
- Construction dewatering (Outfall 003)
- Secondary containment dewatering (Outfall 004)

All other waste streams would be discharged to state waters and would require APDES coverage from ADEC.

2.2.5.2.10 USACE Permitting

Under Alternative 4A, the following proposed activities would require a permit under Section 404 of the CWA:

- Development of a 19-acre gravel mine site (discharge of fill into jurisdictional wetlands)
- Construction of the portion of pipeline located within the territorial seas, totaling 7.1 miles and 51.6 acres (the discharge of fill below mean high tide in navigable waters [the Beaufort Sea])

The construction of the 7.1 miles portion of pipeline within the territorial seas is subject to not only Section 404 of the CWA jurisdiction, but also to Section 10 of the RHA.

A Department of the Army permit under Section 10 of the RWA (as extended by section 4(f) of the OCS Lands Act of 1953 as amended [43 U.S.C. 1333(e)]) would also be required for the construction of the 17.2-acre artificial island and 0.6 miles of the pipeline on the OCS. This work would not be subject to Section 404 of the CWA.

Therefore, Alternative 4A would result in 21.28 acres of impacts subject to Section 404 only (onshore impacts), 51.6 acres subject to both Section 404 and Section 10 (territorial seas impacts), and 21.6 acres subject to Section 10 only (OCS impacts). An Individual Permit would be issued under Section 404 and Section 10 authorities.

Under Alternative 4B, the following proposed activities would require a permit from the USACE because they would impact WOUS. The following activities are subject to Section 404 of the CWA:

- Development of a gravel mine site, totaling 35 acres (discharge of fill into jurisdictional wetlands)
- Construction of an onshore facility, totaling 3.9 acres (discharge of fill into jurisdictional wetlands)

- Construction of a gravel road, totaling 76 acres (discharge of fill into jurisdictional wetlands)
- Construction of ice road crossing pad, totaling 0.15 acres (discharge of fill into jurisdictional wetlands)
- Construction of VSMs (footprints) to support the elevated onshore pipeline over 1.5 miles, totaling 0.03 acres (discharge of fill into jurisdictional wetlands)
- Construction of the pipeline landfall trench, totaling 1.4 acres (discharge of fill into jurisdictional wetlands)
- Construction of the portion of pipeline located within the territorial seas, totaling 4.5 miles and 33 acres (the discharge of fill below mean high tide in navigable waters [the Beaufort Sea])

The construction of the 4.5-mile portion (33 acres) of pipeline within the territorial seas is subject to not only Section 404 of the CWA jurisdiction, but also to Section 10 of the RHA.

A Department of the Army permit under Section 10 of the RHA (as extended by Section 4(f) of the OCS Lands Act of 1953 as amended (43 U.S.C. 1333(e)) would also be required for the construction of the 18.4-acre artificial island and 1.1 miles (8 acres) of the pipeline on the OCS. This work would not be subject to Section 404 of the CWA.

Therefore, Alternative 4B would result in 116.48 acres of impacts subject to Section 404 only (onshore impacts), 33 acres subject to both Section 404 and Section 10 (territorial seas impacts), and 26.4 acres subject to Section 10 only (OCS impacts). An Individual Permit would be issued under Section 404 and Section 10 authorities.

2.2.6 Alternative 5 (Alternate Gravel Sources)

Alternatives 5A and 5B consider different proposed gravel mine site locations. (Figure 2-21 and Figure 2-22). A third site suggested during scoping, the Duck Island Mine site, was considered as Alternative 5C in the Draft Environmental Impact Statement (DEIS) but has been dismissed from analysis in this FEIS because it is no longer considered to be a feasible alternative. Additional information received from cooperating agencies indicate that the Duck Island Mine Site is currently flooded and unlikely to contain enough usable material.

These subalternatives were developed in response to scoping comments suggesting BOEM analyze an alternate location for the proposed West Kadleroshilik River Mine Site #1 to minimize impacts to migratory birds, wetlands, fish used for subsistence purposes, and other resources. BOEM conducted a thorough review of existing technical and survey information and based on this review identified two reasonable alternate locations.

For a comparison of the components of Alternative 5A and 5B with the Proposed Action, see Table 2-5 through Table 2-9.

2.2.6.1 Alternative 5A: East Kadleroshilik River Mine Site #2

2.2.6.1.1 Winter and Summer Access

Ice road construction activities would remain the same under Alternative 5A as for the Proposed Action, though the location and length would differ. The ice roads would run approximately 34 miles in total. Summer access would involve the use of the same marine vessels as described in the Proposed Action.

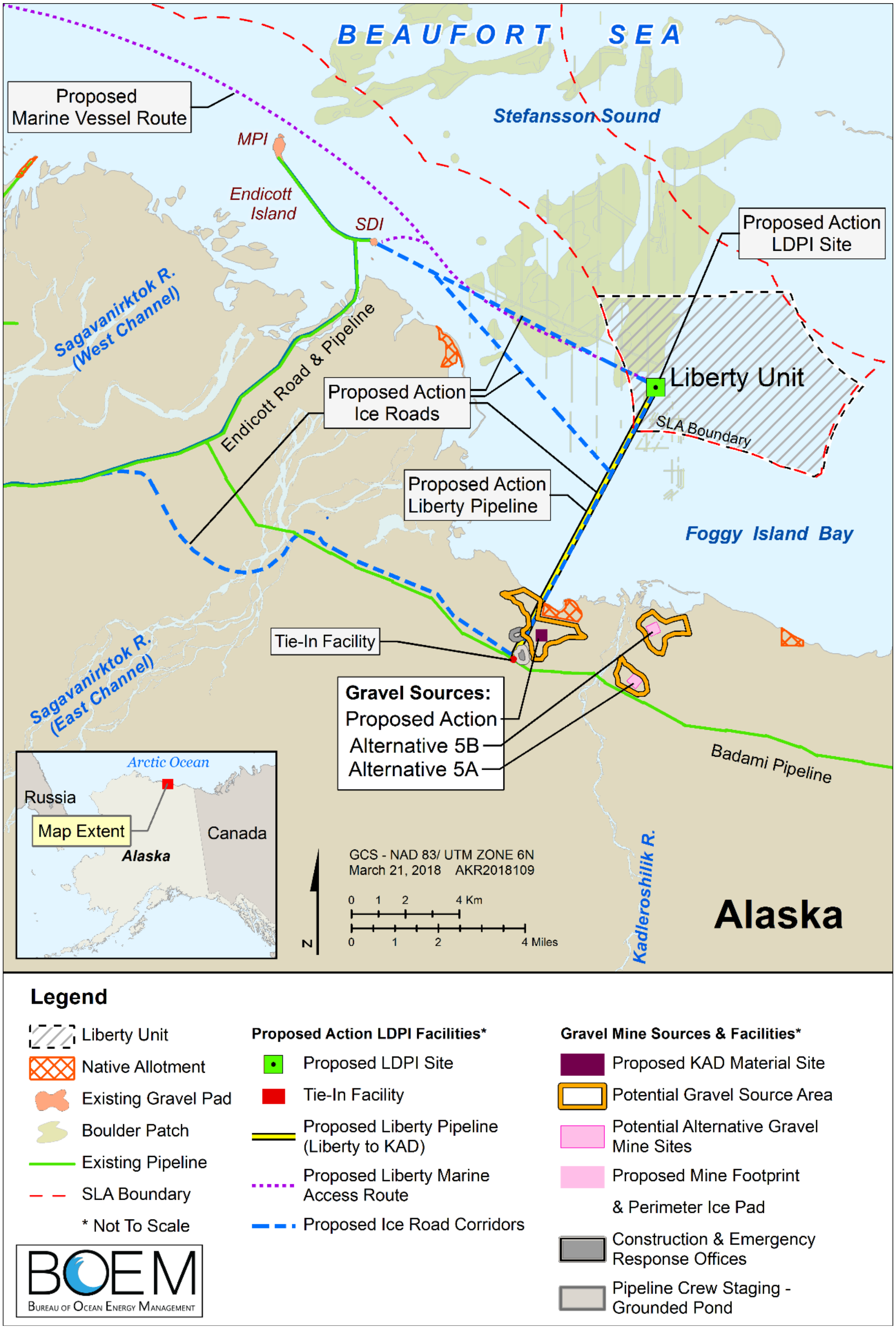

Figure 2-21 Alternative 5: Alternate Mine Site Locations, Overview

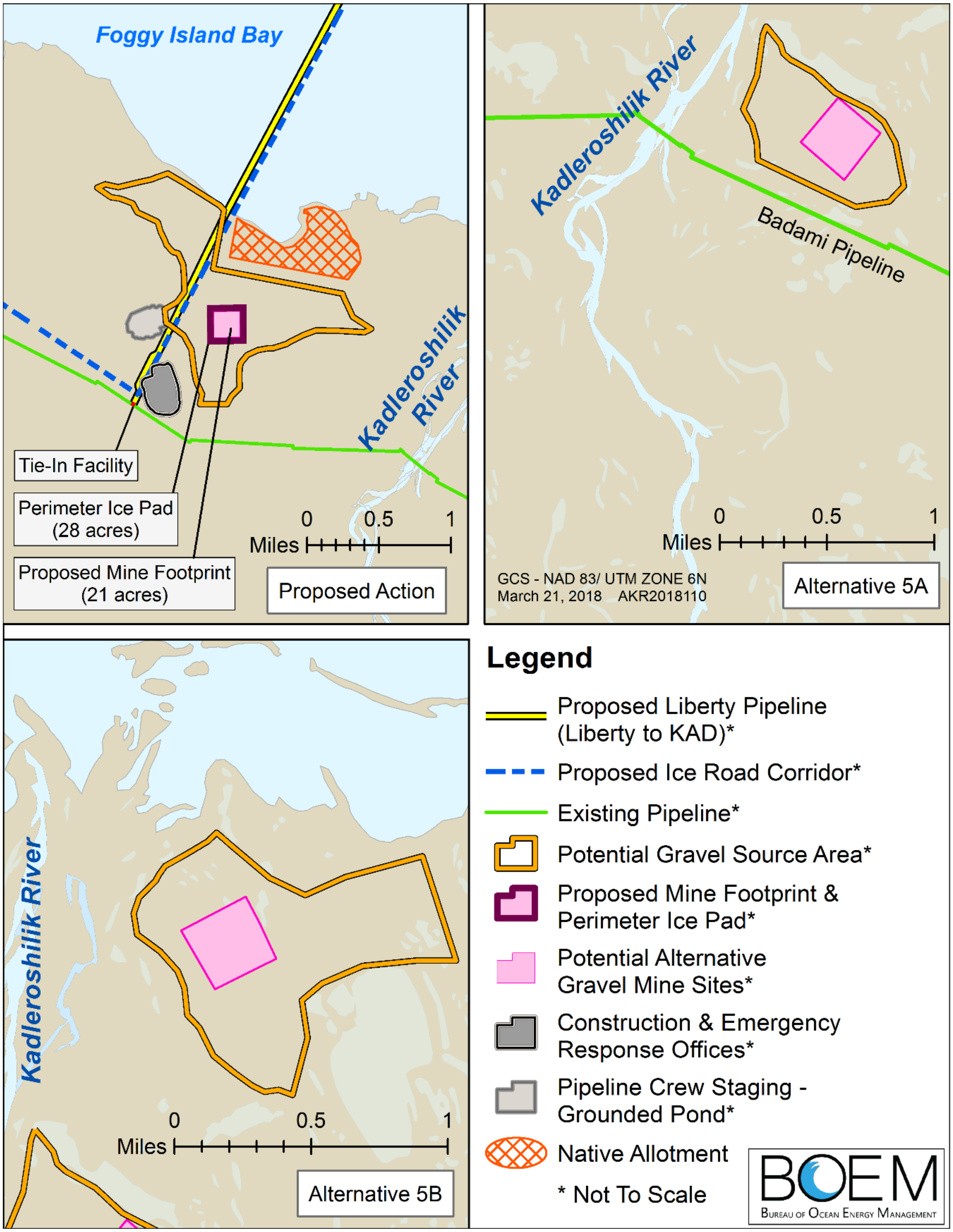

Figure 2-22 Alternative 5: Alternate Mine Site Locations, Detail

2.2.6.1.2 Gravel Mine Site Development

This site lies about 2 miles inland from the coast on an isolated area of high ground immediately east of the Kadleroshilik River. It is outside of the active floodplain. This alternative would require an ice road (not included in the Proposed Action) with a river crossing.

Geotechnical information has not been collected for this specific area. However, nearby areas have shown sandy gravel with fines content of 12 percent, ranging from 15 feet to 40 feet in the subsurface; the first 15 feet is considered overburden.

This location is about a 13-mile round trip from the LDPI. This alternative would require 24 trucks working over a period of 70 days.

2.2.6.1.3 Island, Pipeline, and Facilities Construction, Drilling and Production Operations, and Decommissioning

These activities would remain the same under Alternative 5A as for the Proposed Action.

2.2.6.2 Alternative 5B: East Kadleroshilik River Mine Site #3

2.2.6.2.1 Winter and Summer Access

Ice road construction activities would remain the same under Alternative 5B as for the Proposed Action, though the location and length would differ. The ice roads would run approximately 34 miles in total. Summer access would involve the use of the same marine vessels as described in the Proposed Action.

2.2.6.2.2 Gravel Mine Site Development

This site is near the coast (approximately 0.5 miles), is of adequate elevation to avoid seawater inundation, but is at greater risk for coastal erosion. This alternative would require an additional ice road (not included in the Proposed Action) with a river crossing.

Geotechnical information has not been collected for this specific area. However, nearby areas have shown sandy gravel with fines content of 12 percent, ranging from 15 feet to 40 feet in the subsurface; the first 15 feet is considered overburden.

This location is about a 13-mile round trip from the LDPI. This alternative would require 24 trucks working over a period of 70 days.

2.2.6.2.3 Island, Pipeline, and Facilities Construction, Drilling and Production Operations, and Decommissioning

These activities would remain the same under Alternative 5B as for the Proposed Action.

2.2.6.2.4 EPA Permitting

EPA’s permitting requirements under Alternative 5 are identical to the Proposed Action.

2.2.6.2.5 USACE Permitting

Both Alternative 5A and 5B would generally result in about 27.28 acres of impacts subject to Section 404 only (onshore impacts to WOUS), 33 acres subject to both Section 404 and Section 10 (territorial seas impacts), and 32 acres subject to Section 10 only (OCS impacts). An Individual Permit would be issued under Section 404 and Section 10 authorities.

2.3 Preferred Alternative

The preferred alternative is the Proposed Action (Alternative 1) because it best fulfills BOEM's statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors.

2.3.1 Alternative Comparison Tables

All values within these tables are approximate and represent BOEM's conservative assumptions based on HAK's multiple Federal and State applications, and input from the Cooperating Agencies.

Table 2-5 Alternatives Comparison Table, Onshore Activities

Alternative	Ice Roads	Gravel Mine	Mining Truck Trips (approximate)	Onshore Gravel Pads and Roads	Onshore Pipeline (miles) / VSMs (acres)
Alternative 1 (Proposed Action)	Annual Ice Road: 1 Construction Ice Roads: 3	Acres: 25 Depth: 46 – 60 feet Site: East Kadleroshilik Mine Site #1 Material Volume: 1,337,000 cy	Trucks: 24 Days: 70 Trip Distance (mi): 13	Ice Road Crossing: 1,500 cy (0.15 acres) Tie-In Pad: 3,500 cy (0.70 acres) Pipeline Landfall: 5,000 cy (1.4 acres)	1.5 / 0.03
Alternative 2 (No Action)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Alternative 3A (Relocate LDPI approximately 1 mile to the east)	Annual Ice Road: 1 Construction Ice Roads: 3 Ice roads change length & course.	Acres: 26 Depth: 46 – 60 feet Site: East Kadleroshilik Mine Site #1 Material Volume: 1,398,000 cy	Trucks: 24 Days: 70 Trip Distance (mi): 13	Ice Road Crossing: 1,500 cy (0.15 acres) Tie-In Pad: 3,500 cy (0.70 acres) Pipeline Landfall: 5,000 cy (1.4 acres)	Same as Alternative 1
Alternative 3B (Relocate LDPI approximately 1.5 miles to the southwest)	Annual Ice Road: 1 Construction Ice Roads: 3 Ice roads change length & course.	Acres: 24 Depth: 46 - 60 feet Site: East Kadleroshilik Mine Site #1 Material Volume: 1,297,000 cy	Trucks: 24 Days: 62 Trip Distance (mi): 10	Ice Road Crossing: 1,500 cy (0.15 acres) Tie-In Pad: 3,500 cy (0.70 acres) Pipeline Landfall: 5,000 cy (1.4 acres)	Same as Alternative 1
Alternative 4A (Relocate Oil and Gas Processing to Endicott)	Annual Ice Road: 1 Construction Ice Roads: 3 Ice roads change length & course.	Acres: 19 Depth: 46 – 60 feet Site: East Kadleroshilik Mine Site #1 Material Volume: 1,040,000 cy	Trucks: 24 Days: 47 Trip Distance (mi): 13	None	None
Alternative 4B (Relocate Oil and Gas Processing to a New Onshore Facility)	Annual Ice Road: 1 Construction Ice Roads: 3 Ice roads change length & course.	Acres: 35 Depth: 46 – 60 feet Site: East Kadleroshilik Mine Site #1 Material Volume: 1,848,000 cy	Trucks: 24 Days: 51 Trip Distance (mi): 12	Onshore Facility: 44,800 cy (3.9 acres) Ice Road Crossing: 1,500 cy (0.15 acres) Pipeline Landfall: 5,000 cy (1.4 acres) Gravel Road: 720,000 cy (76 acres)	Same as Alternative 1
Alternative 5A (East Kadleroshilik River Mine Site #2)	Annual Ice Road: 1 Construction Ice Roads: 3 Ice roads change length & course.	Acres: 25 Depth: 42 – 60 feet Site: East Kadleroshilik Mine Site #2 Material Volume: 1,337,000 cy	Trucks: 24 Days: 70 Trip Distance (mi): 13	Ice Road Crossing: 1,500 cy (0.15 acres) Tie-In Pad: 3,500 cy (0.70 acres) Pipeline Landfall: 5,000 cy (1.4 acres)	Same as Alternative 1
Alternative 5B (East Kadleroshilik River Mine Site #3)	Annual Ice Road: 1 Construction Ice Roads: 3 Ice roads change length & course.	Acres: 25 Depth: 42 – 60 feet Site: East Kadleroshilik Mine Site #3 Material Volume: 1,337,000 cy	Trucks: 24 Days: 70 Trip Distance (mi): 13	Ice Road Crossing: 1,500 cy (0.15 acres) Tie-In Pad: 3,500 cy (0.70 acres) Pipeline Landfall: 5,000 cy (1.4 acres)	Same as Alternative 1

Table 2-6 Alternatives Comparison Table, Offshore Activities

Alternative	Island (LDPI)	Facilities & Systems (on island)	Pipeline	Pipeline, territorial seas (miles)(acres)	Pipeline, OCS (miles)(acres)
Alternative 1 (Proposed Action)	Surface (acres): 9.3 Subsea (acres): 24 Water Depth (feet): 19 Material Volume: 929,000 cy	Processing facilities; Produced water treatment; Seawater treatment; Power generation; Communications facilities; Living quarters; Warehouse/Shop space; Vehicle Storage; General Storage Space; Heavy Equipment Storage; Helipad; Process Controls room; Bulk fluid storage; Fuel gas system; Instrument and utility air system; Chemical Injection Facilities; Pollution Prevention Equipment; Process heat recovery system and, Storage tanks	Offshore (mi): 5.6 Offshore (depth, feet): 9 - 13 Onshore (mi): 1.5 Total length (mi): 7.1 Design: 16-inch outer pipe, 12-inch inner pipe, 4-inch utility pipe and fiber optic cable	4.5 (33)	1.1 (8)
Alternative 2 (No Action)	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Alternative 3A (Relocate LDPI Approximately 1 mile to the east)	Surface (acres): 9.3 Subsea (acres): 24.5 Water Depth (feet): 21 Material Volume: 980,000 cy	Same as Alternative 1	Offshore (mi): 6.2 Onshore (mi): 1.5 Total length (mi): 7.7 Design: 16-inch outer pipe, 12-inch inner pipe, 4-inch utility pipe and fiber optic cable Pipeline buried about 2 feet deeper.	4.9 (35.6)	1.3 (9.5)
Alternative 3B (Relocate LDPI approximately 1.5 miles to the southwest)	Surface (acres): 9.3 Subsea (acres): 23.4 Water Depth (feet): 17 Material Volume: 879,000 cy	Same as Alternative 1	Offshore (mi): 4.1 Onshore (mi): 1.5 Total length (mi): 5.6 Design: 16-inch outer pipe, 12-inch inner pipe, 4-inch utility pipe and fiber optic cable	4.1 (29.8)	0 (0)
Alternative 4A (Relocate Oil and Gas Processing to Endicott)	Surface (acres): 5.4 Subsea (acres): 17.2 Water Depth (feet): 19 Material Volume: 622,000 cy	Onshore: Processing facilities; Produced water treatment Offshore: Seawater treatment; Power generation; Communications facilities; Living quarters; Warehouse/Shop space; Vehicle Storage; General Storage Space; Heavy Equipment Storage; Helipad; Process Controls room; (less) Bulk fluid storage; Fuel gas system; Instrument and utility air system; Chemical Injection Facilities; Pollution Prevention Equipment; and, Storage tanks	Offshore (mi): 7.7 Onshore (mi): 1.5 Total length (mi): 9.2 Design: 14-inch outer pipe, 10-inch seawater pipeline, 6-inch natural gas pipeline, power cable and fiber optic cable	7.1 (51.6)	0.6 (4.4)
Alternative 4B (Relocate Oil and Gas Processing to a New Onshore Facility)	Surface (acres): 6.1 Subsea (acres): 18.4 Water Depth (feet): 19 Material Volume: 666,000 cy	Onshore: Processing facilities; Produced water treatment; Power generation; Communications facilities; Living quarters; Warehouse/Shop space; Vehicle Storage; General Storage Space; Heavy Equipment Storage; Helipad; Process Controls room; Bulk fluid storage; Fuel gas system; Instrument and utility air system; Chemical Injection Facilities; Pollution Prevention Equipment; and, Storage tanks Offshore: Seawater treatment; Power generation; Communications facilities; Living quarters; Warehouse/Shop space; Vehicle Storage; General Storage Space; Heavy Equipment Storage; Helipad; Process Controls room; (less) Bulk fluid storage; Fuel gas system; Instrument and utility air system; Chemical Injection Facilities; Pollution Prevention Equipment; and, Storage tanks	Offshore (mi): 5.6 Onshore (mi): 1.5 Total length (mi): 7.1 Design: 16-inch outer pipe, 14-inch inner pipe, 6-inch natural gas pipeline, power cable and fiber optic cable	Same as Alternative 1	Same as Alternative 1
Alternative 5A (East Kadleroshilik River Mine Site #2)	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Alternative 5B (East Kadleroshilik River Mine Site #3)	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1

Table 2-7 Alternatives Comparison Table, Operations and Decommissioning

Alternative	Drilling Operations	Production Operations	Decommissioning
Alternative 1 (Proposed Action)	Producer Wells: 5-8 Injection Wells (water/gas): 4-6 Disposal Wells: 2 disposal wells Average Well Length (feet): 14,350	Routine Production Operations; Routine Equipment Maintenance; Major Overhauls, Major Inspections; Unscheduled Equipment Maintenance; Plant Turnarounds	Project Life (years): 15-20 Pipeline: Cleaned, plugged and left in place. Island: Protective covering removed, left to erode
Alternative 2 (No Action)	Not Applicable	Not Applicable	Not Applicable
Alternative 3A (Relocate LDPI Approximately 1 mile to the east)	Producer Wells: 5-8 Injection Wells (water/gas): 4-6 Disposal Wells: 2 disposal wells Average Well Length (feet): 13,600	Same as Alternative 1	Same as Alternative 1
Alternative 3B (Relocate LDPI approximately 1.5 miles to the southwest)	Producer Wells: 5-8 Injection Wells (water/gas): 4-6 Disposal Wells: 2 disposal wells Average Well Length (feet): 17,200	Same as Alternative 1	Same as Alternative 1
Alternative 4A (Relocate Oil and Gas Processing to Endicott)	Same as Alternative 1	Routine Production Operations; Routine Equipment Maintenance; Major Overhauls, Major Inspections; Unscheduled Equipment Maintenance; Plant Turnarounds	Additional decommissioning would occur on Endicott
Alternative 4B (Relocate Oil and Gas Processing to a New Onshore Facility)	Same as Alternative 1	Routine Production Operations; Routine Equipment Maintenance; Major Overhauls, Major Inspections; Unscheduled Equipment Maintenance; Plant Turnarounds	Additional decommissioning would occur at new onshore facility
Alternative 5A (East Kadleroshilik River Mine Site #2)	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Alternative 5B (East Kadleroshilik River Mine Site #3)	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1

Table 2-8 Alternatives Comparison Table, Permitting Summaries

Alternative	USACE Impacts & Permitting[1]	EPA Permitting	BSEE Permitting	NMFS Permitting
Alternative 1 (Proposed Action)	The Proposed Action would result in 27.28 acres subject to Section 404 only (onshore impacts), 33 acres subject to both Section 404 and Section 10 (territorial seas impacts), and 32 acres subject to Section 10 only (OCS impacts). An Individual Permit would be issued under Section 404 and Section 10 authorities.	Issue an NPDES permit for five requested waste streams	Platform approval, issue APDs, Prod. Safety Systems.	Issue incidental take authorizations (ITAs) for take of marine mammals.
Alternative 2 (No Action)	No permit issued	No permit issued	No plans, permits or grants approved	No ITA for marine mammals issued.
Alternative 3A (Relocate LDPI Approximately 1 mile to the east)	This alternative would result in 28.28 acres subject to Section 404 only (onshore impacts), 35.6 acres subject to both Section 404 and Section 10 (territorial seas impacts), and 34 acres subject to Section 10 only (OCS impacts). An Individual Permit would be issued under Section 404 and Section 10 authorities.	Same regulatory process as Alternative 1	Same regulatory process as Alternative 1	Same regulatory process as Alternative 1
Alternative 3B (Relocate LDPI approximately 1.5 miles to the southwest)	This alternative would result in 26.28 acres subject to Section 404 only (onshore impacts), and 53.2 acres subject to both Section 404 and Section 10 (territorial seas impacts). An Individual Permit would be issued under Section 404 and Section 10 authorities.	Same as Alternative 2; ADEC would be the permitting authority	Same regulatory process as Alternative 1	Same regulatory process as Alternative 1
Alternative 4A (Relocate Oil and Gas Processing to Endicott)	This alternative would result in 21.28 acres subject to Section 404 only (onshore impacts), 51.6 acres subject to both Section 404 and Section 10 (territorial seas impacts), and 21.6 acres subject to Section 10 only (OCS impacts). An Individual Permit would be issued under Section 404 and Section 10 authorities.	Issue a NPDES permit for four waste streams to federal waters; ADEC is the permitting authority for discharges from the STP to state waters.	Same regulatory process as Alternative 1	Same regulatory process as Alternative 1
Alternative 4B (Relocate Oil and Gas Processing to a New Onshore Facility)	This alternative would result in 116.48 acres subject to Section 404 only (onshore impacts), 33 acres subject to both Section 404 and Section 10 (territorial seas impacts), and 26.4 acres subject to Section 10 only (OCS impacts). An Individual Permit would be issued under Section 404 and Section 10 authorities.	Same regulatory process as Alternative 4A	Same regulatory process as Alternative 1	Same regulatory process as Alternative 1
Alternative 5A (East Kadleroshilik River Mine Site #2)	The size of the material site, and hence the acres of wetlands impacted due to the site's development may differ depending on amount and quality of gravel at the site. Impacts for this alternative are generally the same as Alternative 1.	Same regulatory process as Alternative 1	Same regulatory process as Alternative 1	Same regulatory process as Alternative 1
Alternative 5B (East Kadleroshilik River Mine Site #3)	The size of the material site, and hence the acres of wetlands impacted due to the site's development may differ depending on amount and quality of gravel at the site. Impacts for this alternative are generally the same as Alternative 1.	Same regulatory process as Alternative 1	Same regulatory process as Alternative 1	Same regulatory process as Alternative 1

[1] Onshore impacts include the gravel mine site, tie-in pad, ice road crossing pad, VSMs footprints, pipeline landfall trench and construction of onshore processing facilities (as applicable). Territorial seas impacts include the construction located within territorial seas. OCS impacts include construction within OCS waters.

Table 2-9 Alternatives Comparison Table, Key Changes from the Proposed Action

Alternative	Winter and Summer Access	Gravel Mine Site Development	Island Construction	Pipeline Construction	Facilities Construction	Drilling Operations	Production Operations	Decommissioning
Alternative 2 (No Action)	No Action	No Action	No Action	No Action	No Action	No Action	No Action	No Action
Alternative 3A (Relocate LDPI Approximately 1 mile to the east)	Ice roads change length and course	More gravel extracted; larger mine site	Larger island, further from Boulder Patch	Longer pipeline, transits through strudel scour zone	Same as Proposed Action	Longer wells	Same as Proposed Action	Same as Proposed Action
Alternative 3B (Relocate LDPI approximately 1.5 miles to the southwest)	Ice roads change length and course	Less gravel extracted; smaller mine site	Smaller island, further from the Boulder Patch	Shorter pipeline	Same as Proposed Action	Longer and more complex wells	Same as Proposed Action	Same as Proposed Action
Alternative 4A (Relocate Oil and Gas Processing to Endicott)	Ice roads change length and course	Less gravel extracted, smaller mine site	Smaller island	Longer pipeline in close proximity to Boulder Patch	Less construction on island, significant modifications to Endicott facilities	Same as Proposed Action	Significant changes since processing facilities on Endicott	Additional work due to Endicott facilities
Alternative 4B (Relocate Oil and Gas Processing to a New Onshore Facility)	Ice roads change length and course A new 12-mile gravel road and bridges are required	More gravel extracted; larger mine site	Smaller island	3-phase pipeline	Less construction on island, additional onshore facilities	Same as Proposed Action	Significant changes since processing facilities onshore	Additional work due to onshore facilities
Alternative 5A (East Kadleroshilik River Mine Site #2)	Ice roads change length and course	Different mine site location	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Alternative 5B (East Kadleroshilik River Mine Site #3)	Ice roads change length and course	Different mine site location	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action

2.4 Alternatives Considered but Not Carried Forward for Further Analysis

Several potential alternatives suggested during scoping are not considered for detailed study in this FEIS because they are not reasonable alternatives as defined under NEPA. An EIS need not consider every conceivable alternative to a project; rather, an EIS fosters informed decision making when it considers a reasonable range of technically and economically feasible alternatives.

2.4.1 Ultra Extended-Reach Drilling (uERD)

In 2007, BP Exploration Alaska (BPXA) proposed to develop the Liberty Prospect by means of ultra extended-reach drilling (uERD) from the Endicott SDI. Recognizing that an uERD project of this length in the Arctic would be unprecedented, British Petroleum Exploration (Alaska) (BPXA) proposed to first drill a single uERD well to ensure such drilling was feasible before committing to this method for the entire project. The uERD approach required the design and construction of a new specialized drilling rig. After preparing an environmental assessment (USDOI, MMS, 2007a) and issuing a Finding of No Significant Impact (FONSI), MMS approved the DPP, thereby authorizing BPXA to proceed with their intended development approach. In June 2012, BPXA indicated that the new drilling rig still required substantial modifications to be functional and ultimately concluded in a November 20, 2012, letter to the BSEE that the uERD "concept was not the safest or most environmentally responsible course of development." No further development actions occurred at the Liberty prospect under BPXA's DPP.

During scoping, Cooperating Agencies on this EIS suggested uERD as a potential alternative method for developing the Liberty Prospect, instead of constructing an artificial island in the Beaufort Sea. BOEM re-evaluated the feasibility of using uERD technology from two locations: Endicott SDI, or from the onshore site nearest the Liberty reservoir. BOEM's analysis utilized the following methodologies:

2.4.1.1 Technical Feasibility

1. Identify the technical challenges associated with uERD projects.
2. Identify the technical capabilities of existing uERD equipment on the Alaska North Slope as well as globally.
3. Determine if uERD development of the Liberty Prospect can be achieved using existing technology.

2.4.1.2 Economic Feasibility

1. Estimate the volume of resources that would be recovered from the Liberty Prospect if an uERD approach were used.
2. Estimate the commissioning costs of an uERD development concept at Liberty.
3. Compare the cost to recovery ratio of a Liberty uERD project with the cost to recovery ratios associated with other relevant projects.

Based on the findings of this feasibility analysis, BOEM determined that uERD is not a technically feasible manner of developing the Liberty prospect, because:

- An uERD approach to developing Liberty would require drilling highly deviated wells of unprecedented length. Wellbores drilled from the Endicott SDI or an onshore location would extend almost a mile beyond the existing world record of 40,602 feet for the longest wellbore.

- Technical challenges, including configuring drilling mud, hydraulics, casing strings up to four times as long as a standard well drilled at the reservoir, and other systems are beyond the capabilities of existing drill rigs.

BOEM's analysis also suggested that an uERD approach may not be economically feasible or capable of complying with BOEM regulatory requirements concerning sound conservation practices and protecting the rights of the lessor. A reservoir simulation performed by BOEM Resource Evaluation Program Office (RE) comparing the unchoked primary oil production of a well drilled at Liberty to that of an ultra-extended reach drilled well from Endicott indicated that additional uERD wells would need to be drilled to achieve the same production rate at Liberty. Additional uERD wells would need to be drilled to offset the higher frictional losses induced by the longer pipe lengths and larger cross-sectional area of the wellbore.

Subsequent to BOEM’s publication of the Draft EIS, a new world-record setting uERD well was drilled by the Sakhalin-1 Consortium. Information on how this new record was achieved is proprietary to the Consortium and not available to BOEM. The technical and economic circumstances of expanding drilling at the Sakhalin development are also very different than those for commencing development at the Liberty Prospect. As such, recent events at Sakhalin do not alter BOEM’s conclusions concerning the feasibility of uERD at the Liberty Prospect.

Because an uERD approach to developing the Liberty Project is not technically feasible and does not appear to be economically feasible, BOEM does not consider it a “reasonable” alternative, and this approach is not carried forward for full analysis in the EIS.

2.4.2 Other Alternate LDPI Locations

Some commenters suggested during the public comment period that BOEM analyze other alternative LDPI locations, including a location 3 miles offshore, or a location as far southwest as possible, as a means to mitigate potential impacts to Nuiqsut whalers. These alternative locations are within the range of the Alternative LDPI and production (and power generation) locations already analyzed: Alternate LDPI locations are thoroughly examined in Alternative 3 (see Section 4.2.1 for more detail about the technical and safety issues associated with Alternate LDPI locations). Overall, alternate LDPI locations would place the island in potentially unstable sediments, increase borehole lengths (which amplifies drilling risks or may result in technically infeasible drilling distances), and reduce the volume of ultimately recoverable hydrocarbons over the life of the field as compared to the Proposed Action. Alternatives 4A and 4B consider the impacts of processing and or power generation at the existing Endicott Main Production Island or at a new onshore production facility. These alternatives would require pipelines to run through areas of unstable sediments and 100% strudel scour, which would result in pipeline damage. See Section 4.2.1 of this FEIS for more detail about the potential impacts of relocating production and power generation.

2.4.3 Horizontal Directional Drilling (HDD) Pipeline Landfall

The Proposed Action includes a pipeline to be installed via a trench from LDPI through the beachhead/dune and into the tundra, where it would surface and be elevated on VSMs. The landfall area would be reinforced with gravel, and thermosyphons would be installed to prevent thermokarsting (very irregular surfaces of marshy hollows and small hummocks formed as ice-rich permafrost thaws) and beach erosion in the area of the pipeline crossing (see Section 2.1.4 for more detail).

During scoping, it was suggested that BOEM evaluate an alternative whereby HDD, rather than trenching, would be used to transition between the onshore and offshore portions of the pipeline. This stated purpose behind this suggestion was to avoid/minimize coastal erosion and maintain the integrity of the beachhead/dune.

As an initial matter, BOEM notes that it does not expect the Liberty pipeline landfall to encourage coastal erosion. This expectation is based on BOEM's independent review of the proposed project as well as similar projects. For instance, coastal erosion rates at the Northstar Project's pipeline landfall, which was installed using similar trenching techniques, remain within the range of natural erosion observed prior to construction. The Liberty site is also more protected from storm surge by the Foggy Island Bay barrier islands and shoals, which further decreases the likelihood for any project-induced erosion. Meanwhile, BOEM finds that comparisons between the proposed Liberty pipeline landfall and the Badami pipeline's Sagavanirktok River crossing (where erosion has been observed) are not appropriate, due to dissimilarities in project specification and local environmental processes (i.e. riverine erosion versus shoreline erosion).

BOEM nevertheless assessed the feasibility of an HDD pipeline landfall. BOEM analysts identified the technical challenges of HDD projects in part by reviewing similar projects based on location, permafrost conditions, oceanic shoreline location, winter and/or ice conditions, borehole length and pipeline diameter. BOEM found that an HDD project of the type described during scoping would not be based on, or in accordance with, any typical HDD project. HDD for the pipeline landfall would need to begin several hundred feet offshore and extend to at least 0.25 miles onshore. Shore approaches using HDD are more complex than typical surface-to-surface HDD installations. HDD projects in Alaska have been installed onshore from surface-to-surface installations (e.g., Colville River pipeline crossing), but not from shore to sea. A schematic drawing of a possible offshore to onshore HDD is shown on Figure 2-23.

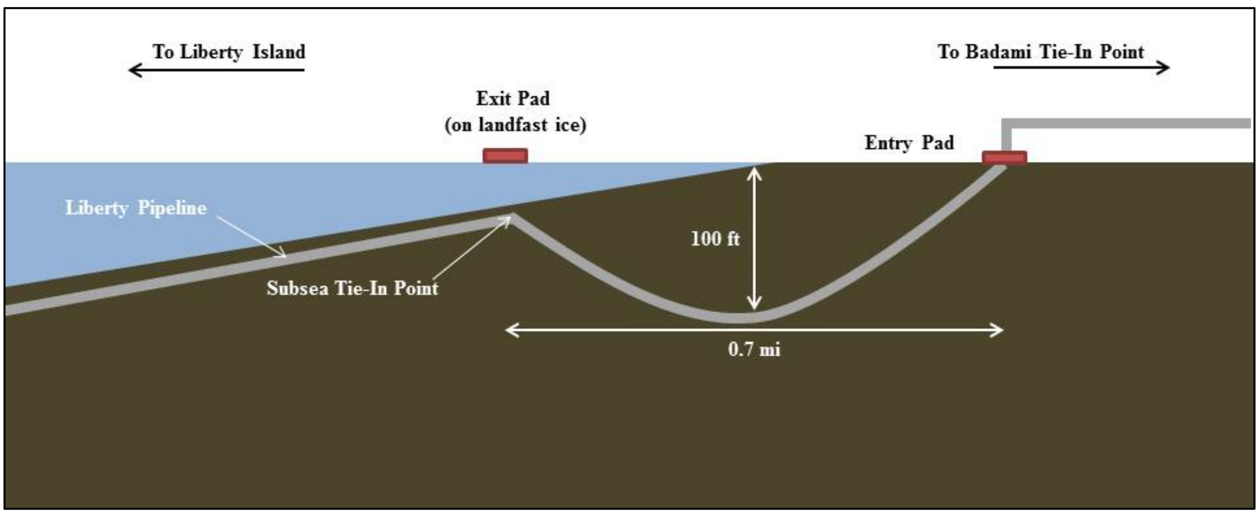

Figure 2-23 Schematic Depicting a Possible HDD Alternative for the Liberty Project

The primary challenges/risks of an offshore to onshore HDD at this site include:

- **Exit site (offshore).** Placing the pipeline in summer (as proposed) would require storing the pipe offshore or on a barge. If stored offshore, it would be laid on the ocean floor, and an onshore anchoring and an offshore "pulling barge" would be needed to winch the pipe through the borehole from sea to land. Storing the pipe on a barge and winching it from the barge to the land is not feasible because the water depth is too shallow for a pipe-laying barge to operate. A possible method, although it would be experimental, would be to construct the borehole in winter from two stable surfaces (land and landfast ice).
- **Entry and exit elevation.** HDD entry and exit points should be as close to the same elevation as possible. For an HDD at this location, the difference in entry and exit elevations would range from 25 to 35 feet. While HDD is possible with this difference in elevation, the risk of pipe rupture increases.

- **Thermoregulation of soils.** For the HDD alternative, the pipeline would be drilled through permafrost soils, with no gravel backfill. Thus, the HDD pipeline and its associated heat would directly contact native soils. It is anticipated that this would result in greater permafrost thawing and associated subsidence, increasing risk of pipeline rupture/buckling.
- **Other technical issues.** With a 16-inch pipe-in-pipe design, the Liberty pipeline would be largest HDD project attempted in Alaska. The large diameter increases the risk of hydraulic fracture and wellbore collapse.

A project of this nature has not been completed previously, and BOEM does not foresee how the difficulties associated with the shore approaches and the lack of an acceptable exit site could be overcome for this project. The compounding risks from potential hydraulic fracture and borehole collapse, and the presence of permafrost in the nearshore environment further contribute to a determination that using HDD is not a technically feasible approach for this project. Even if HDD were feasible, it would be a technically inferior engineering solution, given that the inability to surround the pipeline with thaw-stable materials would likely result in thawing of local permafrost and subsidence which could compromise the structural integrity of the Liberty pipeline. Due to technically infeasibility and heightened (rather than reduced) erosion concerns, BOEM does not consider an HDD pipeline landfall to be a reasonable alternative, and this approach is not carried forward or further analyzed in the EIS.

2.4.4 OCS Gravel Mining and Summer LDPI Construction

An alternative suggested during public scoping was to use gravel mined from the Federal OCS seabed to construct the LDPI during the open-water season. The commenter stated that there are several months of open-water conditions that could allow the project to be built with marine support rather than using ice roads. Constructing the LDPI using gravel mined from the OCS would eliminate much (but not all) of the project’s need for onshore gravel. This concept is not considered a reasonable alternative warranting further analysis in the EIS, for the following reasons:

First, the technical and economic feasibility of this alternative is speculative. It is unknown whether the Beaufort Sea OCS (or other portions of the Alaska OCS) features a suitable gravel source. Also, the costs and environmental impacts of dredging and barging this gravel to the LDPI site would far exceed those from mining and trucking gravel from the proposed onshore mine located less than 10 miles away.

Second, this alternative fails to meet the Purpose and Need for the proposed action. Requiring HAK to use gravel mined from the OCS would delay project implementation for several years. One or more open-water seasons of geological and geophysical surveying would be required to identify potential gravel sources. Mining rights must then be offered in a competitive lease sale, which would require at least 2 years of preparation. Further delays in project implementation would result from the shift from winter to summer mining and construction of the LDPI. The resulting years of delay would conflict with BOEM’s mandate under the Outer Continental Shelf Lands Act (OCSLA) to facilitate expeditious development of OCS resources.

Finally, the implementation of this alternative would likely create unacceptable environmental and social impacts. The 2003 Liberty EIS, in addressing a similar suggested alternative, determined it would be “much more disruptive to wildlife, including the threatened and endangered species, which are in the project area only during summer, and subsistence activities in the area.” This determination holds true today. The suggested alternative runs counter to stakeholders’ consistent request that BOEM limit industrial activities in areas important to marine mammals and other key environmental resources, particularly during subsistence hunting periods.

2.4.5 Other Alternate Gravel Mine Sites

BOEM dismissed the Oxbow Pit, Badami Mine Site, Shaviovik Pit and Liberty Mine Site for further analysis because the required gravel quantity was not known to be present, or the State of Alaska requested that the site be removed from analysis since it was rehabilitated (impractical) and/or fish-bearing (considered special habitat).

The Duck Island Mine site was considered as Alternative 5C in the DEIS but has been dismissed from analysis in this FEIS because it is unlikely to contain any usable material. The location is currently flooded and would take up to 1 year to dewater (it has an ephemeral connection to Duck Island Creek, and contains fish). Given the volume of water in the site and the lack of usable material, this location is not a feasible alternative.

2.5 Mitigation

Appendix C includes a description of existing mitigation measures contained in lease stipulations, design features and best management practices (BMPs) committed to by the operator, or permitting requirements expected to be imposed by other agencies. In analyzing potential impacts from the Proposed Action and other Action Alternatives, BOEM assumed implementation of, and compliance with, these existing mitigation measures.

In addition to these existing mitigation measures, BOEM is proposing several new mitigation measures to further avoid and minimize potential impacts. Below, BOEM describes a proposed mitigation measure that would restrict drilling into hydrocarbon bearing zones to periods of solid ice conditions. Additional, resource-specific mitigation measures (e.g., mitigation measures specific to migratory birds) are proposed and analyzed in individual sections of Chapter 4.

2.5.1 Proposed Solid Ice Condition

During scoping, BOEM received several comments which proposed seasonal restrictions on drilling into hydrocarbon zones as a means to reduce the likelihood of a large or very large oil spill contacting the Beaufort Sea and adjacent coastal areas during broken ice or open weather conditions. These comments suggested that oil spilled during solid ice conditions (as opposed to broken ice or open water conditions) would be easier to clean up, and thus less likely to affect subsistence activities, resources used for subsistence, and/or other marine mammals and threatened and endangered species. Commenter recommendations varied in terms of length and timing of proposed drilling restrictions, but cumulatively, they suggest limiting drilling into hydrocarbon zones to periods when:

- solid ice conditions surround the LDPI
- there remained sufficient time to drill a relief well prior to spring break-up.

Based on these comments, and an independent review of factors relevant to development drilling and oil spill response techniques, BOEM developed for analysis in the Liberty FEIS a proposed mitigation measure that, if implemented, would restrict certain drilling activities on a seasonal basis.

- Reservoir drilling is authorized only during times of solid ice conditions. For the purposes of this condition, "reservoir drilling" is defined to include initial development drilling (as opposed to workovers, recompletions, and other such well operations subsequently conducted on existing wells) beyond the shoe (base) of the last casing string above the Kekiktuk Formation (i.e. drilling that exposes the Kekiktuk Formation to an open, uncased wellbore). 'Solid ice conditions' is defined as at least 18 inches of ice in all areas within 500 ft of the LDPI.

The practical effects of imposing such a restriction would be a change in the order in which HAK drills its wells and a potential delay (approximately 3 to 15 months) in completing the proposed drilling program. Waste disposal wells, as well as the top hole portions of development wells, could still be drilled year-round (subject to self-imposed limitations in HAK's DPP).

Chapter 3

Description of the Environment

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CHAPTER 3. DESCRIPTION OF THE ENVIRONMENT

3.1 Physical Environment

3.1.1 Bathymetry and Physiography

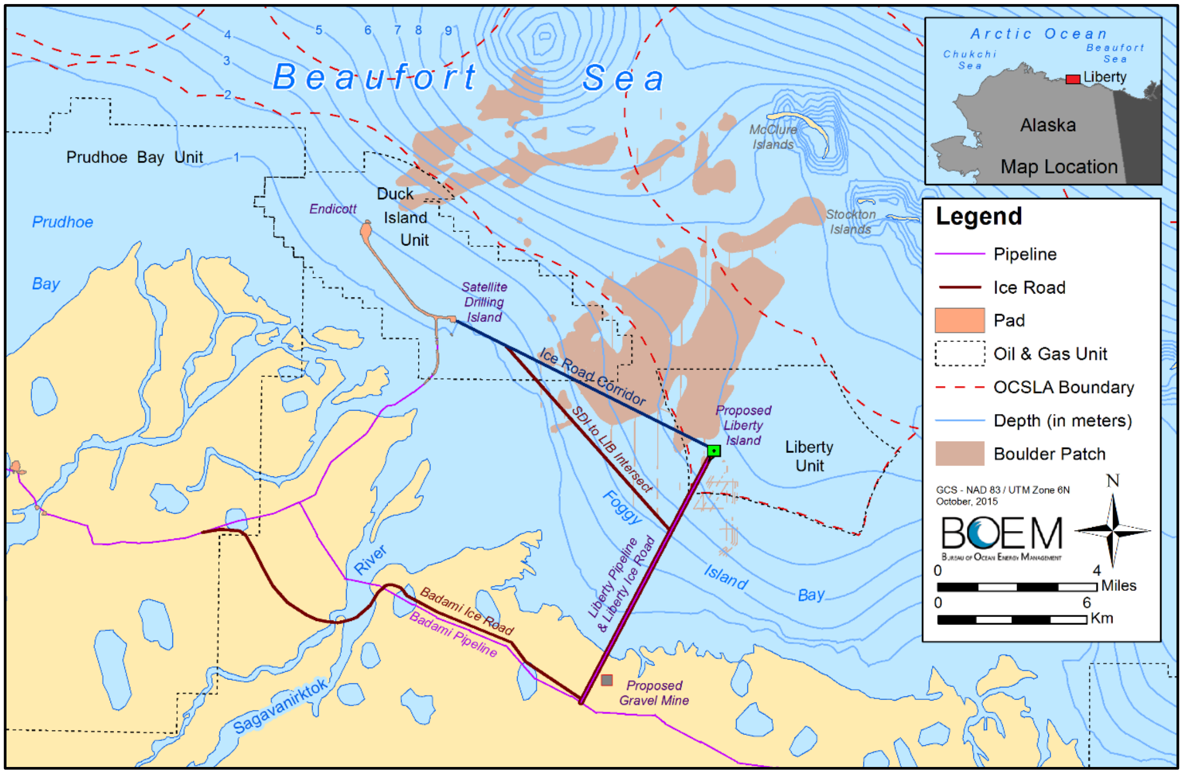

Figure 3-1 **Bathymetry and Physiography**
Illustration of the bathymetry and physiography in and around the Proposed Action Area. Map includes the Boulder Patch.

3.1.2 Oceanography

The Alaska Beaufort Sea shelf (Figure 3-1) extends approximately 311 miles from the shelf area between Barrow Canyon and the Mackenzie Shelf in Canada. The continental shelf width ranges between 37 and 75 miles with an average water depth of 121 feet. Narrow and low relief barrier islands are found between 1 and 12 miles seaward of the coast. Foggy Island Bay is inside these barrier islands and has water depths of slightly less than 23 feet.

Foggy Island Bay is situated between the Sagavanirktok and Shaviovik rivers, and is sheltered by offshore shoals associated with Dinkum Sands and the McClure and Stockton barrier island complexes. Three rivers discharge into Foggy Island Bay: the Sagavanirktok River east channel, the Kadleroshilik River, and the Shaviovik River.

The Boulder Patch is an area near Foggy Island Bay characterized by a substrate of cobbles and boulders which were deposited by Pleistocene glaciers (Reimnitz and Ross, 1979; Wilce and Dunton, 2014). This type of substrate is uncommon in the Beaufort Sea. "Boulder Patch" is used to describe both the substrate and the diverse faunal community that relies on algae attached to the boulders. Sections 3.1.4 and 3.2.1 contain further description of the Boulder Patch.

Landfast ice begins to form in the fall months, thickening and growing seaward throughout the winter. It forms a protective barrier from the winds and sets up unique hydrographic conditions beneath the ice canopy. In the spring and summer months, fresh water and sediment are added to the nearshore environment as landfast ice melts.

3.1.2.1 Circulation within Stefansson Sound

The dominant source of nearshore fresh water in the environment is the Beaufort Sea coastal river system, particularly the Sagavanirktok River. Freshwater discharge begins during the spring freshet as sediment-laden waters discharge on top of and beneath the landfast ice. Fresh water can move for many miles seaward beneath the landfast ice.

East of the Alaska Beaufort Shelf, the Mackenzie Canyon outflow can move large volumes of fresh and warm near-surface waters westward to the area north of Stefansson Sound. These waters melt sea ice during the spring and early summer months and carry along nutrients, organic carbon, suspended sediments, and plankton. Advection (horizontal flow of water) of Mackenzie Shelf waters depends on the persistence and strength of the Beaufort Sea winds. When winds are from the east, the Mackenzie Plume can be transported west to the Chukchi Sea. The migratory behavior of Arctic cisco is linked to the strength and persistence of the Mackenzie Plume westward track (ABR et al., 2007).

To the west, the influx of Pacific origin waters northward through the Bering Strait and onto the southern Chukchi Shelf diverges into three main channels. The waters most important to the Beaufort Shelf are those waters that advect northward on the Chukchi Shelf and then down Barrow Canyon. These waters exit the Canyon, pass Point Barrow, and continue east toward the Canadian Beaufort Sea along the shelf break.

In the absence of wind, the shelf break jet advects waters to the east. When the winds are from the west, the shelf break jet accelerates to the east causing downwelling of fresh water. In contrast, when winds are from the east, at speeds greater than 8.9 mph, the shelf break jet reverses direction to the west and upwelling of subsurface salty waters from the deep basin onto the shallow shelf can occur. These upwelling events can bring nutrients, carbon, and zooplankton onto the shallow shelf and spawn increased primary productivity. In addition to the waters within the shelfbreak jet, a portion of the Pacific water that flows through the head of Barrow Canyon spills out onto the shallow Beaufort Shelf before exiting the Barrow Canyon mouth. This flow can bring Pacific-borne waters and their biological contents onto the shallow Beaufort Shelf and get transported eastward into the central Beaufort shelf.

Circulation in Foggy Island Bay and Stefansson Sound is strongly influenced by atmospheric forcing of wind-driven currents during the open water season. Winds during the open water season are the main driving force of surface and subsurface currents and the mixing of the water column.

Weingartner et al. (2009) conducted year-round measurements of subsurface currents utilizing acoustic Doppler current profilers (ADCP) that were moored to the seabed within the landfast ice zone of Stefansson Sound. These moorings measured the seasonal changes in subsurface currents with the growth and melting of the landfast ice cover.

During the spring freshet, the large and sudden discharge of fresh water from rivers can produce under-ice currents and increased turbidity (decrease in transmissivity). A significant portion of the river runoff flows beneath the landfast ice forming a strongly stratified water column (Figure 3-2). Weingartner, Okkonen, and Danielson (2005) estimated that the freshwater plume associated with spring river discharge can extend up to 12.4 miles offshore. During May and June in both 2004 and 2006 Alkire and Trefry (2006) measured an under-ice plume from the Sagavanirktok River which extended approximately 10.5 miles to the north and 9.3 miles to the west.

3.1.2.2 Salinity and Temperatures

Bottom water properties vary on a seasonal basis primarily as a result of the seasonal formation and melting of sea ice, the discharge of fresh waters from coastal rivers, and the mixing of the water column by winter stress during the open water season (Figure 3-2).

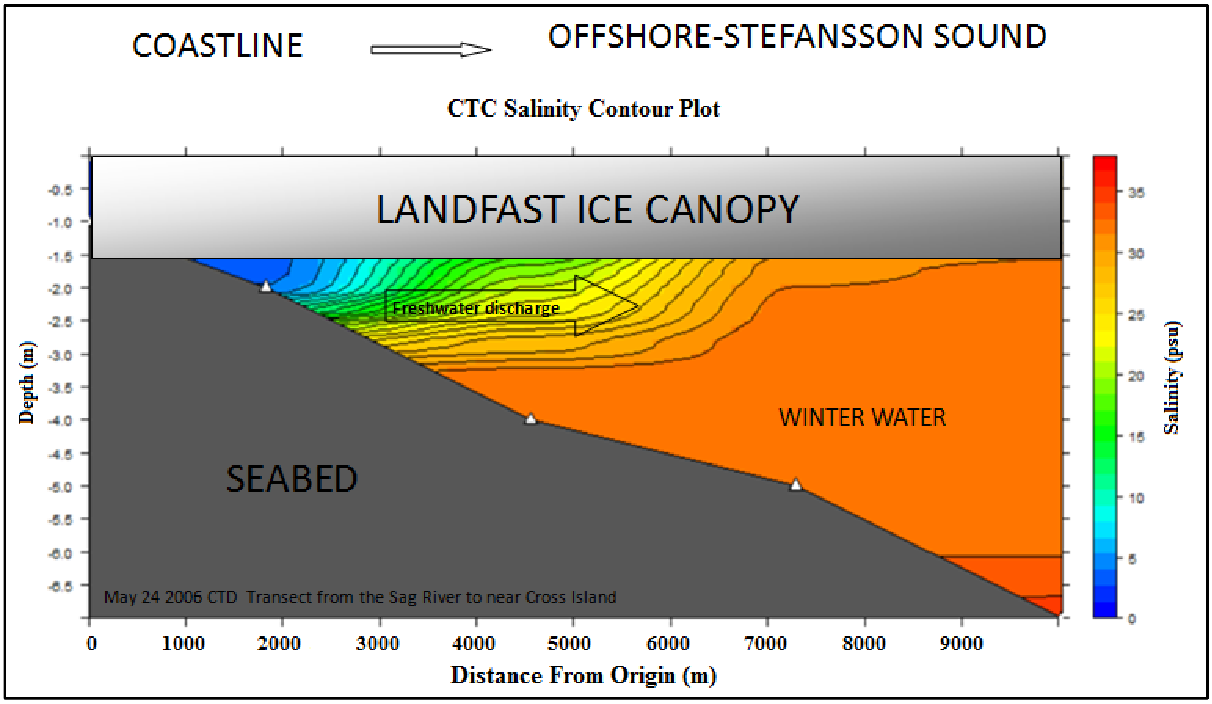

Figure 3-2 **Stratified Water Column in Stefansson Sound**
River discharge beneath the landfast ice canopy within Stefansson Sound forms a saline stratified water column Depths and distances are in meters; Salinity is measured in practical salinity units.

The transition from fall to initial freeze-up conditions occurs during the month of September, when bottom water temperatures decrease from a high of 35.6 °F, to a low of below 30.2 °F (Figure 3-2). During this same period in 2000, air temperatures as measured from the West Dock Meteorological Station were below freezing and rapidly decreased throughout the month of September. Sea ice began to form adjacent to the McClure Mooring by mid-September, and completely covered the mooring by the end of September.

Bottom water temperatures remain near freezing levels, and bottom salinities increase rapidly during the winter months. During the early winter period from November 2000 through mid-April 2001, ambient air temperatures rapidly decreased from 23ºF to -31ºF, interrupted by minor pulses of warmer events. Sea ice thickened rapidly over the mooring, and bottom water temperatures decreased below 29.3ºF, whereas bottom water salinities rose sharply above 30 Practical Salinity Units (psu) to peak at over 35 psu by mid-April 2001.

Bottom water salinities slowly decrease and water temperatures slowly increase in late winter. Air temperatures were also on an upward trend. Ice thickness overlying the mooring was gradually decreasing from its peak of 7.5 feet in April. Concurrently, bottom water salinities were slowly decreasing and bottom water temperatures were slowly increasing (28.7ºF to 29.3ºF).

Freshwater discharge from the Sagavanirktok River during the spring flooding season influences the temperatures and salinities of Stefansson Sound. Fresh and relatively warm water (slightly warmer than 32°F) from the Sagavanirktok River spring river plume flows out onto and under the landfast ice where it mixes with marine water to form a 3.3- to 6.6-foot thick, under-ice lense of brackish water that extends more than 9.3 miles offshore (Trefry et al., 2009). Fresh water transport of dissolved chemicals and land-borne contaminants can be transported long distances offshore (12.4 miles) because the landfast ice canopy inhibits the mixing of the underlying water column from winds (Rember and Trefry, 2005). Turbidity values of suspended sediments measured as Total Suspended Solids (TSS) decrease from nearshore to offshore.

Later in the season, these coastal discharges of fresh water may get collectively entrained into the larger and stronger flows of such regional water masses as the Mackenzie Plume and can get carried off the shelf and west. These local discharges can also move with the local nearshore circulation and retain their distinct geochemical signatures (Granskog et al, 2005). Freshwater river discharges that remain on the inner shelf can freshen the local waters, including those deep, colder, and saltier waters that were formed during the winter months from the formation of landfast ice (Eicken, 2005).

Bottom salinities decreased into mid-July (Table 3-1). Bottom water salinity values rapidly decreased from mid-July through the beginning of August before salinities reversed their trend into the fall season. Bottom water temperatures increased to above freezing values in July and August with the loss of sea ice and the concurrent mixing of the water column. At the same time, surface water salinities decreased and temperatures increased due to the mixing of river water throughout the water column. The fresh water initially creates a brackish nearshore zone with salinities of 10 to 15 parts per trillion (ppt). As shown in Table 3-1, when mixing begins, salinities increase to 15 to 25 ppt with water temperatures ranging from 32°F to 48.2°F. The nearshore waters become relatively well-mixed as the open-water season progresses, with salinities greater than 25 ppt and temperatures gradually decreasing to 30.2°F to 35.6°F.

Table 3-1 Seasonal Bottom Water Changes at McClure Mooring

Season	Months	Bottom Temperature Range (ºF)	Bottom Salinity Range (psu)
Fall Freeze-up	Sept to Early October	35.6 to 30.2	28-29
Early Winter	Mid-October to Mid-April	29.3 to 28.76	27-36
Late Winter	Mid-April to May	28.76 to 29.3	35
Spring Break-up	May-June to Mid- July	28.94 to 29.3	32-35
Summer	Mid-July to August	29.3 to 39.2	15-30

Note: Seasonal changes in bottom water temperatures and salinities were measured from the McClure Mooring from September 2000 through August 2001.

3.1.2.3 Water Levels

Given the relatively small tidal range, water level fluctuations in the vicinity of the proposed Liberty Development and Production Island (LDPI) are controlled more by the effects of wind stress than by astronomical tides. The moorings that Weingartner et al. (2009) deployed in Stefansson Sound showed significant correlations with eastward (downwelling-favorable) winds producing sea level increases and westward (upwelling-favorable) winds resulting in a decrease in sea levels during the open-water season.

Seasonal variability in tides are small, although those associated with the spring flooding can be larger (Weingartner, 2009).

During the open-water season, wave heights are limited by the shallow waters adjacent to the coast and the shelter provided by barrier islands. Moreover, the proximity of the Arctic pack ice limits the fetch available for wave generation.

Beaufort Sea storms, and hence wave directions, can be classified as either easterly or westerly. Easterly storms typically are of longer duration than westerly storms (Oceanweather, 1982). Westerly storms often are accompanied by elevated coastal water levels (storm surge); while easterly storms may produce lower than normal water levels along the coastline. Westerly storms tend to be more severe, in part due to the associated storm surge.

Wave measurements were obtained in the vicinity of Foggy Island Bay during the summers of 1980 through 1983 in support of the Endicott Development (LGL Ecological Research Associates, Inc. and Northern Technical Services, 1983; and Sohio, 1983). In 1980 and 1981, wave heights were less than 2 feet approximately 90 percent of the time, with average wave periods less than 4 seconds. The greatest wave height measured was 2 feet on October 6.

Given the scarcity of wave measurements in the Beaufort Sea, extreme wave information must be generated using oceanographic hindcast models. A site-specific hindcast of oceanographic conditions was conducted for the Proposed Action in 2013 (see 2015 Liberty EIA, page 3-16). Extreme wave statistics for easterly and westerly storms were predicted for four alternate island locations, the shoreline east of Point Brower, and the east side of the Satellite Drilling Island (SDI).

Wave heights associated with westerly storms were found to be larger than those for easterly storms. The 100-year westerly wave height at the island sites (located in a water depth of 18 to 19 feet, mean lower low water [MLLW]) was predicted to be 8.5 feet with a period of 11.6 seconds. At the SDI, located in a water depth of 6 feet, the 100-year westerly wave height was predicted to be negligible, given the shelter provided by the Endicott Causeway (2015 Liberty EIA, Page 3-18).

3.1.2.4 Sea Ice

Sea ice initially forms in the shallow lagoons of Foggy Island Bay in late September and early October, then gradually thickens and grows seaward in the form of landfast ice until Stefansson Sound is ice covered by the second or third week of October. Landfast ice stabilizes and thickens from October through mid-April and maintains a near stable thickness of 5.6 to 7.2 feet into May. Break-up of the nearshore landfast ice zone begins in late May and lasts through June or early July. During break-up, coastal rivers discharge warm, fresh, sediment-laden water onto the landfast ice hastening its near shore melting. Through July, the offshore sea ice (once attached to land as landfast ice) rapidly breaks up freshening the surface waters while dispersing large amounts of sediment and organic matter into the water column. By the third week in July, the area within Foggy Island Bay is typically ice free, although small floating ice can drift into the waters within Stefansson Sound through August and sometimes into September, as was seen in 2015.

From 1999 through 2007, Weingartner et al. (2009) collected and analyzed 6 years of year-round ADCP, and conductivity, temperature, and depth (CTD) data from five moorings deployed within the landfast ice zone of Stefansson Sound. These moorings were deployed in relatively shallow water depths of less than 59 feet outside the barrier islands, and less than 33 feet inside the barrier islands (Figure 3-3). These moorings display the seasonal changes in ice thickness within Stefansson Sound. Based upon the mooring data, landfast ice setup dates varied between October 13 (2001) and October 27 (2004).

The transition from freeze-up to more stable landfast ice conditions in Foggy Island Bay and Stefansson Sound usually occurs in mid-November as the floating landfast ice growth attains a thickness of approximately 3.3 feet. As the floating landfast ice sheet continues to grow, the temperatures in the bottom waters are near freezing and ice begins to adhere to the sediments in shallow areas at water depths shallower than 6.6 feet. This ice becomes anchored to the seabed as bottomfast ice.

During the early winter months, the mean extent of landfast ice covers much of Stefansson Sound, whereas in some years the maximum extent can extend almost as far seaward as the 66-foot contour. By mid-November, there is less risk of ice movement, although the more stable period is when the mean extent of landfast ice reaches the Seaward Landfast Ice Edge (SLIE) in January. The proposed LDPI site becomes more stable as the ice grows confined by the shoreline of Foggy Island Bay to the south, the McClure Island chain to the north, Tigvariak Island to the east, and Endicott SDI to the west. By May, the mean extent of the landfast ice is found seaward of the SLIE and the maximum extent can reach the shelf edge. The landfast ice reaches a maximum thickness of between 5.6 to 7.2 feet stabilizing between 6.6 and 8.2 feet through the end of May.

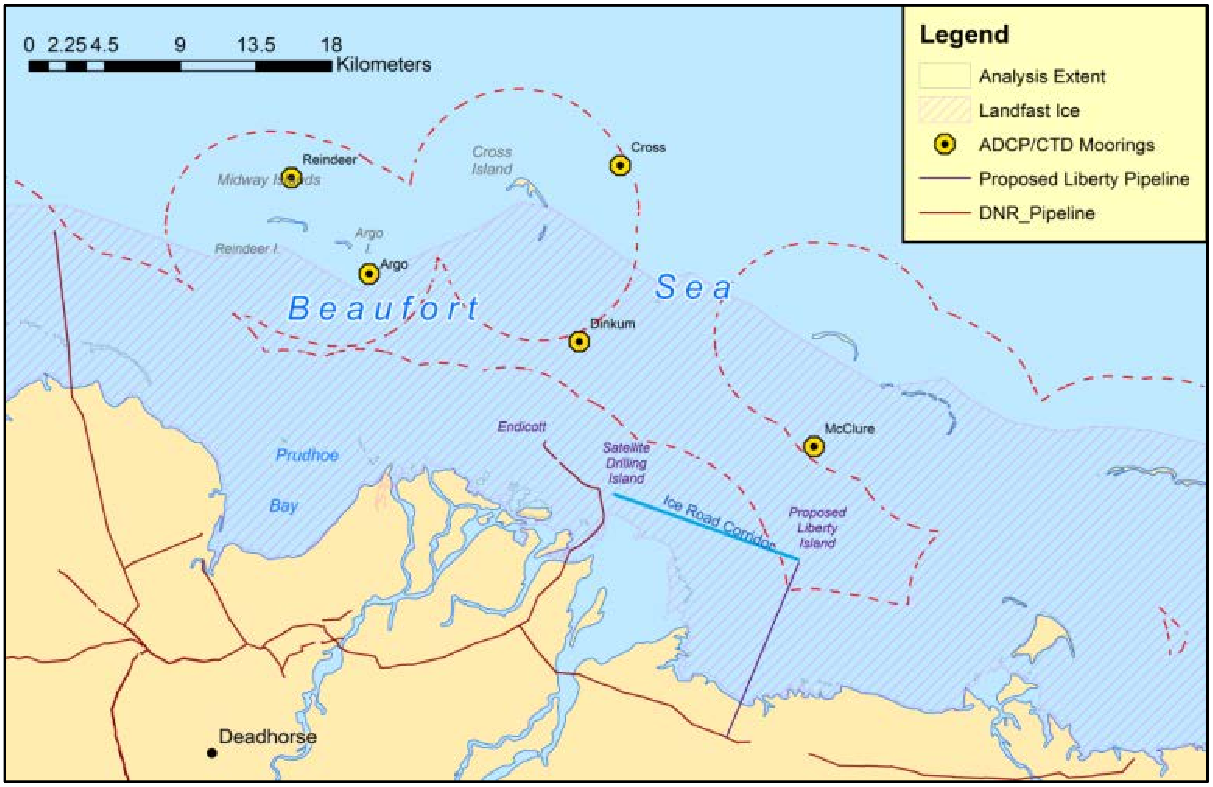

Figure 3-3 **Mooring Locations within Stefansson Sound**
Moorings were deployed within the Stefansson Sound area from 1999 through 2008 (Weingartner et al, 2009).

During the winter months, rapid changes in temperature may produce thermally induced shrinkage cracks in the floating landfast ice, usually propagating from sources of stress concentration such as man-made gravel islands (including the Endicott SDI) or promontories along the coast (e.g., Point Brower). In addition, a working tidal crack can be expected at the perimeter of the floating fast ice along the shoreline and around any grounded ice feature. Other than these minor cracking events, the first-year sheet ice in Stefansson Sound and Foggy Island Bay remains stable (Liberty Development and Production Plan [DPP]).

By early to mid-May, the ice sheet has weakened until ice roads can no longer support over-ice operations. Before the sea ice starts to show apparent signs of deterioration, melting snow in early May helps swell the upland river channels. During the spring freshet in late May or early June, sediment-laden waters flood out onto the landfast ice. The overflood waters can exceed a depth of 3.3 feet and can spread out several miles from shore. The overflood waters are transported over the nearshore bottomfast ice onto the floating landfast ice. The overflood waters then drain through holes and discontinuities in the landfast ice due to tidal cracks, thermal cracks, stress cracks, and seal breathing holes. This annual spring event results in a large decrease in transmissivity, an optical measurement of how light passes through a column of water measuring the concentration of particulate material in the water, which shows an increase in suspended sediment in the water column. These impacts can be observed many kilometers from shore as evident in the sharp drop in transmissivity values at the Dinkum Mooring in Stefansson Sound during the period of spring break-up for June 2000.

The warm sediment-laden flood waters and increased solar radiation weaken the bottomfast ice detaching it from the seabed. The flood waters gradually cover the nearshore area weakening the ice platform. Just before break-up in late June and early July, the number of melt pools increases dramatically, covering approximately 40 to 50 percent of the sheet ice surface. Open water typically appears first along the shoreline and gradually expands along the coast and then seaward.

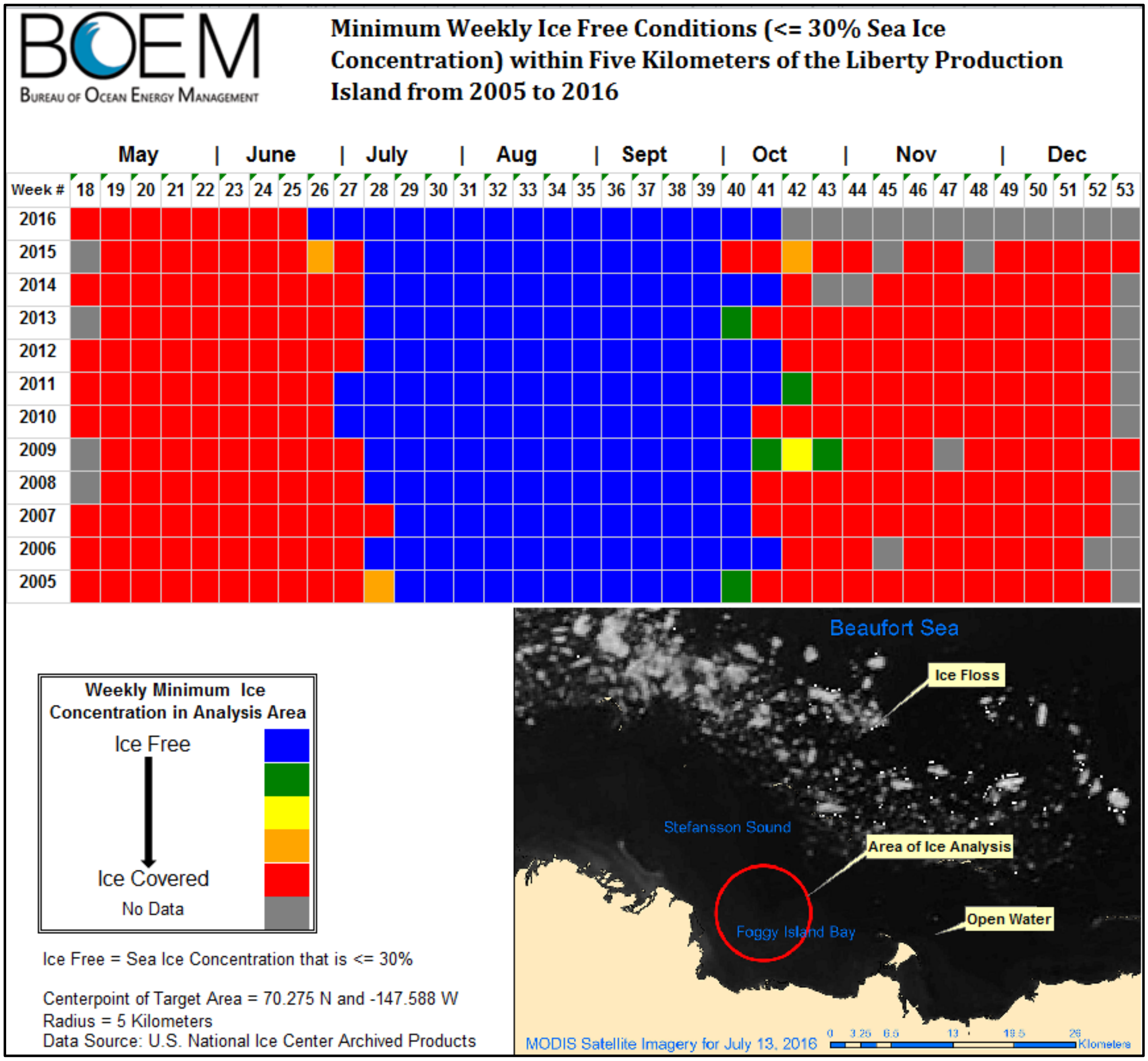

Figure 3-4 **Foggy Island Bay Ice Free or Near Ice Free Conditions: 2005 through 2016**

The blue boxes represent those weeks when the minimum ice concentration within the ice analysis polygon was less than or equal to 30 percent. An example of ice free conditions is shown within the MODIS satellite imagery for July 13, 2016 (bottom right). The blue to red squares represent the transition period from open water to ice covered conditions as larger areas of the ice analysis polygon contained ice concentrations that were greater than 30 percent.

Navigable ice conditions with no more than 30 percent ice coverage, (see Figure 3-4) occur between the months of July and September in most years, although open water can in some years occur as early as late June and as late as the second week of October, as shown for the year 2016.

3.1.2.4.1 Spring Overflooding, Strudel Scours, and Impacts from Pipelines within Foggy Island Bay

The Sagavanirktok River east channel, the Kadleroshilik River, and the Shaviovik River discharge into Foggy Island Bay. The historical average break-up date along the coast for the Sagavanirktok River to overflood the sea ice is May 22, with a maximum date of June 3 and a minimum date of May 8 (Hearon et al, 2009). During the spring break-up period in late May and early June, coastal rivers discharge large volumes of fresh water on top of the coastal bottomfast and floating landfast ice. These flood waters can spread up to 6.2 miles offshore. This brief period of high volume energetic flow of surface waters can be considered a potential hazard to offshore oil and gas development operations since these flooding events can hinder access to facilities, disperse spilled oil, and expose buried pipelines through scouring of the seabed below the landfast ice zone as strudel scouring (Dickens, 2009).

The overflood and strudel scour field mapping and analysis for the Proposed Action were conducted by Coastal Frontiers Corporation for British Petroleum Exploration (Alaska), Inc. (BPXA) in 1997 and 1998. They mapped drainage features and overflood extents via a helicopter survey during spring break-up when bottomfast ice and landfast ice was still present offshore. During the open-water season in August, they mapped the locations of strudel scours on the seabed using sidescan and multi-beam sonar. The recorded drain cracks, drain holes, and strudel scours from those surveys are shown in Figure 3-5.

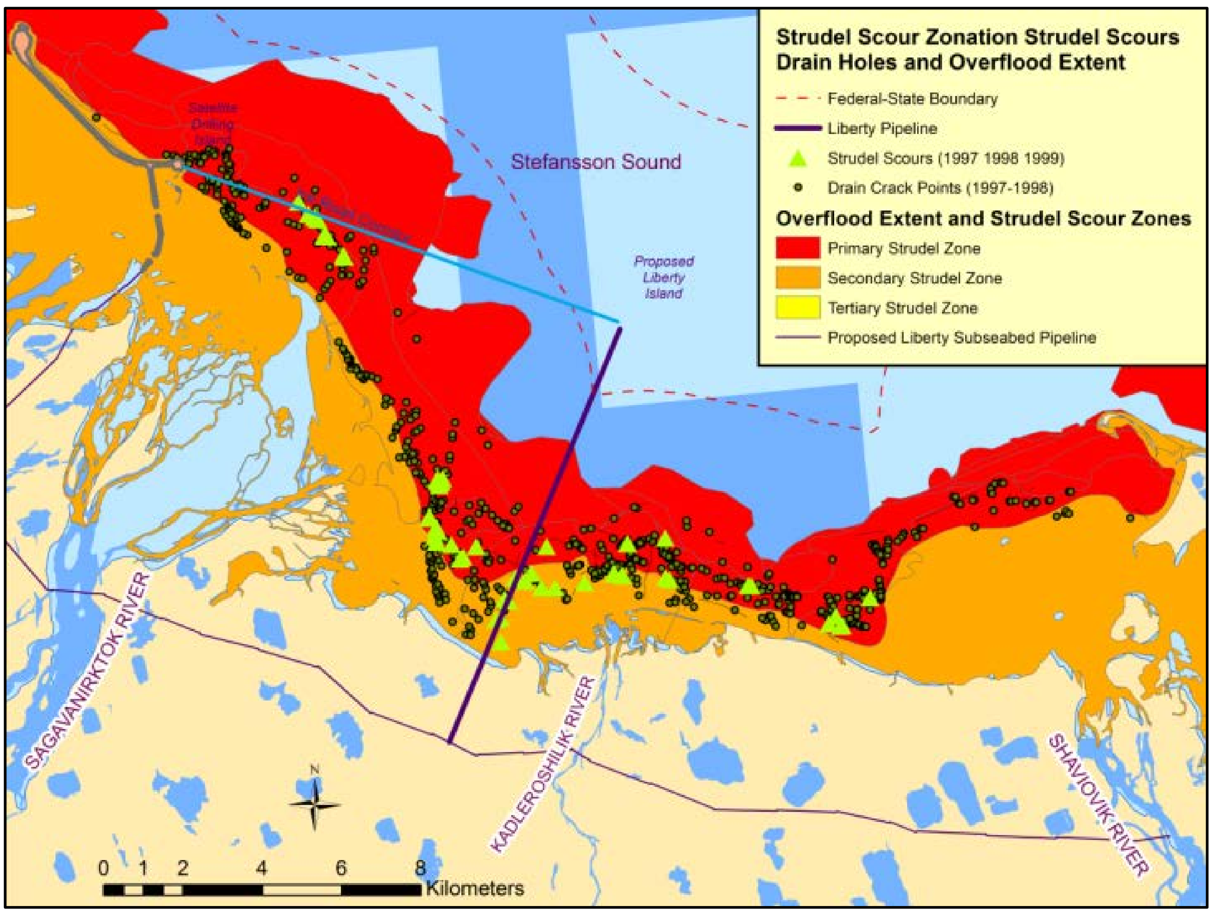

Figure 3-5 Strudel Scours and Drain Cracks – 1997, 1998, and 1999

Strudel scours occur when overflood waters drain through tidal cracks, thermal cracks, stress cracks, or seal breathing holes in the landfast ice. Sufficiently deep strudel scours that form directly over a buried pipeline can remove the underlying fill and cause an unsupported span of pipe; they could also remove the overlying fill material needed to prevent damage from ice gouges and forestall upheaval bucking.

Hearon et al. (2009) also conducted a study to map the relationship between overflood extent, water depth, and strudel scour severity across the North Slope of Alaska. This study included the strudel scour data from the strudel scour surveys conducted for this area in 1997 and 1998. They found that strudel scour frequency and severity could be segregated into separate overflood zones based upon water depth (Hearon et al, 2009). Strudel scouring is most widespread and acute within the Primary Strudel Zone (red zone on Figure 3-5) which extends from the seaward edge of the bottomfast ice edge at 5 feet water depth to the 19.7 feet water depth. In the zone of bottomfast ice or Secondary Strudel Zone (orange) and offshore of the Primary Strudel Zone called the Tertiary Strudel Zone, scours occur on a less frequent basis and tend to be smaller in lateral and vertical extent to those found in the primary zone. Strudel scours that are circular in form were the most prevalent, whereas linear scours formed by drainage through elongated cracks, were found less frequently but were also measured. The maximum scour depths associated with the Sagavanirktok River were 7.8 feet and maximum horizontal extent was 130 feet. These large scours occurred within the Primary Strudel Scour Zone. Seaward of the Kadleroshilik River, the deepest strudel scours did not exceed 3.3 feet for either zone.

Man-made features such as ice roads and causeways can play a significant role in focusing the direction of overflooding within the coastal zone. For example, Endicott Causeway can focus a larger area of floodwater along its length. During the construction of Northstar Island, the height of the ice road and ice berms along the road formed an artificial barrier that restricted the eastward movement of the Kuparuk River flood waters. The effect of these ice roads can create a higher density of strudel scours along this boundary. The presence of an operational pipeline can increase the scour frequency in the area overlying the pipelines due to radiant heat propagating through the backfill and degrading the overlying bottomfast and floating landfast ice (Hearon, 2009).

3.1.2.4.2 Ice Gouges

The U.S. Geological Survey (USGS) conducted extensive ice gouge surveys on the Beaufort Sea Shelf in the 1970s and 1980s (Barnes et al., 1984; Barnes and Rearic, Remnitz, 1985; Barnes, McDowell, and Reimnitz, 1977; Wolf, Reimnitz, and Barnes, 1985; Rearic, 1986; and Rearic and Ticken 1988); with additional surveys performed by the oil and gas industry related to oil and gas exploration in the 1980s and 1990s (Horowitz, 2002). These surveys found that most of the Beaufort Shelf area was heavily gouged, though the area within Foggy Island Bay had sparse ice gouging.

In some areas of the Beaufort Shelf, ice gouges completely cover the seabed, and gouge incision depth can be over 9.8 feet. However, inside the protected area of barrier islands within Stefansson Sound and Foggy Island Bay, ice gouges are significantly less prevalent with much shallower incision depths.

The first extensive ice gouge survey specific to the Proposed Action Area was conducted by Coastal Frontiers Corporation in 1997 and continued for a second year in 1998. The results of these ice gouge surveys suggest that the Proposed Action Area is not heavily gouged and gouges only penetrate the seabed to very shallow depths of less than 1.6 feet.

3.1.3 Oil and Gas Geology

3.1.3.1 Regional Geologic Setting

The Arctic Alaska Petroleum Province encompasses all the lands and adjacent Continental Shelf areas north of the Brooks Range-Herald arch, and is amongst the most petroleum-productive areas in the United States (Figure 3-6). Most of the known petroleum accumulations occur in three regional stratigraphic reservoir units called the Brookian, Beaufortian, and Ellesmerian. The Ellesmerian sequence includes rocks that are Mississippian through Triassic age and consist of mainly nonmarine to shallow marine siliciclastic deposits and carbonates that formed as continental shelf deposits on a passive margin (Bird, 2001). Oil production from the Ellesmerian sequence is from the Endicott, Lisburne, and Sadlerochit Groups.

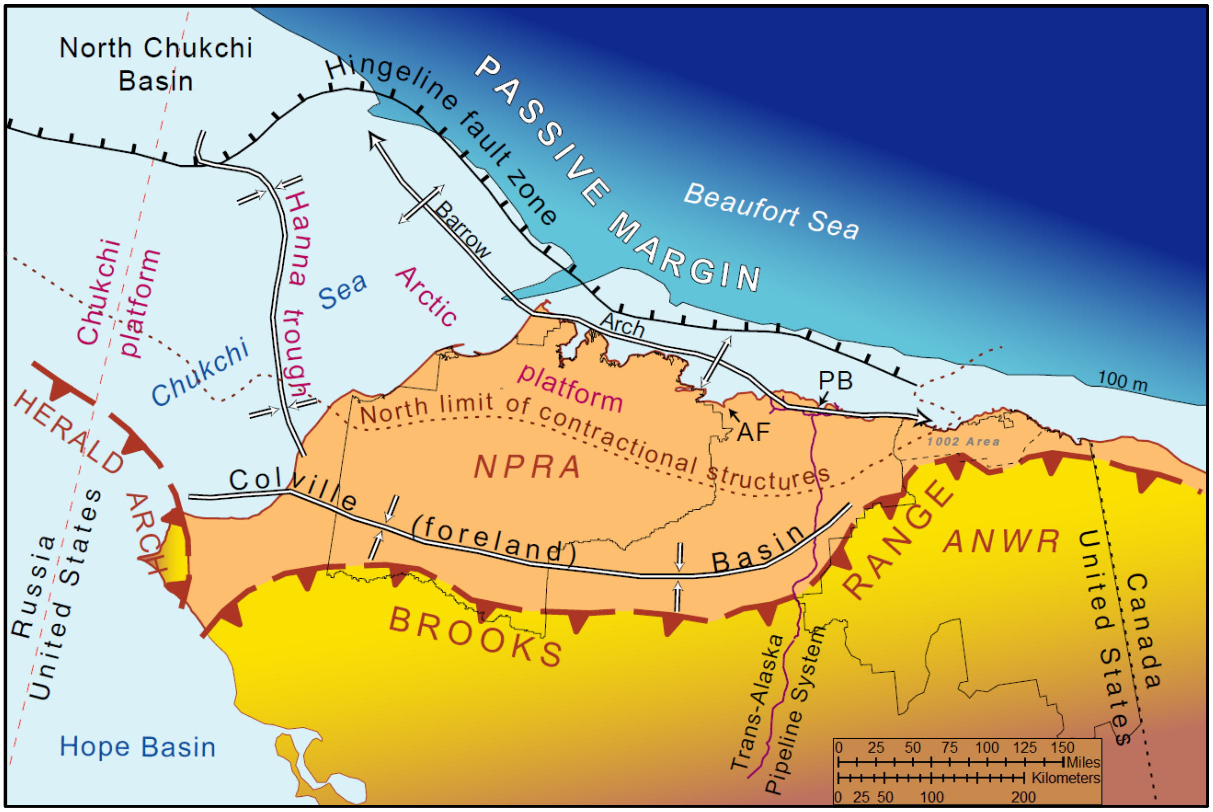

Figure 3-6 Arctic Alaska Petroleum Province

3.1.3.2 Liberty Field

3.1.3.2.1 Reservoir Discovery

The Liberty Field is one of the largest undeveloped reservoirs near North Slope infrastructure. Located in Federal waters approximately 6 miles north of Mikkelson Bay and 15 miles east of Prudhoe Bay, the Liberty Field was discovered by Shell in the early 1980s and confirmed by British Petroleum (BP) in 1997. The Tern #3 and Liberty #1 wells established the presence of producible hydrocarbons within the Kekiktuk Formation. The Tern #3 well encountered mostly very heavy (less than 10° API) immovable oil that forms a thick tar mat underlying the movable oil column in the Liberty Reservoir (Kekiktuk Formation) that was flow-tested at the Liberty #1 well. The Kekiktuk Formation is the lower most of three formations comprising the Endicott Group and is the oldest unit within the Ellesmerian Sequence. Two additional wells exist in the Proposed Action Area (Tern Island #1A and #2A) and provide additional data on the field.

3.1.3.2.2 Reservoir Analog

The Endicott Field, which is contained in the Duck Island Unit, is approximately 5 miles to the west/ northwest of the Liberty Field in State of Alaska (SOA) waters. It is a reasonable analog for the Liberty Field because it has a similar geologic depositional environment and maturation history; analog information from the Endicott Field also provides useful insight into the Liberty Field rock, fluid, and other properties required for modeling and simulation studies. The primary geologic formation containing the hydrocarbon bearing resources in both the Endicott Field and the Liberty Field is the Kekiktuk Formation, and the development and depletion history of the Endicott Field provides insight into how the Liberty Field may respond to possible development activities.

3.1.3.2.3 Reservoir Model and Simulation Study

BOEM's 2016 independent reservoir model of the proposed Liberty DPP, based upon best available exploration, discovery, and analog field information, estimates an areal extent of approximately 2,355 acres with 180 million barrels of original oil in place. The reservoir model consists of two producible zones separated by a thin non-flowing baffle zone with a tar layer at the base of the movable oil column. The porosity and permeability of the reservoir formation differ significantly between the upper and lower zones but the properties of each zone are assumed for modeling purposes, at this time, to remain relatively constant and homogenous across the Liberty oil pool. Reservoir rocks typically are not flat but rather are folded and slope away from a localized high point. As fluids migrate within the rock layers, they separate, stratify, and collect due to their density differences. As a result, any free gas will migrate to the top or crest of a sloping structure with a sealing cap of impermeable rock while liquid hydrocarbons will collect below the free gas layer, if present, further downdip (liquid oil and water will always pool below gas in a reservoir). A water layer will separate out below the liquid hydrocarbon layer (Figure 3-7). If free gas does exist, it will be located "updip" in the highest portion of the reservoir rocks in a free gas cap. Rock layers can be thicker and thinner depending on deposition, erosion, and deformation histories. Based on an interpretation of seismic data, the reservoir is thickest in the northwest portion of the field and thins significantly downdip in the southeast direction. Seismic interpretation puts the top of the reservoir at 10,500 feet below mean sea level.

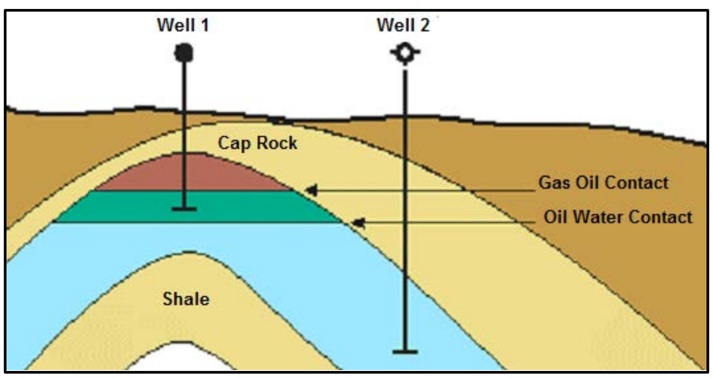

Figure 3-7 Updip and Downdip
(Location along the slope of a dipping plane or surface). In a dipping (not flat-lying) hydrocarbon reservoir that contains gas, oil and water, the gas is updip, the gas-oil contact is downdip from the gas, and the oil-water contact is still farther downdip.

BOEM performed a reservoir simulation study using a full field reservoir model to evaluate reservoir development options and the likely production characteristics of the field. The development plan describes five producing wells, three water injection wells, and one gas or water injection well. As the first well drilled into the reservoir, the gas or water injection well penetrates the reservoir in the thick northwest updip section to evaluate if a gas cap is present. The DPP places three water injectors in the center of the reservoir with two producers to the northwest and up to three additional production wells in the southeast section of the reservoir. A water injection to oil production ratio of at least one barrel (bbl) of water to one bbl of oil will maintain reservoir pressure. As actual drilling, logging, and completion activities provide more information about the reservoir, well count and placement will adjust to optimize efficient recovery of oil from the Liberty Field.

The results of the full field reservoir simulation study of the BOEM reservoir model using the proposed development plan indicates that the Liberty Field would recover from 41 percent to 48 percent of the 180 million barrels of oil (MMBO) in place. The simulation study also indicates a peak production rate of 57,909 barrels of oil per day (BOPD) within the first 2 years of production.

3.1.3.2.4 Reservoir Access

Wells drilled from the surface into the Liberty Field reservoir would access and produce its hydrocarbons. A fixed platform is required to support the equipment used to access and produce those hydrocarbons. In the Arctic, weather conditions including wind, water, and sea ice load necessitate the use of man-made gravel islands instead of other types of bottom-founded structures when water depth is appropriate. The basic design concept for an Arctic offshore artificial gravel island involves the placement of suitable gravel materials with adequate height, mass, and slope protection and maintenance to secure the island against damage by wind, water, and ice forces over the productive life of the reservoir.

There are currently six man-made gravel islands in use for oil and gas development in the Beaufort Sea. The Duck Island Unit/Oilfield required three gravel islands for development – the Endicott Satellite Drilling Island (30 acres), Endicott Main Production Island (45 acres), and Endeavor Island. The Northstar Oilfield/Unit is accessed by Seal Island (5 acres). The Nikaitchuq Oilfield/Unit is accessed by the Spy Island Drill Site (11 acres, not attached to the natural Spy Island). The Oooguruk Oilfield/Unit is accessed by Oooguruk Island. These gravel islands were built near their target reservoir or reservoir compartments supporting the optimum development of the trapped hydrocarbon resources with conventional, available, and field-proven technologies.

The proposed LDPI would be the first permanent man-made gravel island built in Federal waters off the coast of Alaska. From the LDPI, the Liberty Reservoir can be accessed and produced through conventional slant angle wells. The wells would be directionally drilled from the LDPI surface wellhead locations to reach the full extent of the reservoir with a departure of no more than 2.6 miles radius. This means that the bottom hole well location would be no more than 2.6 miles in a horizontal direction away from the well's surface location. The resulting well angles would allow for coiled tubing and/or wireline services as needed during the life of the wells. Coiled tubing refers to a long, continuous length of pipe wound on a spool that is straightened and pushed into a wellbore during well workover, intervention, or other operations. Wireline refers to the use of cabling technology to lower equipment into a well for workover, intervention, or other operations.

3.1.3.2.5 Reservoir Depletion

Studies of fluid samples from the Liberty #1 well indicate that the Liberty Field is a normally pressured reservoir containing light crude at normal reservoir temperatures. The fluid samples indicate hydrogen sulfide (H_2S) in small enough quantities to meet the classification of "H_2S Absent." Lab and field data indicate the reservoir may either have a gas cap or be near the oil's bubble point – the pressure at which gas begins to come out of solution. Keeping the pressure at or above the bubble point pressure is necessary to optimize the recovery of oil. As soon as possible after startup, any produced water would be separated from the produced reservoir fluids, combined with treated seawater, and reinjected to replace produced fluids and initiate waterflood enhanced oil recovery (EOR). Produced gas would be used on LDPI for fuel and to support artificial gas lift support with the unused portion reinjected into the reservoir for additional pressure maintenance and EOR. The waterflood and gas injection would optimize oil recovery and resource conservation.

Surface spacing between wellheads would be 15 feet and a maximum of 16 wellhead slots are planned for the well row. Initially, 10 wells are planned to be drilled with 5 producing wells, 4 water and/or gas injection wells, and 1 disposal well. As wells are drilled and additional information about the Liberty reservoir and individual well performance is gathered, modifications to future well completion designs, placement, count, and other development aspects would be made to optimize field performance.

3.1.4 Water Quality

Stefansson Sound is about 20 kilometers northeast of Prudhoe Bay and immediately east of the Endicott production facility. Extending from the Midway Islands in the west to the Tigvariak Island in the east, the Sound is enclosed by a barrier island chain to the north, including Cross Island. The Proposed Action Area is located in the southwestern part of Stefansson Sound in Foggy Island Bay, at a water depth of about 19 feet. The area includes the Sagavanirktok River Delta to the west and the Shaviovik River Delta to the east (Figure 1-1). The Kadleroshilik River flows into the central part of the Bay.

Consisting of a mixture of marine and freshwater, coastal waters are transported through Foggy Island Bay based upon the direction of the prevailing winds. During the open-water season, the winds are generally from the east, driving water currents to the west. In addition to wind direction and speed, the characteristics of coastal waters are influenced by other factors including the season, amount of solar heating, coastal erosion, freshwater river/stream inputs, and the characteristics of the terrestrial environment.

The quality of water, marine or freshwater, is determined by the water's physical, chemical and biological constituents. These individual attributes are derived atmospherically, terrestrially, and from other sources of fresh or marine environments. Sediments, hydrocarbons, and trace metals are examples of potential contaminants that are introduced into the marine environment by river runoff, coastal erosion, atmospheric deposition, and naturally occurring hydrocarbon seeps. Table 3-2 shows the total solids entering the central Beaufort Sea by three major rivers and coastal erosion.

Table 3-2 River Discharges and Coastal Erosion Discharges into Marine Waters

River/Drainage	Peak River Flow	Annual Rate River Flow	Total Solids
Sagavanirktok River	300 - 1200 (m^3/sec)	~6.5 km^3/year	330,000 Metric Tons/Year
Kuparuk River	500 - 3500 (m^3/sec)	~1.2 km^3/year	21,000 Metric Tons/Year
Colville River	~8500 (m^3/sec)	~15 km^3/year	~5,000,000 Metric Tons/Year
Coastal Erosion	---	---	~1,000,000 Metric Tons/Year
Total	---	~22.7 km^3/year	~6,350,000 Metric Tons/Year

Notes: Table summarizes the rate of discharge of water and total solids from the three largest North Slope Rivers and from coastal erosion into the Proposed Action Area of the central Alaskan Beaufort Sea. Peak flow and sediment discharge, representing 30 to 90 percent of the total annual discharge, occurs during 3 – 12 days in late May and early June each year (Neff, 2010a).

Sources: Rember and Trefry, 2004; Trefry et al., 2004; Alkire and Trefry, 2006.

Studies by AMAP (1997, 2004) and Hopcroft et al. (2008), state that existing degradation of Beaufort Sea Outer Continental Shelf (OCS) water quality is primarily related to aerosol transport and deposition of pollutants; pollutant transport into the region by sea ice, biota and currents; and from increasing greenhouse gases in the atmosphere, which affect water temperature and acidity.

The Colville, Kuparuk, Sagavanirktok and Canning rivers that flow into the Alaskan Beaufort Sea remain relatively unpolluted by humans, however man-made pollutants in the Project Area may be present. Sources of pollutants are primarily the result of industrial activities related to the petroleum industry and include wastewater discharges and accidental spills of crude or petroleum or other substances.

For a complete discussion on regulatory controls over permitted point-source discharges, see Section 2.2.9, EPA Permitting, for the Proposed Action.

3.1.4.1 Characteristics of the Beaufort Sea

Much of our current understanding of the Beaufort Sea is due, in part, to the development of oil and gas resources of Alaska's North Slope exploration activities along the coast and offshore, and development and production offshore in State waters.

BOEM Alaska OCS Region is responsible for managing oil and gas development in Federal waters of Alaska, and beginning in 1979 the Beaufort Sea continental shelf was made available for exploratory drilling. Since then BOEM has sponsored three major environmental effects monitoring projects in the Beaufort Sea: The Beaufort Sea Monitoring Program (BSMP), the Arctic Nearshore Impact Monitoring in the Development Area (ANIMIDA) Project, and the Continuation of the Arctic Nearshore Impact Monitoring in the Development Area (cANIMIDA) Project (Neff, 2010a.) Figure 3-8 illustrates the BSMP water sampling stations in the areas of the proposed LDPI and Northstar Island.

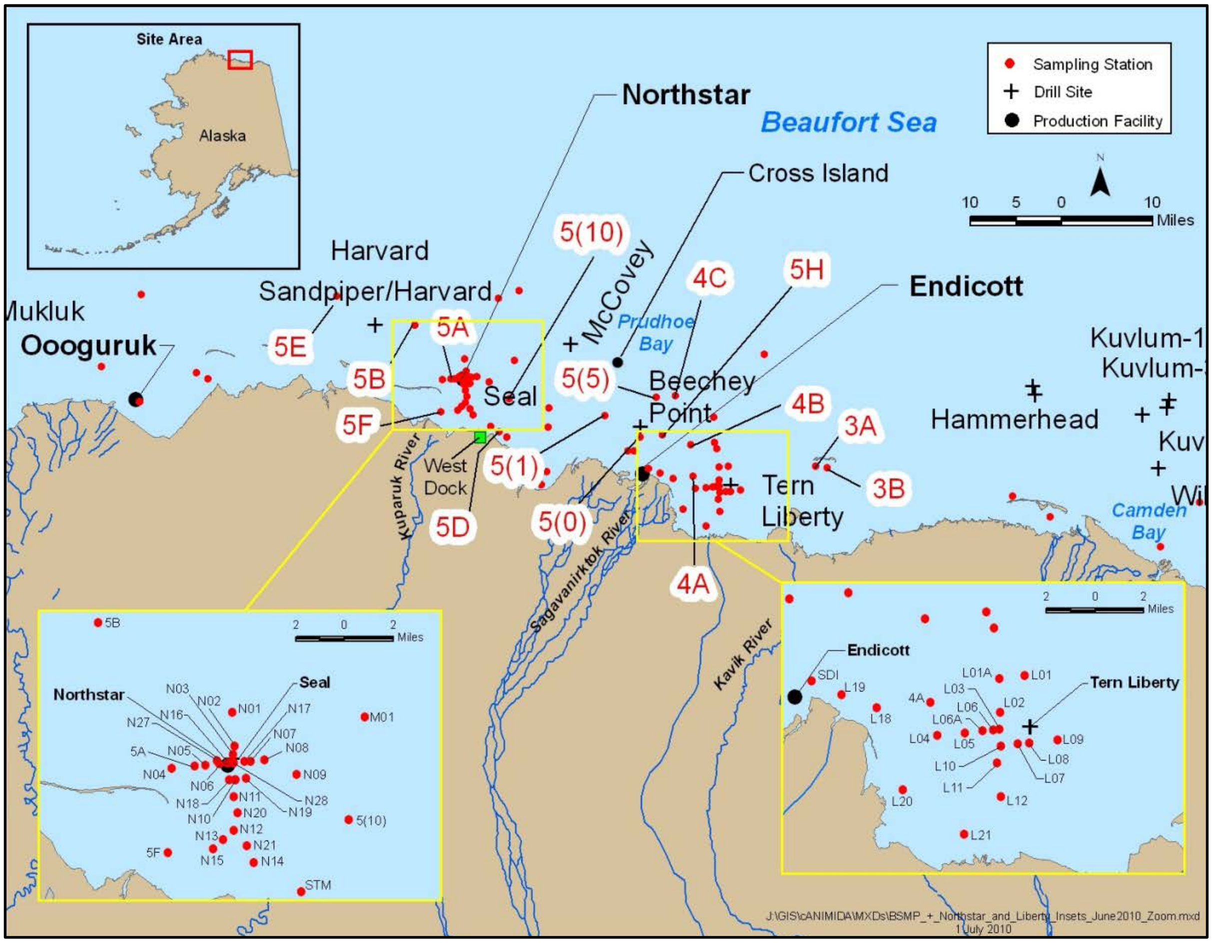

Figure 3-8 **BSMP Sampling Locations near Northstar and Liberty Islands**
Stations displayed have been sampled in relation to the cANIMIDA Program near to exploration drilling sites and production facilities (Neff, 2010a).

The Beaufort Sea Monitoring Program was initiated in 1984 to develop and implement a monitoring program for evaluating potential impacts of anticipated offshore oil and gas exploration and production activities.

The primary objectives of the more recent ANIMIDA and cANIMIDA studies were to monitor and characterize the marine environment of the Northstar and Liberty development areas and to evaluate potential and actual effects of these offshore oil developments (Neff, 2010a). The ANIMIDA Project Phase 1 (1999, 2000) was designed and implemented with a focus on the 1999 late-summer open-water period and the 2000 winter ice-covered period. The late summer 1999 sampling represented pre-construction baselines at both the Northstar and Liberty areas. Final results from Phase 1 of the ANIMIDA Project were summarized in a report titled, “ANIMIDA Phase I: Arctic Nearshore

Characterization and Monitoring of the Physical Environment in the Northstar and Liberty Development Areas" (Boehm et al., 2001).

Phase 2 of ANIMIDA focused on monitoring during the summers of 2000 and 2002 and sampled at the same Northstar and Liberty stations sampled in Phase 1. The winter 2000 sampling represented the first construction monitoring period at Northstar and another pre-construction opportunity for the Liberty Area (Neff, 2010a).

The cANIMIDA Project extended Phase 2 ANIMIDA field program to the summers of 2004, 2005, and 2006 with the explicit goal of examining the temporal and spatial changes and to determine if any observed changes in chemical and biological characteristics of the development area of the Beaufort Sea are related to the current Northstar development and production operations (Neff, 2010a).

Among the numerous tasks assigned to the cANIMIDA project, aspects of the following points are applicable to this analysis:

- Determine the major element, trace metal, and organic carbon content of water and suspended sediments carried to the coastal Beaufort Sea by the Sagavanirktok, Kuparuk and Colville rivers.
- What are the background concentrations of metals and hydrocarbons known to be associated with oil exploration, development, and production activities, and are the concentrations of these chemicals increasing in area sediments as a result of development and production?
- Determine concentrations of suspended sediments, dissolved metals, particulate metals, and supporting parameters in the coastal Beaufort Sea.
- Determine the impacts of TSS on kelp productivity and ecosystem status in the Stefansson Sound Boulder Patch.

The results of both the ANIMIDA and cANIMIDA were integrated in a final synthesis report entitled, "*Continuation of the Arctic Nearshore Impact Monitoring in the Development Area (cANIMIDA) Synthesis, 1999-2007*" (Neff, 2010a).

3.1.4.1.1 Total Suspended Solids – (Turbidity)

Summer – Open Water

Turbidity is caused by fine-grained particles suspended in the water column. These particles come from rivers discharging into the marine environment, coastal erosion, and resuspension by wave action of particles deposited on the seafloor. Seafloor sediments in Foggy Island Bay include a heterogeneous mixture of fine sand, silt, and clay-sized particles less than 0.01 inches in diameter. Turbidity blocks light and measurably reduces primary productivity of waters shallower than about 40 feet.

On the Alaskan North Slope, the frozen tundra and snow pack upstream begin to melt during spring and meltwater slowly flows downstream (northward), melting the river water en route. The meltwater carries particulate and dissolved components frozen in the ice and snow from the previous year along with weathered rock and soil layers from the surrounding river banks. This thawing and weathering contribute to the specific chemical compositions of the particulate and aqueous phases carried by each river. During high discharge, which lasts only 1 to 2 weeks, Alaskan Arctic rivers typically transport 40 percent to 80 percent of their total annual discharge of water and greater than 80 percent of their load of suspended sediments (Neff, 2010; Rember and Trefry, 2004). As a result, spring melt and river runoff not only contribute substantial freshwater to the marine system, but also greatly influence the characteristics of nearshore waters of the Beaufort Sea. For this reason, measuring and understanding the water quality of the major contributing river systems on the North Slope is critical to understanding the water quality of the coastal Beaufort Sea.

Concentrations of TSS in the spring water flow from the Sagavanirktok, Kuparuk, and Colville rivers are highly variable among year and within each annual spring flood. Based on data collected during the cANIMIDA Project, TSS concentrations were highest in the Colville River and lowest in the Kuparuk River. While daily concentrations varied, about 90 percent of the annual transport of TSS from rivers occurs during the spring flood (Neff, 2010a; Trefry et al., 2009). Table 3-3 shows the mean, maximum and minimum concentrations of TSS in the Kuparuk, Sagavanirktok, and Colville Rivers during May through June of the years listed.

Deltas at the mouths of rivers indicate deposition of riverborne sediments and the composition of the suspended matter in rivers can provide a geochemical signature that may allow differentiation between incoming natural suspended sediment and anthropogenic contributions from industrial activity (Neff, 2010a). Suspended sediments and turbidity, and particulate and dissolved metals in the water column were monitored during the cANIMIDA Project at several nearshore stations off the Sagavanirktok and Kuparuk rivers, at selected stations near Northstar, in the Proposed Action Area, and historic BSMP stations (see Figure 3-8). A summary of this data for TSS for all stations in the ANIMIDA and cANIMIDA study area during the open-water period and for a subset of stations in the area of Northstar Island can be seen in Table 3-3 and Table 3-4 (Trefry et al., 2009).

Table 3-3 Total Suspended Solids Sampled During Open Water

Sampling Year	Samples Taken	TSS Mean ± SD (mg/L)	TSS Maximum (mg/L)	TSS Minimum (mg/L)
1999	31	30 ± 27	119	2.9
2000	51	8.2 ± 4.8	26	1.7
2001	34	5.1 ± 2.1	8.7	0.9
2002	32	2.1 ± 1.3	4.4	0.2
2004	45	13 ± 16	64	0.5
2005	65	1.7 ± 1.4	6.7	0.3
2006	26	1.3 ± 0.7	4.0	0.4

Notes: SD = Standard Deviation; TSS=Total Suspended Solids
Samples taken from all ANIMIDA and cANIMIDA Sampling Stations in the study area during the open-water period.
Source: Trefry et al., 2009

The mean concentrations of TSS were higher for years 1999, 2000, and 2004. The very high TSS value in 1999 is probably a reflection of the weather conditions under which it was collected. Much of the 1999 data set was collected following a 5-day storm with greater than 20 knot winds. In contrast, 2002, 2005, and 2006 data were collected during relatively calm conditions with considerable sea ice throughout the study area (Neff, 2010a). During the 2000, 2001, and 2004 sampling periods, conditions were moderate with 5 to 15 knot winds during most of the sampling period. During 2004, relative calm was encountered during most of the study period as reflected in the low mean value for TSS in the Northstar area and in much of the study area. Thus during a given summer, the mean and range of measured TSS concentrations typically reflect the winds and weather (Neff, 2010a; Trefry et al., 2004).

Table 3-4 Total Suspended Solids Sampled near Northstar Island during Open Water

Northstar Area	Samples Taken	TSS Mean ± SD (mg/L)	TSS Maximum (mg/L)	TSS Minimum (mg/L)
1999	17	38 ± 33	119	2.9
2000	35	7.3 ± 4.0	16	1.7
2001	15	4.1 ± 1.8	6.3	0.9
2002	11	2.5 ± 1.5	4.4	0.2
2004	15	6.2 ± 4.8	16	0.5
2005	9	1.4 ± 0.8	3.6	0.8
2006	12	1.1 ± 0.4	2.1	0.6

Notes: SD = Standard Deviation; TSS=Total Suspended Solids
Samples were taken from ANIMIDA and cANIMIDA Sampling Stations near Northstar Island during the open-water period.
Source: Trefry et al., 2009

As noted in Table 3-5 (Trefrey et al., 2009) TSS concentrations are strongly correlated with wind and sea conditions during the open-water season. TSS concentrations tend to be low until the wind speed exceeds 20 knots when current and wave action intensifies. Bottom sediments are re-suspended and TSS levels would increase to 50 mg/L to 100 mg/L or more under stormy conditions.

Data from the cANIMIDA and from many other vertical profiles and horizontal tows presented in previous reports (Trefry et al., 2004) show no significant differences in turbidity or concentrations of TSS in proximity (within 328 to 1,640 feet) to Northstar Island relative to other locations in the ANIMIDA study area.

Table 3-5 Surface Water Relationship between Wind Speed and Total Suspended Solids

Wind Speed (Knots)	TSS Concentration (mg/L)
Calm to 5	~1 – 4
5 - 10	3 – 8
10 to 20	5 to 15
>20	50 - >100
Under Ice	<0.1 - 0.5

Notes: Relationship between wind speed and total suspended solids (TSS) concentrations in surface waters of the Beaufort Sea development area during the open water season. Under- ice TSS concentration range is included for comparison.
Source: Trefry et al., 2004.

Winter – Ice Covered Period

In April 2000, as part of the ANIMIDA project, the concentrations of suspended-particulate matter at various depths in the water column under about 6.5 feet of ice were determined from water samples collected from stations in the vicinity of the Endicott development island, the Northstar Island, and in Foggy Island Bay in the vicinity of the proposed Liberty Project Area (Boehm et al., 2001). TSS measurements ranged from 0.14 mg/L to 0.58 mg/L, and turbidity measurements ranged from 0.15 to 070 nephelometric turbidity units (Boehm et al., 2001). These concentration ranges were lower than the concentrations of suspended particulate matter in the column in August 1999. The ANIMIDA Project also reported that during the winter ice covered season, TSS levels tend to be about 10 to more than 100 times lower than values obtained during the open-water period averaging 0.25 ±0.06 mg/L.

Suspended sediment concentrations measured during the winter construction of BF-37, a gravel island located about 3 kilometers north of the Endicott Main Production Island (MPI), showed that TSS did not increase significantly near the island. Suspended sediment concentrations were measured during the first 7 days after fill placement at radial distances of 492 feet and 558 feet from the island. The maximum TSS concentration increase relative to ambient conditions was 3 mg/L. It was speculated that the sediment plume was limited by low under-ice currents, ice bonding of fine-grained material, and the formation of silt/ice agglomerates (Coastal Frontiers, 2014).

TSS and the Stefansson Sound Boulder Patch

The Proposed Action Area includes an area commonly referred to as the “Stefansson Sound Boulder Patch,” or simply Boulder Patch. The Boulder Patch is characterized by boulders, cobbles, and pebbles that cover large areas of silt-clay sediment. The Boulder Patch supports the only known kelp bed on the Alaskan Arctic coast (Dunton, 2005; Neff, 2010a) where the endemic Arctic kelp *Laminaria solidungula* is abundant in the area. Growth and production of the kelp bed is regulated primarily by photosynthetically active radiation (PAR) available during the summer open-water period and any variation in underwater PAR caused by changes in water transparency can have significant effects on the annual productivity of this species (Dunton, 2005).

The ANIMIDA and cANIMIDA Projects performed field surveys and monitored water quality parameters during the summers of 2001 through 2006. The initial effort in the ANIMIDA Project was focused on establishing a quantitative relationship between TSS and benthic kelp productivity (Aumack et al., 2007; Neff, 2010a).

The cANIMIDA Project elaborated further to determine the impact of sediment resuspension on kelp productivity and to address any ecosystem change as related to anthropogenic activities from oil and gas development, particularly in the proposed Liberty Project Area. Thirty sites from across the monitoring area were sampled during the summers of 2004, 2005, and 2006 in order to describe the spatial extent and patterns of TSS, light attenuation, chlorophyll, nutrients, and physicochemical properties across Stefansson Sound (Neff, 2010a). A general trend of decreasing TSS with distance offshore was observed in all three sampling years (see Figure 3-59, Neff, 2010a).

Dissolved and Particulate Metals

Trefry et al. (2009) noted that barium, copper, chromium, nickel, and lead comprised more than 85 percent of the TSS. The concentrations of these metals in the Beaufort Sea sediment are not significantly influenced by anthropogenic inputs or diagenetic (transformation into sedimentary rock) processes but assumed to be naturally occurring and originating from geophysical formations of the rivers and their tributaries (Neff, 2010b). Neff (2010a) found no significant differences in concentrations of TSS due to oil and gas operations near Northstar Island relative to the overall cANIMIDA study area.

Climate Change and Ocean Acidification

Ocean acidification in the marine environment is occurring as carbon dioxide (CO_2) increases in the atmosphere and the ocean absorbs more CO_2 (AMAP, 2013). This increase in CO_2 forces an increase in hydrogen ion concentration and a lowering of pH over time. Decreasing pH changes the equilibrium of the inorganic carbon system in the sea by reducing the concentration of carbonate ions (CO_3^{-2}), an essential molecule for many organisms that produce structures of calcium carbonate ($CaCO_3$).

Researchers (AMAP, 2013; Steinacher et al., 2009; IPCC, 2013; Mathis et al., 2015a; Mathis et al., 2015b; Mathis et al., 2014; Mathis, Cross and Bates, 2011) found that the greatest degree of ocean acidification worldwide is predicted to occur in the Arctic Ocean (AMAP, 2013). This amplified scenario in the Arctic is related to:

- Warming air temperatures; sea-ice decrease resulting in a greater surface area of the sea exposed to atmospheric CO_2;
- increases in the occurrences of phytoplankton blooms;
- increased freshwater from snowmelt, ice-melt, and rivers discharged to the marine environment;
- decomposition in the sea of land-originated organic matter, and
- increase in storm frequency and intensity forcing mixing and upwelling of organic matter.

If CO_2 continues to increase in the atmosphere at the current rate, it is predicted that the future rate of pH decrease would be greater than the current rate of pH decrease (Mathis et al., 2015a; Mathis et al., 2015b; Mathis et al., 2014; Steinacher et al., 2009; IPCC, 2013).

Increasing ocean acidification is predicted to cause changes in ecosystem processes and present additional stressors to organisms in the Arctic (Mathis et al., 2015a; Mathis et al., 2015b; Mathis et al., 2014; AMAP, 2013; Kroeker et al., 2013; Steinacher et al., 2009; Bednaršek et al., 2014; Fabry et al., 2008, 2009). Decreased thickness of calcium carbonate structures, and in some cases increased structure thickness, has been demonstrated with depressed pH (Reis et al., 2009). Decreased pH can also affect other important physiological functions such as cell function (Rossi et al., 2015; Portner, 2008; Dupont et al., 2008).

The Arctic Monitoring and Assessment Programme notes:

> "Sea-ice cover, freshwater inputs, and plant growth and decay can also influence local ocean acidification. The contributions of these processes vary not only from place to place, but also season to season, and year to year. The result is a complex, unevenly distributed, ever-changing mosaic of Arctic acidification states" (AMAP, 2014).

3.1.5 Air Quality

Air quality describes that portion of the atmosphere, external to buildings, to which the general public has access (where people breathe) and the rating of air quality is based on the cleanliness of the air relative to established standards. On a geographic scale, and having no natural boundaries, air quality is assessed relative to local sources of pollutants that have both local and regional areas of effect, and in the case of greenhouse gases (GHGs), a global effect. The affected environment is assessed by determining the current status of local air quality of onshore areas adjacent to the Beaufort Sea OCS Planning Area, and examining the sources of regulated pollutants already present in the Proposed Action Area.

The Environmental Impact Analysis provided as Appendix A to the Liberty DPP provides an in-depth description of the air quality over the area of affected environment. This analysis is incorporated here by reference and summarized below, with additional supporting and new scientific information included where available.

Contaminants that deteriorate the quality of ambient air can, when present in sufficient concentrations and for sufficient time, cause poor air quality that endangers human health and the environment. The pollutants may be comprised of gaseous, liquid, or solid substances. Contamination of ambient air can be the result of both natural (biogenic) factors such as volcanic eruptions and spontaneous forest fires, and man-made (anthropogenic) factors such as burning of fossil fuels. Poor air quality occurs when concentrations of pollutants from these sources reach levels high enough to be a danger to human health and the environment.

To discern what constitutes poor air quality and where it occurs, EPA has established National Ambient Air Quality Standards (NAAQS) along with a monitoring system to identify geographical areas where the standards are exceeded. The NAAQS are comprised of science-based "limiting criteria" which define maximum concentrations of six air pollutants the U.S. Congress defines as having the potential to endanger human health and the environment when found in high enough concentrations. Each state can also establish their own standards for air quality, but these must be at least as stringent as the NAAQS. The six pollutants assigned limiting criteria under the NAAQS, referred to as the "criteria" pollutants, include:

- Carbon monoxide (CO)
- Lead (Pb)
- Nitrogen dioxide (NO_2), including the family of mono-nitrogen oxides (NO_x, i.e., NO and NO_2)
- Ozone (O_3)
- Particle pollution, including:
  - Inhalable Course Particles (PM_{10}) (particles with a diameter of 10 micrometers or smaller)
  - Fine particles ($PM_{2.5}$) (particles with a diameter of 2.5 micrometers or smaller)
- Sulfur dioxide (SO_2), including the family of sulfur oxides formed when fuel containing sulfur is burned

The NAAQS and the Alaska Ambient Air Quality Standards (AAAQS) valid at the time this document was prepared are summarized in the Liberty EIA, Table 3.4-1 (Hilcorp, 2015, Appendix A, Section 3.4, Table 3.4-1).

Standards for each of the criteria pollutants (referred to as "indicators"), are comprised of several elements, including limiting criteria, which are associated with one or more unique "averaging times," where the frequency of occurrence is limited by the "form" of each standard. Every 5 years the EPA reviews each standard, and if necessary revises them. Thus, periodic reviews may result in the designation of new limiting criteria, updated averaging times, or revised forms for compliance.

The four elements of a standard are:

- Indicators – The six potentially harmful pollutants that are valid at the time of the preparation of this environmental review and listed above. Congress focused regulatory attention on these six pollutants because they have been found to endanger public health and the environment at certain concentrations, are widespread throughout the United States, and come from a variety of sources.
- Limiting criteria – The science-based maximum concentrations below which healthful outside (ambient) air is presumed to exist. Concentrations are expressed as the mass of pollutants per volume unit of ambient air; for instance, parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$).
- Averaging time – The time periods associated uniquely with each pollutant and limiting criteria. The period of time over which concentrations of the pollutant are averaged; health effects are assumed derived from controlled human exposure studies or based on environmentally-based criteria. Averaging times may be short-term (e.g., 1-hour, 3-hour) or long-term (i.e., annual mean).
- Form – The conditions that define compliance to the NAAQS. For instance, compliance requires that the 8-hour average concentration of CO cannot exceed 9 ppm more than once per year, and the rolling 3-month average concentration of Pb cannot exceed 0.15 $\mu g/m^3$ at any time. There is a published form for each standard.

In addition, there are two types of NAAQS: primary and secondary standards, where each standard – whether primary or secondary – includes an indicator, the limiting criteria, the averaging time, and form. Primary standards are established based on human health and focus on the health of sensitive populations such as asthmatics, children, and the elderly; secondary standards are based on public welfare and focus on protecting the environment, preventing property damage, protecting against decreased visibility, and preventing damage to animals, crops, vegetation, and buildings. While some NAAQS have separate and distinct primary and secondary standards, other NAAQS are assigned a single value for both types. Some NAAQS have no established secondary standard, but all NAAQS have at least a primary standard.

The EPA demarcates air quality control regions (AQCRs) that define geographical areas of homogeneous air quality characteristics and then designates the areas as nonattainment or attainment relative to each of the NAAQS. The AQCRs are not sensitive to city, county, or state boundaries. The AQCRs are designated by the EPA pursuant to Sec. 107 of the CAA (42 U.S.C. Section 7407) and are listed in 40 CFR Part 81.

If pollutants exceed any of the NAAQS, or contribute to NAAQS non-compliance in a nearby onshore area relative to either primary or secondary standards, EPA may designate the AQCR as a "nonattainment area." An AQCR is designated "attainment," for specific pollutants in areas where a pollutant does not exceed either a primary or secondary NAAQS. An area may be designated nonattainment for one standard and attainment for another over the same geographical area.

The EPA further categorizes attainment areas into Class I, Class II, and Class III Areas. Class I Areas are defined in the CAA as federally owned land for which Air Quality Related Values (AQRV) are resources that are sensitive to air quality impacts. The incremental amount of degradation to air quality, including visibility allowed within Class I Areas, is limited (prevention of significant deterioration [PSD] increment) and depends on the baseline pollutant concentrations than Class II areas. Less rigorous requirements are established for Class II Areas, and even less structure is required for Class III attainment areas. There are currently no Class III areas in the U.S., and areas that are not designated as Class I areas are by default designated as Class II areas. The EPA recommends any proposed new or modified source of emissions located within 62 miles of a Class I area should be evaluated for potential adverse air quality or AQRV impacts on the Class I Area. This regulatory framework is intended to ensure that new or modified emission sources do not cause or contribute to exceedances of the NAAQS, nor adversely impact AQRVs in Class I areas.

The air quality status within an AQCR applies only to onshore areas, as the EPA does not classify the quality of air above State waters or the OCS. Compliance with the NAAQS is the responsibility of the state for the atmosphere above state waters extending from the shoreline to the seaward boundary, which in Alaska is 3 nautical miles (nmi) beyond the shoreline. BOEM is responsible for the control of OCS sources of air emissions located within the Beaufort Sea OCS Planning Area – an area of Federal waters which extends from the seaward boundary to 200 nmi.

3.1.5.1 Attainment Status

The current status of onshore air quality adjacent to the Beaufort Sea OCS Planning Areas is designated by the EPA as unclassifiable/attainment. Also, there is no Class I Area within 62 miles of the Alaska North Slope (ANS).

3.1.5.2 Jurisdictional Authority for Air Pollution Control

Air pollution prevention and control of new or modified sources within the Beaufort Sea OCS Planning Area is regulated by BOEM pursuant to its regulations at 30 CFR Part 550 subpart C.

These regulations require controls on new and modified OCS sources that they have the potential to significantly affect the air quality of any state. The regulations may require compliance with the EPA Significant Impact Levels (SILs) [40 CFR Section 51.165(b)(2)] and the EPA Prevention of Significant Deterioration (PSD) levels [40 CFR Section 52.21(c)]. The BOEM regulation is further dependent on the air quality attainment status of the affected onshore area.

3.1.5.3 Existing Emissions

Emission sources likely responsible for existing air quality conditions are related to current levels of onshore and offshore industry. The existing sources of pollutants adjacent to the Beaufort Sea OCS Planning Area vary considerably in quantity and type. There are relatively few offshore and onshore sources on and near the ANS. Most are associated with the operation of the Prudhoe Bay oil field and the several relatively small villages located along the coast of the ANS. Existing annual emissions onshore and offshore along the ANS are summarized in Table 3-6.

Table 3-6 Existing Emissions (Tons per Year)

Pollutant	Offshore	Onshore	Total
Nitrogen Oxides	1,816	45,734	47,550
Sulfur Dioxide	38	1,235	1,273
Volatile Organic Compound	106	2,886	2,992
Carbon Monoxide	249	14,002	14,251
PM_{10}	36	35,644	35,680
$PM_{2.5}$	27	4,771	4,780
Lead	0.005	0.325	0.330
Carbon Dioxide equivalent	141,933	13,796,135	13,938,067

Pollutant	Offshore	Onshore	Total
Hazardous Air Pollutant	18	390	408
Hydrogen Sulfide	0.0	196	16
Ammonia	0.7	4.4	5.2

Source: Fields, Billings, and Pring et al. (2014, Table VI-1).

3.1.5.4 Arctic Haze

Air quality on the ANS can be affected by a phenomena referred to as "Arctic haze." Arctic haze is most frequently visible during the winter and spring months and is the result of the long-range transport of pollution mainly from coal-burning power plants in the Eurasian mid-latitude countries of Russia and China. The poleward transport of the aerosols from Eurasia occurs under the influence of high pressure systems causing the aerosols to be concentrated within the lower 10,000 feet of the atmosphere in the same general location each year. The haze is comprised of aerosols such as smoke, particle matter, sulfates, and black carbon, all of a diameter generally less than 1.0 micrometer in diameter, and trace gas pollutants such as ozone. The aerosols may have a regional effect on climate change because they increase the number and concentration of cloud droplets. Zhao and Garret (2014) found that in Utqiaġvik, Alaska, the net radiative effect of clouds is to warm the surface during all months except June through September. They also found the average indirect warming effects from the aerosols over the Arctic to be modest because the clouds are present and polluted only one quarter of the time.

3.1.6 Climate Change

Climate change in the context of this FEIS is defined as the unusually rapid change in the Earth's average (or net) surface temperature over the past century, which is primarily due to GHGs released from the burning of fossil fuels. Although the Earth's climate is naturally variable, the current concern with global climate focuses on how this change is accelerating.

Fluctuations in the global climate are the consequence of the Earth's energy budget (radiation balance), which is the system of heat transfer between the earth and the sun; a natural process that seeks equilibrium (NASA, 2016). When the system's natural radiation balance is modified by excess GHGs in the atmosphere, an acceleration of net warming occurs.

The Intergovernmental Panel on Climate Change (IPCC) released its Fifth Assessment Report (AR5) in 2013, providing updates with respect to global climate change. Scientific publications on climate change impacts, adaptations, and vulnerabilities doubled between 2005 and 2010. While the science of climate modeling is evolving, scientists generally agree the warming trend is accelerating at a remarkable rate, which is, at least in part, the result of increased emissions of GHGs produced by human activities (IPCC, 2013). The United Nations Framework Convention on Climate Change suggests that climate change is attributable to human activities that have altered atmospheric composition and caused climate variability beyond what can be explained by natural causes; the IPCC explains that recent climate changes cannot be explained by natural causes alone, and that it is likely that human activities have been the dominant cause of warming (IPCC, 2013). Not yet apparent are the impacts to many biological systems, as many impacts are still within natural high variability, and may be further influenced by confounding local and regional factors (IPCC, 2013); however, the scientific confidence that these changes will occur is high.

3.1.6.1 Greenhouse Gases

GHGs are chemical compounds that contribute to the greenhouse effect by absorbing infrared radiation from the sun. When an overabundance of GHG is present in the lower atmosphere, more heat can be trapped, and the net temperature of the Earth increases. Some GHGs, such as CO_2, are emitted to the atmosphere both through human activities and natural processes. Other GHGs are created and emitted solely through human activities. The three most abundant GHGs caused by human activities are:

Carbon dioxide. CO_2 enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions. CO_2 is removed from the atmosphere when it is absorbed by plants as part of the biological carbon cycles (EPA, 2011d). Concentrations of CO_2 have increased steadily since the beginning of the industrial era, from an annual average of 280,000 parts per billion (by volume) (ppbv) in the late 1700s to 396,000 ppbv, or 0.0396 percent, at Mauna Loa Observatory in 2013 (EPA, 2014d). CO_2 is not destroyed in the atmosphere over time; some molecules may remain in the atmosphere for 50 to 500 years before it is absorbed by plants. The graphs in Figure 3-9 depict recent increases in CO_2 emissions.

Methane (CH_4). The warming impact from emissions per pound of CH_4 is over 20 times greater than CO_2 (EPA, 2014a). CH4 is emitted during the production and transport of coal, natural gas, and oil. CH_4 emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills (EPA, 2011c). Concentrations of CH_4 have more than doubled since preindustrial times, primarily due to the use of fossil fuels; CH_4 concentrations were measured at 1,800 ppbv, or 0.00018 percent, in 2013 (EPA, 2014d). Methane remains in the atmosphere for an average of 12 years.

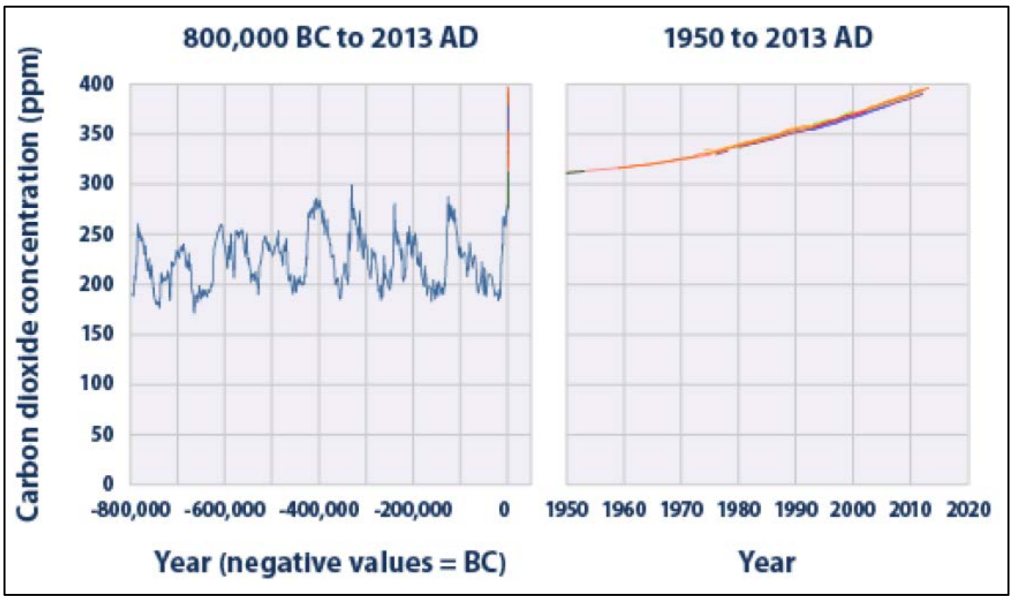

Figure 3-9 **Global Atmospheric Concentrations of Carbon Dioxide over Time**
These graphs show the concentrations of CO_2 in the earth's atmosphere dating back hundreds of thousands of years through 2013, measured in parts per million (ppm). The graph on the right shows the increase of CO_2 emissions in the past 63 years until 2013.
Source: EPA 2014d

Nitrous oxide (N_2O). The impact of one pound of N_2O is over 300 times that of one pound of CO_2 with respect to the ability to absorb heat (and thus retain it in the atmosphere) (EPA, 2014a). N_2O is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste (EPA, 2011d). After rarely exceeding 280 ppbv over the last 800,000 years, levels of N_2O have increased since the 1920s to a new high of 326 ppbv, or 3.2E-5 percent, due primarily to agriculture (EPA, 2014d). Nitrous oxide molecules remain in the atmosphere for an average of 120 years, until transformed through chemical reactions.

3.1.6.2 Systems Driving Global Climate Change

Climate zones are controlled by various topographical, oceanographic, and meteorological features (Ahrens, 2013). These features include intensity of sunshine (which can vary by latitude), distribution of land and water, ocean currents, prevailing winds, high- and low-pressure areas, mountain barriers, and altitude. The natural fluctuations of these systems can have an impact on the climate, both locally and on the global scale.

The Pacific Decadal Oscillation (PDO), the North Atlantic Oscillation (NAO), and the Arctic Oscillation (AO) are all patterns of climate variability that are believed to influence global and Arctic climate. Figure 3-13 illustrates the AO from 1950 through 2014. The PDO describes the fluctuation in northern Pacific sea surface temperatures that alternate between above normal (negative phase) and below normal (positive phase). These cycles operate on a 20- to 30-year time scale (NOAA, 2011), and are believed to be associated with shifts in the climate of the North Pacific around 1948 and 1976 (Bond, 2011). The last major shift in the PDO occurred in 1976 to 1977, marking a change from cold to warm conditions in Alaskan waters (Bond, 2011).

The NAO is a climate system that is the dominant mode of winter climate variability for a geographic area extending from the North Atlantic region to central North America, Europe, and Northern Asia. The NAO is a large-scale atmospheric mass that controls the strength and direction of the westerly winds and storm tracks across the North Atlantic. A positive NAO index is associated with stronger and more frequent winter storms crossing the Atlantic Ocean. The NAO has trended toward the positive phase over the past 30 years (Bell, 2011), which is associated with stronger and more frequent winter storms crossing the Atlantic Ocean.

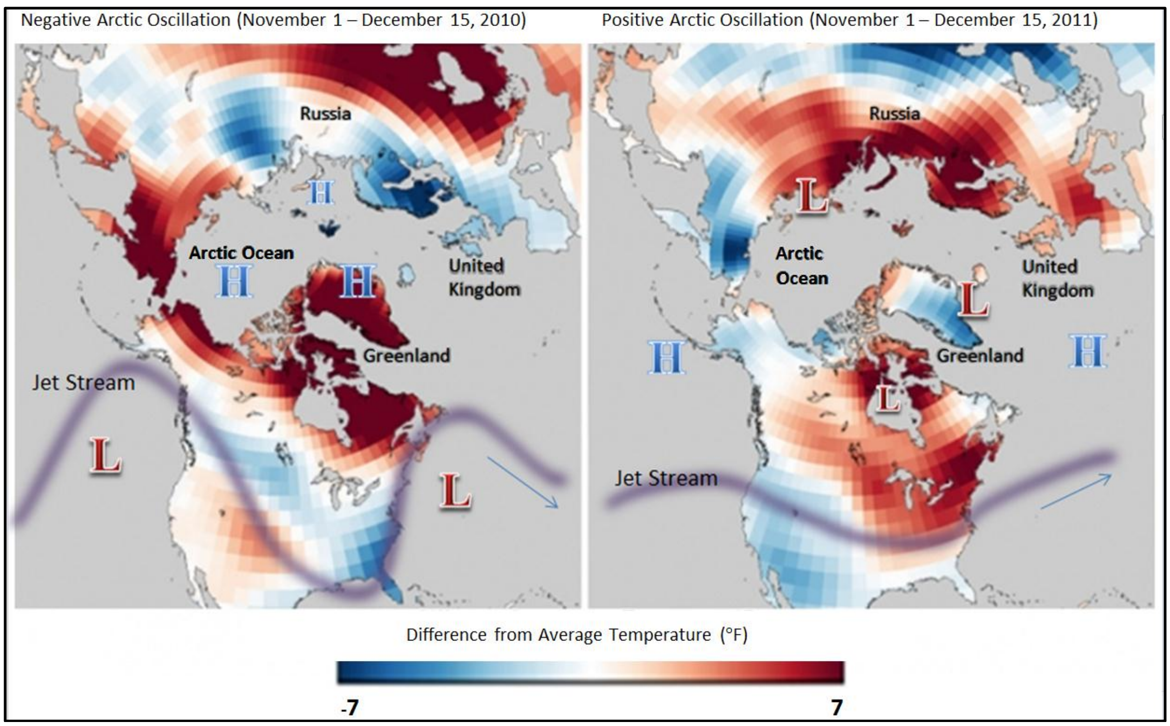

Figure 3-10 Arctic Oscillation Phases

Diagram shows the approximate average locations of high and low pressure centers and the jet stream, defining the negative and positive phases of the Arctic Oscillation, superimposed on a world temperature map of 2010 and 2011. During the negative phase, winds become weaker and the jet stream develops a deep trough over the central United States, allowing cold air to drive southward (Douglas, 2012). The positive phase shows low pressure over the polar region and higher pressure in the Northern Pacific and Northern Atlantic Oceans.

Source: Adapted by BOEM from Douglas 2012.

The AO is a climate cycle system that influences climate patterns in the Arctic. The AO is very similar to the NAO with respect to timing and effects on local temperatures and precipitation. The AO is defined by the location of synoptic surface pressure patterns (highs and lows) at the polar and middle latitudes that, on occasion, nearly reverse position, and "oscillate" between positive and negative phases from one winter to the next.

Graphs of the historical occurrence of the annual AO index, whether positive or negative, are shown on Figure 3-10. On the graphs, the positive phases of the AO are indicated by marks above the zero-line, and the negative phases, below the line. Since the 1950s, the AO has fluctuated between the negative and positive phases, being mostly negative through the 1990s, when a more intense positive phase prevailed. During the 2000s, the AO has fluctuated, having a more intense negative phase in 2010, followed by another positive phase. The AO can change from a positive to negative mode, or vice versa, in a matter of weeks. The increase in incidence of the AO negative phase supports continued warming in the Arctic Ocean and Alaska (NASA, 2011).

3.1.6.2.1 Global Temperature

Scientists began to derive equations in the 1860s that are still used to calculate how changes in the levels of carbon dioxide in the atmosphere can alter the surface temperature through the greenhouse effect. The greenhouse effect is the process by which radiation from a planet's atmosphere warms the planet's surface to a temperature above what it would be without its atmosphere (IPCC, 2013).

Evidence from ice-core data from Antarctica has been used to determine the historical record of temperature versus the concentration of carbon dioxide from 420,000 years ago to present, as depicted on Figure 3-11. The core analysis, from which this figure's data was derived, shows that CO_2 and CH_4 concentrations correlate with the Antarctic isotopic temperature (Petit, Jouzel, and Raynaud et al., 1999).

The figure below illustrates that in the past, the main trends of CO_2 concentration and temperature changes are similar for each glacial cycle. The last ice age ended approximately 7,000 years ago, marking the beginning of the current climate era and the onset of human civilization. Most climate changes are attributed to very small variations in Earth's orbit that change the amount of solar energy the planet receives (IPCC, 2013).

The notable spike in CO_2 shows that present-day atmospheric burden of CO_2 is unprecedented during the past 420,000 years (Petit, Jouzel, and Raynaud et al., 1999) and of particular significance since it is very likely human-induced (IPCC, 2013).

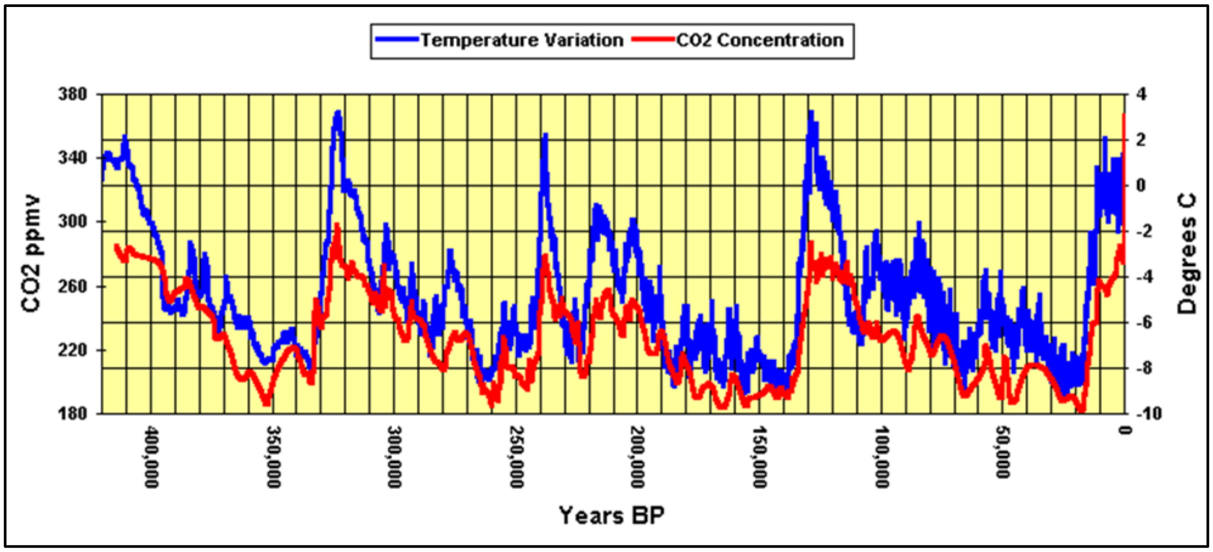

Figure 3-11 **Chronological Temperature and CO_2 Concentrations**

This image reflects results from ice-core data collected from the Vostok site in Antarctica and published in the British journal, Nature. The graph shows the correlation between CO_2 concentration levels, over time, and temperature changes through four glacial cycles dating back 420,000 years. The graph measures the concentration of CO_2, in units of parts per million by volume (ppmv) against temperature in degrees Celsius, against the years "before present" (B.P.) in demarcations of 10,000 years. The thicker lines of temperature beginning approximately 100,000 B.P. are the result of more copious data than was available for the previous periods.

Source: Petit et al. 1999

The U.S. Global Change Research Program (USGCRP) estimated that increases in average global temperatures are expected to be within the range of 0.5°F to 8.6°F by 2100, with a likely increase of at least 2.7°F for all scenarios except the one representing the most aggressive mitigation of greenhouse gas emissions. Except under the most aggressive mitigation scenario studied, global average temperature is expected to warm at least twice as much in the next 100 years as it has during the last 100 years. Ground-level air temperatures are expected to continue to warm more rapidly over land than oceans. Some parts of the world are projected to see larger temperature increases than the global average (USGCRP, 2014). By 2100, the average U.S. temperature is projected to increase by about 3°F to 12°F, depending on emissions scenario and climate model. An increase in average temperatures worldwide implies more frequent and intense extreme heat events, or heat waves. The number of days with high temperatures above 90°F is expected to increase throughout the United States, especially toward the end of the century. Climate models project that if global emissions of greenhouse gases continue to grow, summertime temperatures in the United States that ranked among the hottest 5 percent in 1950 through 1979, will occur at least 70 percent of the time by 2035 through 2064 (IPCC, 2013). Figure 3-12 illustrates the IPCC (2013) modelling.

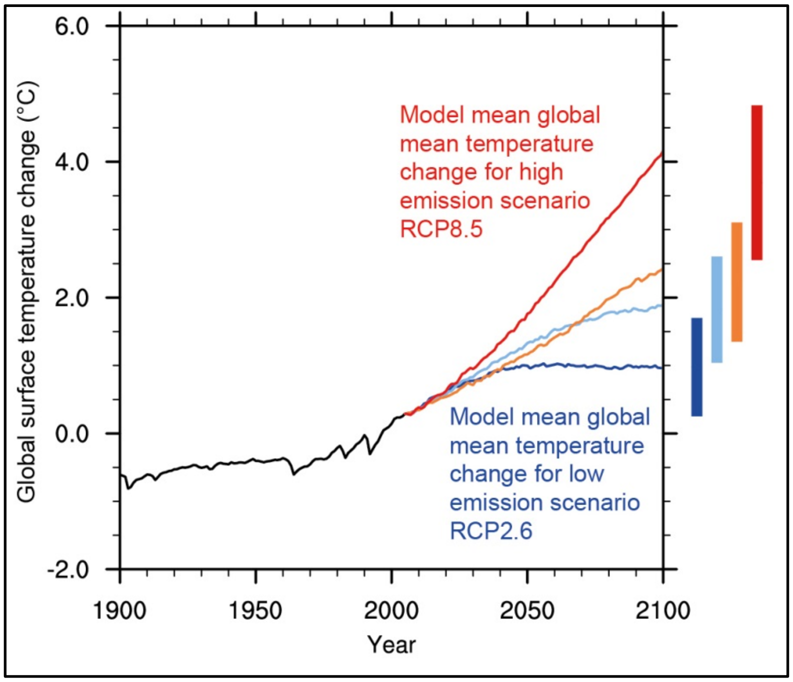

Figure 3-12 Observed and Projected Changes in Global Average Temperature
Observed and projected changes in global average temperature under four emissions pathways. The vertical bars at right show likely ranges in temperature by the end of the century, while the lines show projections averaged across a range of climate models. Changes are relative to the 1986-2005 average.

Source: IPCC 2013

3.1.6.2.2 Sea Level Rise

The global sea level has risen and fallen by approximately 400 feet in the past four glacial cycles (since approximately 400,000 years ago) (Siddall et al., 2003). The global sea level rise in the last century is approximately 6.7 to 7.5 inches (USGCRP, 2014) (IPCC, 2013). Since 1992, satellite altimeters indicate that the rate of rise has increased to 1.2 inches per decade—a significantly larger rate than at any other time over the last 2,000 years (NOAA, 2016).

An increase in the global net temperature contributes to sea level rise by expanding the ocean water (by increasing the net temperature of the seawater), melting mountain glaciers and polar ice caps, and causing portions of Greenland and Antarctic ice sheets to melt into the ocean.

3.1.6.2.3 Ocean Acidification

The oceans are natural reservoirs of inorganic carbon. About 30 percent of the total anthropogenic emissions of CO_2 accumulate in the ocean, which is resulting in gradual increased acidification. This additional CO_2 and corresponding decrease in ocean pH levels increases potential threats to the health of the world's oceans ecosystems (IPCC, 2013).

Seawater that is supersaturated with calcium carbonate minerals typically supports abundant healthy marine life. Calcium carbonate minerals provide the means for calcifying organisms to build their skeletons and shells. Continued ocean acidification would cause some parts of the ocean to become less saturated with the needed mineral, which is likely to affect the ability of some organisms to produce and maintain their shells (NOAA, 2014b). See Section 3.1.4, Water Quality, for additional detail on ocean acidification.

3.1.6.2.4 Polar Ice Conditions

Data from NASA's Gravity Recovery and Climate Experiment show Greenland lost 36 to 60 cubic miles of ice per year between 2002 and 2006, while Antarctica lost about 36 cubic miles of ice between 2002 and 2005.

3.1.6.3 Climate Change in the Arctic

The climate is changing faster in the Arctic than any other region in the world (NOAA, 2014a). Temperature recordings taken by the National Weather Service Office in Utqiaġvik from 1961 through 2010 and compiled by the Western Regional Climate Center in Reno, Nevada provide evidence of the warming in the Arctic (WRCC, 2014). The temperature recordings show that Utqiaġvik's mean temperature increased from 9.4°F during the 30 years from 1961 to 1990, to 11.8°F during the 30 years from 1981 to 2010, an increase of 2.4°F (Figure 3-13).

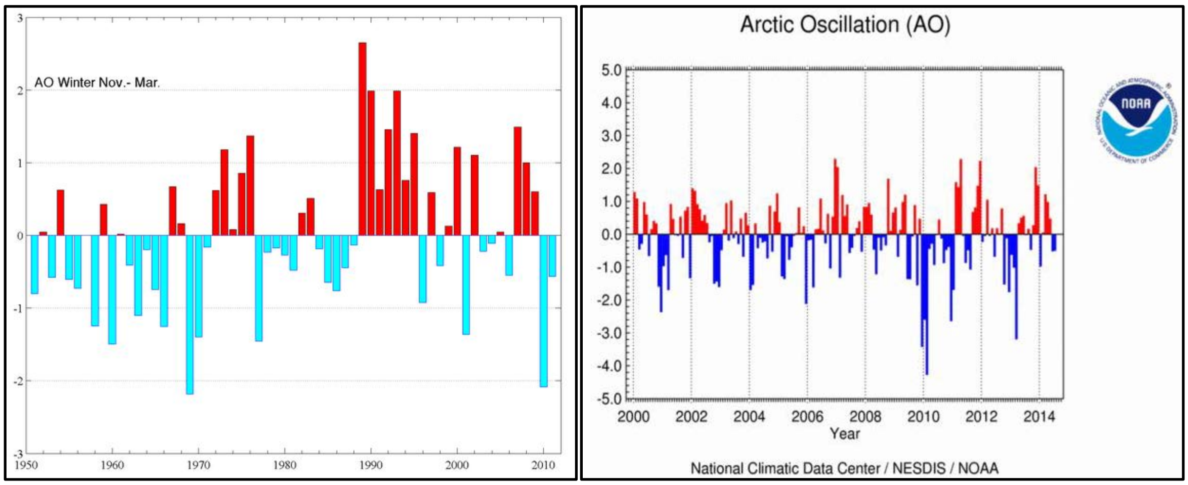

Figure 3-13 Chronological Arctic Oscillation Phases
The charts show the changes in the Arctic Oscillation beginning in 1950 until 2010 (left) and in the decade of the 2000s (right).

Source: NOAA, 2014b

Evidence of the Arctic climate warming is also supported by traditional knowledge from Alaska Native communities along the Beaufort and Chukchi seas. The IPCC noted that evidence of climate change is more apparent in natural systems, notably global warming, shifts in precipitation patterns and ocean acidification (IPCC, 2013). Residents of these communities have reported changes in thickness of sea-ice, increased snowfall, drier summers and falls, warmer temperatures, reduced river and lake ice, permafrost degradation, and increased storms and coastal erosion. Changes reported by local residents are generally consistent with the scientific evidence of climate change (NSIDC, 2011), and include the following:

- Air temperatures in the Arctic are increasing at an accelerated rate
- Year-round sea-ice extent and thickness has continually decreased over the past three decades
- Water temperatures in the Arctic Ocean have increased
- Changes in salinity of the Arctic Ocean has occurred
- Sea levels are rising
- Glaciers are retreating
- Terrestrial precipitation is increasing
- Permafrost is warming

- The tree line is migrating northward

Although verifying such trends in the Arctic is challenging due to the small number of monitoring stations and relatively short records of data, the following statistics for the Arctic, published as part of the Arctic Climate Impact Assessment, support these trends (ACIA, 2004 and ACIA, 2005):

- A warming trend in the Arctic of 0.160°F per decade compared to 0.110°F, per decade, for the globe
- A warming trend of 0.70°F per decade over the last four decades
- Precipitation increase of approximately 1 percent per decade over the past century
- Snow extent decrease of approximately 10 percent
- Permafrost warming almost 3.6°F over the past three decades
- A rise in Arctic Sea level of 3.9 to 7.9 inches in the past century
- An 8 percent decrease in annual average sea-ice extent over the past three decades
- A 15 percent to 20 percent decrease in the extent of summer sea ice over the past three decades
- A mean annual increase in temperatures of 4° to 5°F over the last 50 years
- A decrease in sea-ice thickness by 42 percent since the middle 1970s
- An increase in winter temperatures of 6° to 7°F over the past 50 years

Changes in the Arctic climate are illustrated in reductions in sea ice over the past several decades. According to the National Aeronautics and Space Administration (NASA), the annual minimum summer extent of Arctic ice coverage in September 2013 was 1.97 million (M) mi^2. The extent of sea ice varies from year to year; for example, the 2012 annual minimum summer extent was 1.32M mi^2, about half the size of the average minimum extent from 1981 to 2010. According to NASA:

> "The trend with decreasing sea ice is having a high-pressure area in the center of the Arctic, which compresses the ice pack into a smaller area and also results in clear skies, which enhances melting due to the sun." Further, "(t)he character of the ice is fundamentally different: It's thinner, more broken up, and thus more susceptible to melt completely. This year [2013], the cool temperatures saved more of the ice. However, the fact that as much of the ice melted as it did is an indication of how much the ice cover had changed. If we had this weather with the sea ice of 20 years ago we would have had an above-normal extent this year [2013]" (NASA, 2013).

Because thinner ice melts faster than thicker ice, the average thickness of Arctic ice is expected to decrease further, particularly the extent of the summer ice. NASA predicts that at this rate, Arctic summer ice may disappear completely within this century (NASA, 2013).

Continued loss of sea ice could cause further warming through albedo feedback. Albedo feedback occurs when a change in the area of snow-covered land, ice caps, glaciers, or sea ice alters the reflectivity of a surface. Albedo (Î±) is a value that indicates the reflective ability of a surface from 0 to 1. Generally, the whiter the surface, the more reflective it is, and the value tends toward 1; conversely, the darker the surface, the less reflective it is, and the value tends toward 0. Cooling increases ice coverage and increases the albedo. Increased albedo leads to increased cooling as the amount of solar energy absorbed is minimized. Conversely, decreased albedo leads to increased warming as the amount of solar energy absorbed is maximized (Deser, Walsh, and Timlin, 2000).

In the warming Arctic climate, this feedback loop has the potential to:

- Increase sea levels; alter the salinity of the Arctic marine environment, including the Beaufort Sea (NASA, 2013);
- Cause an increased release of CH_4 into the atmosphere due to melting of permafrost; and
- Increase storm tracks, patterns of precipitation, and the frequency and severity of cold-air outbreaks in middle latitudes (ACIA, 2005).

Table 3-7 shows comparisons of the albedo values for three surfaces.

Table 3-7 Ice-Albedo Comparisons

Surface	Cooling (Î±, percent reflected)	Heating (percent absorbed)
Ice	50%	50%
Snow covering ice	90%	10%
Open Ocean	6%	94%

Source: NSIDC, 2014b.

Soot, or Black Carbon (BC), plays a role in short-term climate effects in the Arctic. The particles that comprise BC are created by the combustion of fossil fuels and by forest fires. BC particles can originate in other countries and be transported to the Arctic. The dark color of the particles decreases albedo after deposition on the ice and snow, causing incoming radiation to be absorbed. Unlike GHGs, the particles of BC are short-lived in the atmosphere, with a lifetime of days to weeks. There is a "cloud" of BC that occurs over the Arctic from early winter until springtime. Climate effects from black carbon are especially strong in sensitive areas such as the Arctic, resulting in earlier annual spring melting and sea-ice decline. The visual effect of BC also makes the impacts more immediately recognizable than impacts from GHGs.

The greatest degree of ocean acidification worldwide is predicted to occur in the Arctic Ocean. This is due to the effects of increased freshwater input from melting snow and ice and from increased CO_2 uptake by the sea as a result of ice retreat (Fabry et al., 2009). Measurements in the Canada Basin of the Arctic Ocean demonstrate that over 11 years, melting sea ice forced changes in pH and the inorganic carbon equilibrium, resulting in decreased saturation of calcium carbonate in the seawater (Yamamoto-Kawai, 2009).

3.2 Biological Environment

3.2.1 Lower Trophic Level Organisms

The lower trophic organisms living within the Beaufort Sea OCS consist of three diverse and abundant groups (Hopcroft et al., 2008). These are the pelagic, the epontic, and the benthic organisms.

3.2.1.1 Pelagic Communities

The pelagic communities are comprised primarily of two groups living at the surface and near-surface levels, the phytoplankton and zooplankton. Phytoplankton are the one-celled algae adapted to living in the photic zone (the upper areas where light penetration is adequate for phytoplankton) in the upper layers of the ocean surface. Within Arctic waters, the combination of cold temperature, sea ice, and seasonal fluctuations in light regimes creates variation in the timing and extent of seasonal blooms. Phytoplankton blooms (including concurrent zooplankton organisms) tend to occur in two separate events of early and late summer, generally from July to August. The density and duration of the blooms are dependent upon weather conditions and nutrient fluxes (Horner and Schrader, 1982). Zooplankton consist of permanent residents of the planktonic such as copepods, and animals exhibiting complex life cycles that include a developmental stage within the spring plankton blooms such as the larvae of fish, crustaceans, barnacles, polychaetes, and mollusks (Hopcroft et al., 2008). The pelagic expanses between the surface and the benthic realms support diverse and abundant populations, including the larvaceans, pteropods, ctenophores, jellyfish, salps, squid, and other invertebrate organisms that contribute to the productivity of the region (Hopcroft et al., 2008).

3.2.1.2 Epontic Communities

The epontic organisms are the ice dwellers, or organisms that live on or in the matrix of the ice (Gradinger, Bluhm, and Iken, 2010). These organisms include the ice algae, amphipods, nematodes, polychaetes, and euphausiids (Hopcroft et al., 2008). Ice algae blooms are essential to the primary productivity of the region (Horner and Schrader, 1982) and other epontic organisms are important contributors to the food web (Bradstreet and Cross, 1982). Relative to ice-covered and break-up months, the ice-associated organisms listed previously are not present in high abundances in the open water and early ice-up seasons.

3.2.1.3 Benthic Communities

The final group are the benthic organisms, consisting of groups living within the upper sedimentary matrix (infaunal organisms) and those living on or just above the benthic surface, or strongly associated with the benthic surface (epifaunal organisms). Offshore benthic communities can be quite diverse, but organisms commonly found in surveys include echinoderms, sipunculids, mollusks, polychaetes, copepods, sponges, corals, and amphipods (Dunton, Schonberg, and McTigue, 2009; Rand and Logerwell, 2011).

Most seafloor substrates on the Beaufort Sea OCS consist of aggregations of fine sands, muds, and silts, with percentages of substrate consisting of mud ranging from 17 percent to 84 percent (USDOI, BOEM, 2010). Site-specific geotechnical information is available through HAK’s proprietary Geotechnical Report (File folder 236, 3A). Limited extents of scattered cobblestone or pebbles may be found at shallower depths (Dunton, Schonberg, and McTigue, 2009). A focus on differences in communities based on physical factors is addressed in the BOEM sponsored cANIMIDA studies on hydrocarbon chemistry and substrate composition (USDOI, BOEM, 2010), and the 2006 Final Seismic Programmatic Environmental Assessment.

The Boulder Patch (Figure 3-1) is an area within Stefansson Sound generally defined by having a greater than 10 percent cover of small boulders and cobblestone on the benthic surface (Martin and Gallaway, 1994). This hard bottom benthic surface supports the richest and most diverse biological communities known in the Beaufort Sea (Dunton, Reimnitz, and Schonberg, 1982). These hard bottom surfaces were discovered by USGS marine geologists looking for evidence of oil-rich geological formations during the summers of 1971 and 1972 (Reimnitz and Ross, 1979). Biological surveys in the late 1970s and early 1980s confirmed the existence of benthic substrates consisting of cobble and boulders with diverse epilithic communities of large kelp (such as *Laminaria solidungula*) and corals (such as *Gersemia rubiformis*) growing on the rocks, along with benthic communities consisting of more than 140 types of sponges, bryozoans, polychaetes, clams, snails, copepods, amphipods, cumaceans, seastar, and tunicates (Dunton and Schonberg, 2000). The kelp in the Boulder Patch is an important component of the highly diverse community, especially as a source of carbon (Dunton and Schell, 1986, Dunton and Schell, 1987). *Laminaria solidungula*, the dominant species of kelp in the Boulder Patch, is well adapted for low light conditions; most of its annual linear growth occurs in under-ice darkness during the winter (Dunton, Reimnitz, and Schonberg, 1982; Dunton and Jodwalis, 1988). Continued studies have examined the impacts of disturbance (Konar, 2007; Konar, 2013) as well as characterizations of the community assemblages (Dunton, Reimnitz, and Schonberg, 1982; Dunton and Schonberg, 2000; Konar and Iken, 2005; Wilce and Dunton, 2014). Current knowledge indicates that the Boulder Patch is a relatively small area of high benthic diversity in a larger region affected by frequent seasonal perturbations.

3.2.1.4 Climate Change

Due to climate change processes described in Section 3.1.6, such as ocean acidification, global temperature, and polar ice conditions, the current communities of lower trophic organisms are expected to change throughout the life of the project. Impacts on lower trophic level organisms include direct synergistic impacts such as changes in the timing and magnitude of plankton blooms, physiological changes from altered ocean pH and temperature, and habitat modification that could occur as a result of melting ice, shoreline erosion, and sea level rise. A primary impact of ocean acidification is that it depletes seawater of the carbonate compounds—aragonite and calcite—that many marine creatures need to build shells and skeletons (Fabry et al., 2008). As a result, ocean acidification hinders organisms such as corals, crabs, seastars, sea urchins, and plankton from building the protective armor they need to survive. Rising acidity also affects the basic functions of fish, squid, invertebrates, and other marine species, including detrimental effects on metabolism, and respiration, which can thwart their growth and lead to higher mortality (Fabry et al., 2008). In addition, ocean acidification has the potential to profoundly affect the growth and toxicity of phytoplankton associated with harmful algae blooms (HABs) (Tatters, Fu, and Hutchins, 2012; Fu, Tatters, and Hutchins, 2012). These impacts can have far-reaching effects on the structure of the food web, with some predators forced to eat non-optimal prey items. Habitat modification will expand the range for some species, while reducing it for others. In addition, the decrease of the extent of the Arctic ice pack impacts the epontic community, and subsequently, the pelagic and benthic communities. Warming ocean temperatures associated with climate change may increase all types of plankton growth rates and generation times in the region of the Proposed Action, and change the composition of lower trophic populations as warmer seas, open water, and increased radiative energy from the sun increases.

3.2.2 Fish

3.2.2.1 Aquatic Environment

Fish occupy a variety of habitats in the U.S. Beaufort Sea, including marine, brackish (mix of fresh water and saltwater), and freshwater areas. They are an important link in the food web. The Proposed Action Area is home to marine, diadromous (life cycle includes both marine and freshwater components), and nearshore freshwater fishes (Craig, 1984; Craig and Haldorson, 1986; Logerwell et al., 2015).

3.2.2.2 Fish in the Proposed Action Area

3.2.2.2.1 Cods

Arctic and saffron cod are both found in the Proposed Action Area. Arctic cod is widely distributed throughout the U.S. Arctic, including the pelagic (in the open water column), demersal (near the seafloor), and nearshore environments of the Beaufort Sea. The absolute numbers of Arctic cod and their biomass is one of the highest of any finfish in the region (Logerwell et al., 2011; Frost and Lowry, 1983). Many species of vertebrates depend on Arctic cod as a major food source (Pirtle and Mueter, 2011). The abundance, wide distribution, and the role in the food web of the Arctic cod make this species very important in the overall ecosystem of the U.S. Arctic region.

Arctic cod. Arctic cod move and feed in different groupings – as dispersed individuals, in schools, and in huge shoals. These distribution patterns appear to be dependent on several interacting factors including season, presence or absence of ice, salinity, water temperature, surface wind, currents, length of daylight, and the underside texture of ice. Inter-annual variation also plays a role in the pattern of distributions (Welch, Crawford, and Hop, 1993; Benoit et al., 2010).

The various life stages of Arctic cod occur across a broad range of habitats. Arctic cod migrate between offshore and inshore areas for seasonal spawning and spawn under the ice during winter

(Craig et al., 1982; Craig, 1984; Bradstreet et al., 1986). Arctic cod eggs and larvae develop during late winter until early summer in the pelagic surface water environment.

During open water, pelagic yearling and older Arctic cod were found to occur in high abundance at the continental shelf break (328 feet), and pelagic young-of-year were found most commonly inshore (Logerwell et al., 2010). Frost and Lowry (1983) found smaller Arctic cod more often in water less than 328 feet deep. Craig et al. (1982) found adult and juvenile Arctic cod in shallow nearshore waters (3 to 39 feet) in summer and winter.

Arctic cod are associated with sea ice, using it at various life stages and seasons for shelter and as a forage habitat to feed on microorganisms on the underside of the ice. Amphipods on the underside of ice are an important food source (Bradstreet and Cross, 1982; Lonne and Gulliksen, 1989; Gradinger and Bluhm, 2004). Rough, irregular textures of the underside of ice may provide preferred habitat to avoid predators (Crawford and Jorgenson, 1993). Gradinger and Bluhm (2004) and Lonne and Gulliksen (1989) observed and photographed Arctic cod in summer months using ice crevices and cracks on the underside of textured ice floes for escape and shelter.

Arctic cod also inhabit offshore and nearshore areas without ice during warmer times of year (Bradstreet and Cross, 1982; Bradstreet, 1982; Crawford and Jorgenson, 1993; Gradinger and Bluhm, 2004). Copepods and amphipods are common prey for Arctic cod in open water environments (Frost and Lowry, 1983; Benoit et al., 2010; Rand et al., 2013).

Saffron cod. Saffron cod occur in the Beaufort Sea primarily in nearshore waters. Unlike Arctic cod, they do not specifically associate with ice. Saffron cod move seasonally from summertime feeding offshore to inshore for spawning where they enter coastal waters and tide-influenced riverine environments. Adults and juveniles forage on the epibenthos, opportunistically taking small crustaceans and fish (Morrow, 1980; Pirtle and Mueter, 2011).

3.2.2.2.2 Arctic Flounder

Arctic flounder occur in the Beaufort Sea in nearshore brackish and estuarine waters, and sometimes enter freshwater rivers (Morrow, 1980; Mecklenburg et al., 2002). They exhibit seasonal movement, inhabiting offshore areas in the fall, and moving inshore at night in the spring. Spawning occurs in shallow waters from January to March in areas with strong tidal currents; diet consists of small mollusks, crustaceans, and fish (Morrow, 1980).

3.2.2.2.3 Fourhorn Sculpin

Fourhorn sculpin are found in high abundance in shallow, nearshore habitats in the Beaufort Sea, and have been known to inhabit rivers (Morrow, 1980; Craig, 1984). Similar to Arctic cod, they enter the nearshore environment when the salinity increases in late summer. Overwintering occurs in slightly brackish coastal waters under the ice. Fourhorn sculpin have been collected in the Boulder Patch. They feed on worms, amphipods, isopods, small crustaceans, fish, and eggs. Given its high abundance, the fourhorn sculpin is likely an important part of the nearshore food web, and is occasionally eaten by humans (Morrow, 1980).

3.2.2.2.4 Kelp Snailfish

Snailfish are distributed throughout the Arctic, and are commonly caught in the Beaufort Sea. They are found in nearshore areas with hard substrates and sometimes in kelp beds, such as the Boulder Patch (Walkusz et al., 2016). They feed on benthic amphipods, and are important prey for birds (Gaston, 1985) and seals (Walkusz et al., 2016).

3.2.2.2.5 Capelin

Capelin are a critical link in the Arctic food web. They are present in large numbers in nearshore waters of the Beaufort Sea in the summer. Spawning occurs in very shallow waters in July and

August. Capelin consume primarily zooplankton, and are a forage fish species for upper trophic predators, such fish, birds, and mammals (Pirtle and Mueter, 2011).

3.2.2.2.6 Ninespine Stickleback

Ninespine stickleback occur in freshwater streams and brackish marine waters (Mecklenburg et al., 2002). They inhabit vegetated areas and are most often found in slower moving waters. Overwintering occurs in deeper water with seasonal movements in the spring to shallow, vegetated areas where spawning occurs from May to August. Nests are built in the vegetation using algae and debris, and the young are initially reared by males. Sticklebacks feed primarily on copepods, insects, worms, and small crustaceans. Although they are not of economic importance, they are important prey items for other fish and bird species found in the Proposed Action Area (Morrow, 1980).

3.2.2.2.7 Salmonids

Salmonids are represented by many groups of fish that are common in the Proposed Action Area, including chars, whitefishes, and Pacific salmon. There are no commercial fisheries for any of these species in the Proposed Action Area, however, salmonids are an important subsistence resource.

Chars. Chars include Arctic char and Dolly Varden. These anadromous species primarily reside in freshwater rivers and lakes of the North Slope, using the nearshore marine environment as feeding grounds or as corridors to access feeding grounds (Craig and McCart, 1976). Spawning occurs from August to November in freshwater rivers or streams over gravel substrates. Arctic char and Dolly Varden overwinter in freshwater lakes and rivers, including the Sagavanirktok River. Arctic char are predators of salmonid eggs. Other food items include crustaceans, mollusks, and other fish (Morrow, 1980). For Dolly Varden, feeding occurs primarily in the nearshore, estuarine environment on small fishes, amphipods, krill, polychaetes, and other invertebrates. Little feeding is believed to occur during the overwintering period (Morrow, 1980).

Whitefish. Whitefish commonly found in the Proposed Action Area include Arctic cisco, least cisco, humpback whitefish, and broad whitefish. Whitefishes use the nearshore marine environment for feeding before returning to freshwater streams to spawn (Craig, 1984). In general, spawning occurs in the fall in streams with gravel beds. Arctic cisco spawn in the Mackenzie River and the juveniles are transported to the Alaskan Beaufort Sea through wind-driven currents (Fechhelm and Griffiths, 1990). Some riverine forms of whitefish species are known to Alaska, although the fishes found in the Proposed Action Area are primarily whitefish that feed in the marine environment and overwinter in freshwater environments (Craig and McCart, 1976; Craig, 1984; Morrow, 1980). Whitefish overwintering in the Sagavanirktok River were found to feed very little, despite prey availability. Broad whitefish were observed to lose weight while least cisco were found to increase mean body weight (Schmidt et al., 1989). Similar trends were observed in the Colville River (Schmidt et al., 1989). Whitefish feed on small mollusks and crustaceans (Morrow, 1980). This group of fish is commonly found in subsistence harvests.

Pacific Salmon. Pacific salmon adults and juveniles occur in the Beaufort marine environment; however, their numbers are low compared to the Bering Sea. Of the five Pacific salmon species, pink salmon and chum salmon (*Oncorhynchus gorbuscha* and *O. keta*) have been the salmon species most commonly captured in the Beaufort Sea marine and nearshore environments (Craig, 1984; Craig and Haldorson, 1986; Fechhelm, et al., 2009). In the marine environment, adult pink and chum salmon in the U.S. Beaufort Sea are known to occur down to 660 feet deep. As climate change occurs (ice reduction, warming waters) salmon are moving further north in greater numbers (Moss, et al., 2009; Kondzela, et al., 2009). Chum salmon and pink salmon have been documented as present in the Colville River and Colville delta area in the Alaska Department of Fish and Game (ADF&G) Anadromous Waters Catalog (Johnson and Litchfield, 2016).

3.2.2.3 Climate Change

Due to climate change processes described in Section 3.1.6, such as ocean acidification, global temperature, and polar ice conditions, the current communities of lower trophic organisms are expected to change throughout the life of the project. Climate change is likely to affect the habitat, behavior, abundance, diversity, and distribution of fish. Several studies have examined the effects of climate change (including ocean acidification) on fish. These studies emphasize the implications of potential northern range expansions of fish species, the effects of warming sea surface temperatures on fish biomass, possible changes in fish species complexes, effects on commercially important species, shifts in prey availability and shifts in food webs, and the particular vulnerability of coastal areas in Alaska (Cheung et al., 2009; Sherman et al., 2009). Shifts in the food web as a result of changing climate could result in major ripple effects, with some predators forced to eat non-optimal prey items, or preferred feeding spots becoming unavailable. Some species may benefit from climate change shifts. Rising ocean acidity also affects the basic functions of fish, squid, invertebrates, and other marine species, including detrimental effects on metabolism, respiration and photosynthesis, which can thwart their growth and lead to higher mortality (Fabry, et al., 2008). The decrease of the extent of the Arctic ice pack impacts the lower trophic communities, which has impacts on fish communities. Warming ocean temperatures associated with climate change may increase all types of plankton growth rates and generation times in the region of the Proposed Action, and change the composition of lower trophic populations as warmer seas, open water, and increased radiative energy from the sun increases. Below is a summary of studies contributing to the knowledge of current fish and fish environments potentially affected by the Proposed Action.

3.2.3 Birds

Many bird species use the marine waters and coastal and terrestrial habitats of the Proposed Action Area during spring, summer, and fall months. The Beaufort Sea's shallow shelf waters and coastal lagoon system provide important foraging and staging habitat for seabirds and loons, shorebirds, and waterfowl including sea ducks. Most of these water birds migrate through in the spring and again in late summer/fall months, some staging as they move through from Canadian or Russian breeding grounds or elsewhere. Many waterbirds, landbirds, and raptor species also breed across terrestrial portions of the Proposed Action Area during the short Arctic summer.

Spring migration in the Proposed Action Area occurs between late March and late May, with spring arrival times varying by species and their corresponding availability of habitat. Arrival times for many waterbirds, including eiders, typically coincide with the appearance of open water during migration to coastal breeding areas. Average spring arrival dates for many Arctic-nesting bird species have advanced by several days over recent decades (Ward et al., 2015). The fall migration period is more prolonged than spring migration, and begins in June or July with some failed breeders and nonbreeders. A few waterbird species move from tundra and freshwater habitats in the Proposed Action Area to molt in lagoons along the Beaufort and Chukchi Sea coasts. Fall migration timing from the Beaufort Sea area varies among species, and often by gender and age, with most birds having departed before the formation of sea ice in late October.

A handful of landbird and raptor species may be found in the Proposed Action Area year-round, particularly in the terrestrial landscape. Common raven (*Corvus corax*) is the most abundant species occurring in nearby oilfields in the winter months. It is the only species recorded in the Audubon Christmas Bird Counts that have taken place annually in the Prudhoe Bay area between 1987 and 2012 (Streever and Bishop, 2014).

Although many Arctic species range across both seas, the Beaufort Sea exhibits important characteristics of avian fauna and habitats distinct from that of the adjacent Chukchi Sea. Species diversity and total seabird densities are lower in the Beaufort Sea than the Chukchi Sea, which is more plankton–rich and closer to the Bering Sea's nutrient in-flow and seabird cliff habitat. The

Beaufort Sea coastal shelf is shallow and narrow and the deep Arctic Basin is a dominant physical feature. Beaufort Sea avian marine fauna is characterized by certain pelagic fish-eating birds, and high relative densities of benthic-feeding sea ducks (Sigler et al., 2011). Some birds are top predators on Beaufort Sea fish resources, while others prey on a range of trophic levels. Sensitivity to lower trophic or abiotic linkages in the current dynamic state of these ecosystems may be resulting in significant variability in abundances, relative abundances, and distributions (e.g., new dominance of planktivorous seabirds in northeastern Chukchi Sea over previous decades) (Gall, Day, and Morgan, 2013; Piatt, Sydeman, and Wiese, 2007).

The following sections summarize relevant movement patterns, locations, and life history characteristics for key avian species groups. These groups include species that have special legal status, high populations in the Proposed Action Area, particular sensitivity to certain activities, and/or other relevant life history characteristics in common.

3.2.3.1 ESA Listed Birds

Two diving sea ducks, the spectacled eider (*Somateria fischeri*) and the Alaska-breeding population of Steller's eider (*Polysticta stelleri*) are listed as threatened under the Endangered Species Act (ESA). Both species breed on the ANS and forage on the shallow (32- to 130-foot) Alaskan Beaufort Sea ocean shelf – important habitats for eiders in general (Kuletz et. al., 2015). Spectacled eiders are expected to occur regularly in the Proposed Action Area (Hilcorp, 2015, Appendix A, page 4-117), while Steller's eiders are rare east of the Point Barrow area but may occur occasionally.

3.2.3.1.1 Spectacled Eider

The spectacled eider was listed as a threatened species throughout its range under the ESA in 1993 (58 FR 27474, May 10, 1993). Spectacled eiders on the ANS breed across the Arctic Coastal Plain (ACP) east to approximately between the Shaviovik and Canning River deltas (TERA, 2002; Larned, Stehn, and Platte, 2012). The ANS population is the larger of the species' two North American breeding populations, the other being on the Yukon-Kuskokwim Delta (YKD), and has been stable since surveys began in the early 1990s (Bowman, et al, 2015; Larned, Stehn, and Platte, 2009). The most currently available population estimate for the ACP portion of the ANS is about 14,800 paired birds (Stehn, Larned, and Platte, 2013). It has been estimated that almost 34,000 total spectacled eiders, including fledged (flight capable) juveniles, are present on the entire ANS in October (Stehn et al., 2006).

Spectacled eiders tend to migrate along direct offshore routes or to follow coastlines. They migrate north using the spring lead system from the species' single wintering area in the Bering Sea. The spring lead systems of the Chukchi Sea, including Ledyard Bay, and of the Alaskan Beaufort Sea as far east as the Sagavanirktok River delta (in the Proposed Action Area) are the first available open-water areas along their path to its ACP breeding grounds. The Alaskan Beaufort Sea within approximately 19 miles of the coast is recognized as important habitat for spectacled eiders during most of the open water period, which includes their pre-breeding, breeding, and post-breeding migration periods (Sexson, Pearce, and Petersen, 2014). In marine waters, they are benthic feeders on invertebrates, primarily clams, and possibly also amphipods and crabs (Petersen, Piatt, and Trust, 1998; USFWS, 1996).

Spectacled eiders can be expected in the Proposed Action Area from late May through September or October, nesting, raising or developing as broods, foraging, or moving through on migration. The birds will arrive in open water offshore in late May through early June, and within a week, adults move onto land to nest. Adult female spectacled eiders of the Beaufort Sea area demonstrate high levels of interannual breeding site fidelity, as they do elsewhere in Alaska. Actual nest initiation (i.e., first egg laid) is expected in the second and third weeks of June, with exact timing probably in response to snowmelt and tundra flooding conditions (Sexson, Pearce, and Petersen, 2014; TERA, 2002). Spectacled eiders are known to nest between the coast and approximately 15.5 miles inland from the coast of Foggy Island Bay (TERA, 2002; Larned, Stehn, and Platte, 2006). The center of the species' overall ACP distribution is farther west, along the Chukchi Sea coast and northeast of Teshekpuk Lake. Nesting densities are variable, however, and some of its highest ACP densities do occur in the Prudhoe/Kuparuk area (Larned, Stehn, and Platte, 2011).

In the Kuparuk oilfield, spectacled eiders nest primarily in non-patterned wet meadows within wetland complexes containing emergent grasses and sedges (Anderson and Cooper, 1994; Anderson et al., 2009), and similar breeding habitat affinities may be expected in the nearby Proposed Project Area. After hatching in mid-July (Petersen, Grand, and Dau, 2000), hens and broods move to deep ponds with pendant grass (*Arctophila fulva*) vegetation or shallow water sedge (*Carex aquatilis*) wetlands (Safine, 2011, 2013). While on the breeding grounds, adults and ducklings primarily feed on invertebrates and plant seeds in tundra ponds (Petersen, Piatt, and Trust, 1998; USFWS, 1996).

Post-breeding, male spectacled eiders leave the nesting area first within 7 to 33 days of coming ashore at the onset of incubation. Males move to Beaufort or Chukchi Sea open waters until they depart for Chukchi Sea or Russian molting areas (Sexson, Pearce, and Petersen, 2014). Locally breeding males are not expected to remain in the Beaufort Sea past July. Female spectacled eiders move from land to Beaufort Sea marine waters after their nesting ends between July and September, a few lingering in the Beaufort Sea until October. Females whose nests fail are the first to go to the coast. Juveniles may be found onshore until September, and in Beaufort Sea waters with females until late September or October, although adults generally depart the Alaskan Beaufort Sea 1 to 2 weeks prior to offspring (Sexson, Pearce, and Petersen, 2014).

Male spectacled eiders molt primarily in Russia and Ledyard Bay, beginning to gather in Ledyard Bay in July, almost two months before females. Females and many juveniles from the Proposed Action Area likely migrate with those from the Colville River Delta to the eastern Chukchi Sea, primarily Ledyard Bay, and remain there for the flightless molt period (Sexson, Pearce, and Petersen, 2014). Juvenile post-fledging dispersal is more variable than adult dispersal, some ranging as far as the Alaska Peninsula on their first molt migration. The species' molt migration and fall migration have primarily been observed to occur over offshore waters rather than land, with females flying more than 6 miles farther from the Beaufort Sea shore than males (Petersen, Larned, and Douglas, 1999).

By the end of October, most spectacled eiders have departed their respective molting grounds for the Bering Sea. Most of the species breeds on the Russian Arctic Coastal Plain, and both the Russian and Alaskan birds winter together from late November through mid-February in the species' only known wintering area: openings in pack ice south and southwest of St. Lawrence Island (Petersen, Larned, and Douglas, 1999; Sexson, Pearce, and Petersen, 2014). This wintering area and the Ledyard Bay area are both designated under the ESA as critical habitat for the spectacled eider (66 FR 9145, February 6, 2001). There is no designated spectacled eider critical habitat associated with the Beaufort Sea.

3.2.3.1.2 Steller's Eider

The Alaska breeding population of Steller's eider is listed as threatened under the ESA (62 FR 31748, June 11, 1997). The least abundant eider in Alaska, it had a discontinuous historic breeding range along the coast from the Alaska Peninsula northward to the Beaufort Sea (Quakenbush et al., 2002). Less than 5 percent of the breeding population of Steller's eiders nests in Arctic Alaska (Rothe and Arthur, 1994). A very small remnant population sometimes nests on the YKD, but has "essentially disappeared " according to the Sea Duck Joint Venture (2016), and a small number of Steller's eiders breed on the ACP between Point Lay and the Prudhoe Bay vicinity, primarily near Utqiaġvik (Obritschkewitsch and Ritchie, 2015). The Alaska breeding and majority of the Russia breeding populations molt and winter together in waters off of southwestern Alaska. Periodic non-breeding of the Alaska population, coupled with low nesting and fledging success in general, has resulted in very low productivity (Quakenbush et al., 2004) and may make the population particularly vulnerable to local extinction (extirpation).

Estimating the population of this rare species is difficult, but the most recent estimate for the ACP population is 680 birds (Stehn, Larned and Platte 2013). The authors found an average negative growth rate of 0.95 (Sea Duck Joint Venture, 2016). Intervals of up to 5 years have occurred with little or no evidence of Steller's eider nesting near Utqiaġvik (Safine, 2013). Martin et al. (2015) surmise that most birds in those years depart the area without occupying territories or initiating nesting.

Small Steller's eider flocks appear in the spring leads off Barrow Canyon in May, likely already having begun pair formation, and move onto the tundra breeding grounds in early June. In the Utqiaġvik area, where nest timing is expected to be similar to the Proposed Action Area, nests usually must be initiated by the last week of June to allow the young to fledge prior to freeze-up (Quakenbush et al., 2004). Steller's eiders prefer to nest near ponds with pendant grass (Safine, 2013). Breeding male Steller's eiders depart the ACP after the nest is initiated in mid- to late June. Hatching occurs from mid-July through early August (Rojek, 2006, 2007, 2008). Nest survival rates are significantly affected by nest predation from fox. Other nest predators likely include birds such as jaegers, glaucous gull, snowy owl, and common raven (Safine, 2013).Within about one day after hatch, hens move their broods to ponds with emergent vegetation, particularly water sedge or a mix of water sedge and pendant grass, that provides cover for vulnerable young (Rojek, 2006; Rojek, 2007; Safine, 2011; Safine, 2013).They feed on insect larvae and other wetland invertebrates. Broods may move miles away from the nest prior to fledging (Safine, 2013). Fledging occurs from 32 to 37 days after hatching. Broods may remain in the vicinity of the brood rearing area for up to 17 days post-fledging before moving to marine waters or leaving the area (Safine, 2013; Obritschkewitsch et al., 2001; Rojek, 2006).

Successful female eiders and their young-of-the-year appear to depart the ACP in September. Females and broods occasionally move to Point Barrow nearshore waters, but after early to mid-September females begin their migration to the southwestern Alaska molting areas (Martin, et al., 2015; Safine 2013, 2011). Because of their low overall ACP abundance and the distance of the Proposed Action Area from the known Utqiaġvik center of Steller's eider ACP nesting range, Steller's eider is expected to occur only rarely in the Proposed Action Area.

3.2.3.2 Other Birds

3.2.3.2.1 Waterfowl

Sea ducks, especially common eider (*Somateria mollissima*), king eider (*S. spectabilis*), and long-tailed duck (*Clangula hyemalis*) are common Beaufort Sea coastal breeders. Greater white-fronted goose (*Anser albifrons frontalis*), lesser snow goose (*Chen caerulescens caerulescens*), Canada goose (*Branta canadensis*, *B. hutchinsii*), black brant (*B. bernicla nigricans*), and tundra swan (*Cygnus columbianus*) are other locally breeding waterfowl species common in nearshore coastal waters of the Beaufort and Chukchi seas, as are scoters (*Melanitta spp*), mergansers, and dabbling ducks. Waterfowl most likely to occur in the Proposed Action Area are described further below.

Common Eider

Pacific common eider (*S. mollissima v-nigra*) breeds in Alaska and western Canada. This sea duck migrates during spring along the coastline of the Beaufort and Chukchi seas, staging in leads as they open up between the pack ice and landfast ice. Common eiders nest typically in loose colonies on the barrier islands or spits along the Chukchi and Beaufort sea coasts, with highest densities in Alaska often occurring along the central Beaufort Sea coast between Harrison Bay and the Canning River, in or near the Proposed Action Area (Dau and Bollinger, 2012 and 2009; Lysne, Mallek, and Dau, 2004). Females return to breeding sites year after year. Dau and Bollinger (2012) report that the FWS 2011 common eider ACP barrier island breeding survey, found 83 adults on the mainland shore around Foggy Island Bay and over 60 around the Foggy Island Bay barrier islands during early July (the incubation phase prior to male dispersal).

Common eider is considered highly vulnerable to climate change because of its preference for nesting on low-lying barrier islands and similar coastal areas which are subject to overwash and erosion from the increasing frequency and severity of storms (Liebezeit et al., 2012; Sea Duck Joint Venture, 2015b). A storm surge on July 18, 2016 flooded most of the monitored common eider nests along the coast of the Arctic National Wildlife Refuge (ANWR). It was the largest recorded surge before July 30 in any year since recording began in 1995 (Wiese, Latty, and Hollmen, 2016).

Successful hens seldom leave the nest to feed during incubation. However, common eiders, including failed breeders and males, may be found using local nearshore waters, particularly coastal lagoon habitat, throughout the breeding season. Fischer and Larned (2004) surmised that because eider densities did not vary during summer months, the eiders they observed in the water near barrier islands were local breeders rather than molt or fall migrants. This is consistent with Petersen and Flint (2002), who showed that satellite-tagged common eider hens remained in shallow waters close to their Beaufort Sea coast breeding sites through September, likely molting during that time. The McClure/Stockton Islands area around Foggy Island Bay has held some of the highest concentrations during late July/early August ACP waterfowl surveys, with between 600 to 800 birds observed in the 2002 and 2003 seasons (Lysne, Mallek, and Dau, 2004).

After the molt, some common eiders move offshore into pelagic waters, but most remain close to shore (Petersen and Flint, 2002; Divoky, 1987). For U.S. and Canadian Arctic-breeding subpopulations, primary molt and staging locations and movements among them are not well understood (Sea Duck Joint Venture, 2015b). Post-breeding males and nonbreeders along the Beaufort Sea coast, however, begin to migrate westward through nearshore waters toward the Chukchi Sea in late June; most breeding females and their young follow in late August and September (Dickson, 2012a) and are gone by late October or early November. Most males are out of the Beaufort Sea by late August or early September. Morgan, Day, and Gall (2013) observed very few, all within 12.4 miles of shore, in late September in Camden Bay to the east of the Proposed Action Area.

King Eider

King eider is one of the most abundant birds in the Beaufort Sea, with approximately 400,000 breeding around the Alaskan and U.S. Beaufort Sea coast, many or most migrating in the spring and fall in often enormous flock events close to Point Barrow (Quakenbush, et al, 2009). Average indicated total king eiders on the Alaska ACP between 2005 and 2014 is about 20,000 (Sea Duck Joint Venture, 2015a). Similar to the other eiders, king eiders migrate during spring along the Beaufort and Chukchi sea coasts, staging in open water leads. Arrival times in the Beaufort Sea are dependent upon the location and timing of offshore leads along the Chukchi Sea. King eiders generally begin to arrive in the Beaufort Sea by the middle of May, with peak spring staging numbers occurring until about June 5 (Wilson et al., 2012, Dickson, 2012b, Peterson 2009, Oppel and Powell 2010). Mean first arrival on the local breeding grounds is the end of May, the most recent recorded mean in a Colville River delta study on trends in first arrival dates (Ward et al., 2016). Like the 15 other migratory bird species in that study, however, king eiders' arrival date has significantly advanced (i.e., occurred earlier) over the past 50 years. Because local climactic conditions, i.e., temperature, were found to be the most important indicator of this effect, this trend in advancing arrival dates can be expected to continue (Section 3.1.6).

King eiders nest regularly in ACP coastal areas. Mean king eider breeding density on the ACP is generally highest in an area southeast of Teshekpuk Lake, but has also been high inland from Foggy

Island Bay and in the vicinity of the Sagavanirktok River Delta (Larned, Stehn, and Platte, 2011, 2009). Dau and Bollinger (2009), surveying in early July a few weeks later in the breeding season, observed that king eider densities were higher on the Beaufort Sea coastlines than the Chukchi Sea coastlines, with an observed 400 king eiders along the Beaufort Sea shoreline and 176 along barrier islands, although these numbers were much lower in 2011 when highest densities shifted to Peard Bay (Dau and Bollinger, 2012). Similar to common eiders, king eider females exhibit strong natal site fidelity to breeding areas. Males usually do not return to the same breeding area.

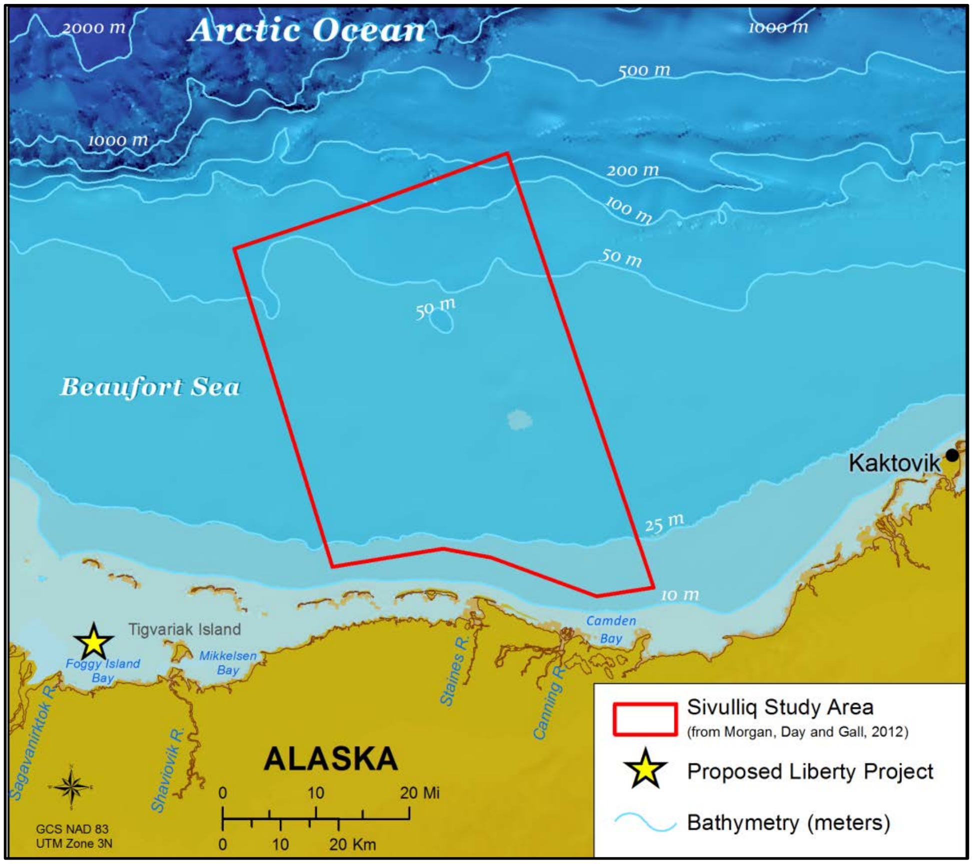

Figure 3-14 Sivulliq Study Area

Post-nesting, the westward molt-migration of several hundred thousand male king eiders past Point Barrow during July and early August is one of the most obvious and well-known avian phenomena of the Beaufort Sea (Johnson and Richardson, 1982). Satellite telemetry shows that, once departed from coastal waters adjacent to breeding areas, king eider individuals may spend more than two weeks staging offshore in the Beaufort Sea prior to fall migration (Dickson, 2012b; Phillips, 2005; Powell et al., 2005). While some king eiders molt in the Beaufort Sea, a majority molt in the Chukchi or Bering seas (Dickson, 2012b; Oppel, Dickson, and Powell, 2009; Phillips et al., 2007). During migration to molting areas, king eiders occupy a wide area ranging from shoreline to more than 31 miles offshore (Phillips, 2005). Females remain in the Beaufort Sea longer than males, possibly to replenish fat stores depleted during egg laying and incubation (Powell et al., 2005). Some females cross the Beaufort Sea in October, post-molt (Dickson, 2012b). Morgan, Day, and Gall (2012) observed over 500 king eiders distributed between about 7.5 to 44 miles from shore in the Sivulliq study area, a large area of open water that begins roughly 31 miles east of the proposed LDPI, extends eastward into Camden Bay and seaward to roughly the edge of the shelf in the eastern Beaufort Sea (Figure 3-14). The authors found greater numbers of king eiders than any other eider species in the late September bird survey (Figure 3-14).

Long Tailed Duck

Long-tailed duck is the most abundant benthic-foraging sea duck in the Beaufort Sea, particularly in the late summer and fall. They feed primarily on benthic invertebrates and are believed to be well adapted to shifts in prey availability, opportunistically feeding according to species availability (Johnson, 1984). They move locally among marine habitat types (e.g., nearshore vs offshore) to locate better foraging (Flint et al., 2016). In the late spring they migrate north and east along the Beaufort and Chukchi sea coastlines to breeding areas on the ACP in Alaska and Canada. Mean first arrival date in the vicinity of the Proposed Project (i.e., on the Colville River Delta) is currently May 27 (Ward et al., 2016), but as with king eider (above) and the other birds studied, this date has been advancing.

Stehn, Larned, and Platte (2013) re-evaluated waterbird breeding (June) survey data across the ACP, including inland habitat, from 1986 to 2012. The average, uncorrected population index was over 50,000 observed long-tailed ducks, surpassed in June only by white-fronted goose, northern pintail (*Anas acuta*, a dabbling duck), and unidentified shorebird species. Aerial surveys a few weeks later in the breeding season in early July typically record more long-tailed ducks than any other sea duck species along ACP coastal habitats, with roughly two-thirds of these associated with mainland habitats, and the rest with barrier islands. In shoreline habitat-only surveys, only glaucous gull (*Larus hyperboreus*) and sometimes surf scoter (*Melanitta perspicillata*) may exceed the numbers of long-tailed ducks among breeding waterbirds (Dau and Bollinger, 2011 and 2009).

Long-tailed duck is also typically one of the most abundant species to undergo a post-breeding flightless wing-molt in the Beaufort Sea coastal lagoons. Individual birds are flightless for 3 to 4 weeks. Like eiders and loons, post-breeding long-tailed ducks generally stage in coastal areas here, move into offshore waters, and then migrate westward out of the Beaufort Sea. They use lagoon and other coastal habitats heavily all along the ACP during July and August, numbering in the tens of thousands (Flint et al., 2016; Johnson and Richardson, 1982). The Tigvariak Island vicinity east of the Proposed Project Area hosts some of the highest densities of long-tailed ducks observed on the Beaufort Sea coast during the molting period: hundreds were observed in the McClure/Stockton Islands in the early 2000s, with thousands in the narrower lagoon system that begins just to the east of Foggy Island Bay (Fischer and Larned, 2004; Lysne, Mallek, and Dau, 2004). In late September, an estimated 29,000 were distributed across the Sivulliq study area (Figure 3-14) just east of the Proposed Action Area alone — second in observed marine bird abundance only to short-tailed shearwaters (Morgan, Day, and Gall, 2012). Surveys suggest that the ACP population of long-tailed ducks underwent a long-term decline in the last decades of the 20th century, stabilizing or slightly increasing more recently (Stehn, Larned, and Platte, 2013; Bowman, et. al., 2015).

Greater White-Fronted Goose

Greater white-fronted goose (white front) is a large herbivorous waterfowl and one of the earlier arriving birds on the ACP in the spring. Mean first arrival date for white-front on the Colville River Delta is currently May 12 (Ward et al., 2016). Spring arrival dates for several Arctic-nesting bird species have been advancing earlier over recent decades. White-front and lesser snow geese, two important subsistence species on the North Slope, demonstrate the greatest mean rates of advancement (Ward et al., 2016). White-front breed in abundance on the ACP, with adult numbers estimated around 200,000 in June (Stehn, Larned, and Platte, 2013; Larned, Stehn, and Platte, 2012, 2011). This species tends to nest only loosely in colonies, compared to snow geese and brant. Site specifically, 33 white-front were observed along the mainland coastline around Foggy Island Bay in a July survey in 2009 but none on its barrier islands. The following year, while none were observed in that same survey segment, numbers had risen at the Sagavanirktok River Delta immediately to the west (Dau and Bollinger, 2011, 2009).

Lesser Snow Goose

Lesser snow goose mean first arrival date on the Colville River Delta is currently May 27 (Ward et al., 2016). This species, an herbivorous colonial nester, has the fastest population growth rate among all ACP waterbird species (Stehn, Larned, and Platte, 2013; Ritchie et. al., 2013). Like brant, it eats salt-tolerant vegetation which appears to be increasing along the coast over recent time as salt water intrudes. Unlike brant, however, snow geese find forage early in the nesting season by grubbing plants from the soil, roots and all. Over 90 percent of the adults observed on the ACP have been along the Beaufort Sea coastline, versus the Chukchi Sea (Dau and Bollinger, 2011, 2009). The original nesting colony and brood-rearing site of snow geese in Alaska was thought to be on Howe Island in the Sagavanirktok River delta, and hundreds of nesting geese continue to be observed on the island from the Endicott Road. In 2014, nest estimates at the Howe Island colony had risen to over 1,500 (Bishop and Streever, 2016). Since the 1990s nesting and brood-rearing sites have continued to spread along the Central Beaufort Sea Coast as well (Noel, Johnson, and Butcher, 2004). Up to 528 adults have been observed during the July breeding season in the Foggy Island Bay area (Dau and Bollinger, 2009).

Black Brant

Black brant, or simply “brant,” arrives on the ACP around the same time as lesser snow geese, with mean first arrival on the Colville River Delta currently on May 25 but advancing (Ward et al., 2016). This goose also forages on salt marsh plants, but cannot take advantage of early grubbing as snow geese can. Brant typically nest colonially on spits or on islands formed in large river deltas, or to a lesser degree on barrier islands. They are typically most abundant along the Central Beaufort Sea coast between the Colville and Canning rivers, in the general vicinity of the Proposed Action Area (Dau and Bollinger, 2011, 2009; Stickney and Ritchie, 1996). Brant have a mildly positive growth trend on the ACP where there are 5,000 or more nesting pairs (Ritchie, et al., 2013; Stehn, Larned and Platte, 2013, 2012), with more population variability in the oil fields east of the Colville River delta (Bishop and Streever, 2016). During the Foggy Island Bay area breeding season they have been associated with barrier island habitat (Dau and Bollinger, 2009). Post-breeding, thousands molt in lake and lagoon habitat on the Central Beaufort Sea coast, primarily west of the Proposed Action Area and north of Teshekpuk Lake in Smith Bay (Flint, Meixell, and Mallek, 2014). Brant have shifted their foraging areas away from inland lakes and toward coastal saltmarsh in recent years. This corresponds with increased goose grazing salt marsh habitat on the Beaufort Sea coast caused by inundation, subsidence, and sedimentation that may in turn be accelerating with sea ice decline, ocean storm surge, freshwater flooding, and increased coastal erosion (Tape, et. al., 2013). As snow goose increase on the ACP, however, it has been suggested that they could eventually out-compete brant and damage the salt marsh habitat, resulting in a negative long-term impact on brant (Ritchie et. al., 2013).

Tundra Swan

Tundra swan, with a broad breeding range that encompasses much of Alaska, is the largest ACP breeding waterbird. Mean Colville River Delta first arrival date is currently May 21 but advancing (Ward et al., 2016). Tundra swans’ ACP breeding population is growing (Streever and Bishop, 2014; Stehn, Larned, and Platte, 2013). In June, tundra swans are found breeding in some of their highest ACP densities on the Colville River and Sagavanirktok River Deltas (Larned, Stehn, and Platte, 2011). Swans share the Surfcote colony on the Sagavanirktok River Delta with small numbers of other birds including brant, king eider, long-tailed duck, Pacific loon, and glaucous and Sabine gulls (Bishop and Streever, 2016). They are observed in low numbers but wide distribution during July along the Beaufort Sea coastline (Dau and Bollinger, 2011; Stehn and Platte, 2000).

Scoters

Three species of scoters (a sea duck) regularly breed on the ACP and use Beaufort Sea coast barrier island habitat between June and September. Surf scoters (*M. perspicillata*) are especially prevalent in high-density rafts of several hundred birds, particularly in Harrison Bay and Simpson Lagoon (Fischer, Tiplady, and Larned, 2002). Fischer and Larned (2004) report that Beaufort Sea coast scoters are more common in June than in August, and more common in shallow waters (less than 33 feet). Surf scoters are found in low numbers in early July around the barrier islands near the Proposed Action Area (e.g., 22 in 2009 and 12 in 2011 near Tigvariak Island; Dau and Bollinger, 2009 and 2012, resp.). A few white-winged (*M. fusca*) and black scoters (*M. nigra*) have also been counted near the mainland shore between the mouth of the Sagavanirktok River and the inside of the Stockton Islands (Dau and Bollinger, 2009 and 2012).

Mergansers

Red-breasted (*Mergus serrator*) and common (*M. merganser*) mergansers are fish-eating sea ducks regularly occurring in low numbers in nearshore waters along the Beaufort Sea coast (Fischer and Larned, 2004), including tens of red-breasted mergansers regularly observed west of Tigvariak Island (Dau and Larned, 2009 and 2012).

Dabbling Ducks

Several species of "dabbling ducks" (i.e., those that feed by skimming in shallow, usually fresh or brackish, water) breed on the ACP. These include American green-winged teal (*Anas crecca*), American wigeon (*A. Americana*), northern pintail (*A. acuta*), and mallard (*A. platyrhynchos*) and possibly others (Larned, Stehn, and Platte, 2012; Stehn, Larned, and Platte, 2013; Streever and Cargill Bishop, 2013). Dabbling ducks, particularly northern pintail, are expected to occur in shallow nearshore marine waters and possibly terrestrial portion of the Proposed Action Area (Dau and Bollinger, 2009 and 2012). Northern pintail's current mean first arrival date is in late May, but this date has been advancing in recent decades (Ward et. al., 2016).

Seabirds and Loons

Arctic tern (*Sterna paradisaea*), black guillemot (*Cepphus grylle*), Ross's gull (*Rhodostethia rosea*), ivory gull (*Pagophila eburnea*), glaucous gull (*Larus hyperboreus*), and Sabine's gull (*Xema sabini*) breed circumpolarly in the Arctic. Of these species, only Arctic tern and glaucous gull may be considered likely to nest in the terrestrial portion of the Proposed Action Area, but all of these species regularly range into the Beaufort Sea. Seabirds that breed in the Bering Sea area or elsewhere, but regularly range into the Beaufort Sea, include black-legged kittiwake (*Rissa tridactyla*) and short-tailed shearwater (*Ardenna tenuirostris*). Another type of seabird, the jaeger, is represented by three species, pomarine (*Stercorarius pomarinus*), parasitic (*S. parasiticus*) and long-tailed (*S. longicaudus*), breeding on the ACP tundra and foraging in open water of the Beaufort and Chukchi Seas. These seabird species are described further below, along with the three species of loons that breed in the vicinity, Pacific loon (*Gavia pacifica*), red-throated (*G. stellata*), and yellow-billed (*G. adamsii*).

Arctic Tern

Arctic tern is a common surface-feeding seabird in the Beaufort Sea in summer (July and August) (Kuletz, et. al., 2015; Wong et. al., 2014; Divoky, 1987), where it forages on Arctic cod, other forage fish, and zooplankton. The Arctic tern has a wide, circumpolar, breeding distribution and nests colonially on open land near marine or fresh water. Nesting densities across the entire ACP have been observed at between 0.11 and 0.15/mi^2 (Larned, Stehn, and Platte, 2012). In aerial surveys along the coast of the ACP, approximately 2,500 breeding birds have been observed, primarily on mainland areas along the Chukchi Sea (Dau and Bollinger, 2009, 2012). In the Proposed Action Area, especially the coastal Beaufort Sea in the vicinity of the Sagavanirktok River Delta, Arctic terns are considered a fairly common migrant and breeder, and regularly nest on barrier islands. In 2011, just over 30 nests were located on the islands around Foggy Island Bay—the highest numbers of Arctic tern barrier island nests anywhere on the ACP that year (USFWS, 2014; Dau and Bollinger, 2012).

Black Guillemot

Black guillemot is a diving seabird that is closely associated with sea ice throughout its lifetime, where it forages extensively on Arctic cod (Gall, Day, and Morgan, 2013; Sigler et al., 2011). Black guillemot is an uncommon local breeder from Seahorse Island and Point Barrow east to Igalik Island, and a rare breeder farther east to Barter Island (USFWS, 2015; Denlinger, 2006). Nests off of the ACP, sometimes occurring singly or in small, loose aggregations, have been located under driftwood or other debris on barrier islands. Despite the small breeding population in Alaska (the Beaufort and Chukchi sea colonies have a combined total of fewer than 1,000 nesting birds [USFWS, 2015]), about 70,000 post-breeding guillemots from the U.S. and Russia use pelagic areas of the Beaufort and Chukchi seas (Divoky, 1987). Recent analysis shows higher relative Beaufort Sea black guillemot abundance than in either the Chukchi or Bering seas, helping to distinguish the Beaufort Sea as a distinct biogeographic zone characterized by piscivorous seabirds and benthic-foraging waterbirds (Sigler et al., 2011). Hotspots (areas of relatively high densities) of foraging black guillemots have been recently identified in the Beaufort Sea, including in offshore waters in fall over the slope north of the mouth of Barrow Canyon and on the shelf near Camden Bay (Kuletz et al., 2015). Black guillemot was the only alcid species identified on transect in the September 2010, Sivulliq study area marine bird survey (Figure 3-14) (Morgan, Day, and Gall, 2012). Black guillemot use open leads if they also appear in the western Beaufort Sea in the winter months (Divoky, 1984).

Ross’s Gull and Ivory Gull

Ross’s gull and ivory gull are ice-associated gulls that have remote circumpolar breeding distributions primarily in Siberia, Greenland, and the Canadian High Arctic, and remain among the least studied seabirds. Ross’s gull has been most well-known in the U.S. Arctic for their conspicuous late fall (September and October) migration off of the coast of Point Barrow. Ross’s gull is expected to be most common in the fall (Gall, Day, and Morgan, 2013), and was the most common of the 4 species of larids (gulls and kittiwakes) encountered on the Sivulliq study area (Figure 3-14), where they were seen in groups of 1 to 14 birds (Morgan, Day, and Gall, 2012). Kuletz et al. (2015) identified several fall hotspots and high density areas for Ross’s gull in pelagic Beaufort and Chukchi sea waters, and nearshore in Camden Bay.

Ivory gulls are also closely associated with the ice edge throughout their lifecycle (Divoky, 1987; Haney et al., 2008), where they feed on fish and invertebrates, and scavenge on marine mammal carcasses left by polar bears. Flocks of a few hundred have been observed moving past Point Barrow in October and small numbers are believed to migrate through the Chukchi and possibly Beaufort seas in September and October to wintering areas (Divoky et al., 1988; Haney et al., 2008). Strong decreases in the numbers of both Ross’s gull and ivory gull have been recently detected in northern Greenland and northern Canadian waters, and may be due to changes in pack ice extent and distribution, shifts in population centers (e.g., potential corresponding increases in Russian waters), or something else (Joiris, 2016).

Glaucous Gull

Glaucous gull is a pelagic surface-feeder and one of the more abundant Beaufort Sea larids, often congregating at food sources (Kuletz, et. al, 2015; Divoky, 1987). More widely distributed in the Beaufort Sea in the fall than in summer (Kuletz et al., 2015), they may be encountered throughout the open-water period. From late July to late September it is most common in distant offshore Arctic Basin waters where it moves to forage and stage post-breeding (Morgan, Day, and Gall, 2012). In the

Sivulliq study area surveys (Figure 3-14), glaucous gulls were less common than Ross's gull and black-legged kittiwake, but as one of the first birds to arrive in spring this anomaly is believed to be because they had already begun to depart (Morgan, Day, and Gall, 2013). Surveys in the same vicinity in the 1970s (Divoky, 1984) found glaucous gulls had the highest larid densities. Glaucous gull is one of the most common and abundant seabird species breeding along the Beaufort Sea coast, where it breeds in roughly the same densities as along the Chukchi Sea coast. In 2011, over 600 adults were counted during the breeding season on roughly 37 miles of mainland and barrier island coastline around Foggy Island Bay (Dau and Bollinger, 2012). Mean first arrival date on the local breeding grounds is currently May 11 (Ward et al., 2016), but as noted above for the various waterfowl species studied, this trend in advancing arrival dates can be expected to continue (Section 3.1.6).

Sabine's Gull

Sabine's gull is a pelagic surface-feeding seabird that occurs in relatively low abundances across the Beaufort Sea, except for some higher density foraging hotspots recently identified (Kuletz et al., 2015). Low numbers nest regularly along the ACP mainland, with 22—one of the survey's highest recorded densities—observed on barrier island nesting habitat in Foggy Island Bay during the 2011 breeding season (Dau and Bollinger, 2012). Mean first arrival date on the Colville River Delta breeding grounds is currently May 25, but this date has been steadily advancing (Ward et al., 2016).

Black-Legged Kittiwake

Black-legged kittiwake is an off-shore surface forager that is primarily a fish eater, but also consumes large zooplankton, including euphausiids (small shrimp-like crustaceans). Breeding colonies in the Chukchi Sea (Cape Thompson and Cape Lisburne) are at the northern limit of their Alaska breeding range. Black-legged kittiwake is one of the most common and widespread surface-feeding avian species across the northern Bering, Chukchi, and Beaufort seas (Kuletz et al., 2015; Wong, 2014). They do not nest in the terrestrial portion of the Proposed Action Area, but forage in the Beaufort Sea, and may be expected to occur in the marine and coastal waters of the Proposed Action Area. They are most abundant from mid-July until September in the Chukchi Sea, and likely the Beaufort Sea, but do also occur in the area in late September to early October (Gall and Day, 2012; Divoky, 1987).

Short-Tailed Shearwater

Short-tailed shearwaters (shearwaters) breed in the Southern Hemisphere. Gall and Day (2012) suggested that these highly migratory birds can rapidly respond to changes in oceanic conditions and exploit food resources when and where they are available. At northern latitudes, shearwaters forage at highly productive patches of large zooplankton (euphausiids and amphipods), but also eat fish and squid, and can feed on the surface or dive (Kuletz et al., 2015). An estimated 100,000 shearwaters have passed Point Barrow in one mid-September day (Divoky, 1987). Kuletz (2011) reported a single flock numbering over 15,000 in the western Beaufort Sea in late August–early September, 2011. Kuletz and Labunski (2017) reports shearwaters as the relatively most abundant seabird in offshore waters of the Alaskan Beaufort Sea and Morgan, Day, and Gall (2012) found short-tailed shearwaters to be the most abundant and perhaps most widely distributed seabird across the Sivulliq study area site (Figure 3-14).

Jaegers

Jaegers forage at sea when they are not breeding, primarily scavenging and stealing from other birds, or directly preying on other seabirds. Three species of jaegers (pomarine, parasitic, and long-tailed) are common in the Beaufort Sea in summer until late September, then move south to the Bering Sea (Divoky, 1984 and 1987). Jaegers are dispersed throughout nearshore and pelagic areas of the Beaufort Sea with high overall abundance, but no known high concentration areas. Abundance and density are believed to be considerably lower in the central and eastern Beaufort Sea than in the

Chukchi Sea (Divoky, 1987). All three species nest on the ACP, where pomarine and long-tailed jaegers are uniquely dependent on lemming prey on the tundra for successful breeding. They are territorial nesters that could breed in tundra in the Proposed Action Area. One or two pomarine and parasitic jaegars were observed during the Sivulliq study area surveys (Figure 3-14) just east of the Proposed Action Area (Morgan, Day, and Gall, 2012).

Loons

Pacific, red-throated, and yellow-billed loons occur in nearshore coastal waters of the Beaufort and Chukchi seas, and breed across the ACP. They are all territorial nesters and diving foragers on primarily fish. Of 16 avian species examined, Ward et al. (2016) found loons to have the latest mean first arrival (i.e., early June) on Colville River Delta nesting grounds. They are unable to walk well on land, but are excellent swimmers that vigorously defend their aquatic breeding territory and floating nests. Large numbers of loons migrate past Point Barrow between August and October.

Pacific loons. Pacific loons are the most abundant loon species on the ACP (Larned, Stehn, and Platte, 2012), and were recorded in the low hundreds across the Sivulliq study area, out to about 43 miles (Figure 3-14) in September (Morgan, Day, and Gall, 2012). Four were recorded near Foggy Island Bay barrier islands during July in the breeding season (Dau and Bollinger, 2009). Pacific loons are generally thickly distributed in nearshore waters all along the Beaufort Sea coastline in late July and August (Lysne, Mallek, and Dau, 2004).

Red-throated loons. Red-throated loons primarily nest on coastal tundra and on smaller ponds than Pacific or yellow-billed loons. Unique among loons, they forage in marine waters throughout the nesting season. The red-throated loon’s average first arrival date is currently June 2. Like other ACP-nesting birds, this date has been shown to be substantially advancing over the past few decades, though at a lesser rate than other types of birds (Ward et al., 2016). Although their ACP breeding density is much lower than for Pacific loons, one identified breeding “hotspot” begins approximately 6.2 miles inland from the Foggy Island Bay coastline (Larned, Stehn, and Platte, 2011). Red-throated loons, with a population index (i.e., abundance uncorrected for visibility rate) of 3,200 on the ACP, are among the few waterbird species with a declining local population (Schmutz, pers. comm., 2017; Stehn, Larned, and Platte, 2013). Only six were recorded in the Sivulliq study area (Figure 3-14) in September (Morgan, Day, and Gall, 2012).

Yellow-billed loons. Yellow-billed loons migrate along the Beaufort Sea coast in the spring. Their average Colville River Delta first arrival date is currently June 1, but advancing (USFWS, 2014; Ward et al., 2016). Yellow-billed loon nesting distribution is clumped, with the greatest concentration of ACP nests found inland between the Meade and Colville rivers (Larned, Stehn, and Platte, 2011). They nest on low islands or narrow peninsulas on the edges of large, deep, coastal, and inland tundra lakes between 62 and 74 degrees north latitude (USFWS, 2014). Breeding birds typically remain on their lakes until young are fledged.

Yellow-billed loon numbers were thought to be declining (74 FR 12932, March 25, 2009), but the population is now considered stable (Stehn, Larned, and Platte, 2013). An average of approximately 2,200 yellow-billed loons were observed on the ACP in mid-June from 2004 to 2013, with the actual population estimate higher to account for undetected birds (Stehn, Larned, and Platte, 2014; Earnst et al., 2005; Schmutz, 2012). Eight were recorded in the breeding season in July in Foggy Island Bay, near mainland coastline and barrier island habitats (Dau and Bollinger, 2009). Twenty of this species were distributed in the Sivulliq study area (Figure 3-14) in September 2011 (Morgan, Day, and Gall, 2012).

Shorebirds

The ACP is renowned for the abundance and diversity of shorebirds drawn here in the short Arctic summer to breed. They are the dominant avifauna on the ACP in terms of both breeding species diversity and abundance (Liebezeit et al., 2009). Most breed on the tundra after arriving in May on the river deltas, relying on coastal areas such as beaches, barrier islands, lagoons, and mudflats for some portion of their lifecycle. Like other birds, shorebirds have been arriving earlier in the spring, correlated with increase in local temperatures and earlier snowmelt in recent decades. Recent ACP shorebird habitat suitability maps show mainland habitat around Foggy Island Bay in the Proposed Action Area as having among the highest possible levels of predicted breeding shorebird species richness (Saalfeld et al., 2013; ADNR, 2014). Post-breeding, shorebird flocks stage and forage in the hundreds and thousands along the Beaufort Sea coast. This coast is rich with freshwater discharges that produce an estuarine trophic structure and high primary productivity. The flocks feed on invertebrates in the river deltas and mudflats, gravel beaches, and salt marshes to prepare for migration to wintering areas (Powell et al., 2016; Taylor, et al., 2010; Andres, 1994). Species using coastal and nearshore habitats for July through September staging, and likely to occur in the Proposed Action Area, include black-bellied plover (*Pluvialis squatarola*), American golden plover (*P. dominica*), semipalmated plover (*Charadrius semipalmatus*), bar-tailed godwit (*Limosa lapponica*), ruddy turnstone (*Arenaria interpres*), sanderling (*Calidris alba*), semipalmated sandpiper (*C. pusilla*), western sandpiper (*C. mauri*), least sandpiper (*C. minutilla*), stilt sandpiper (*C. himantopus*), pectoral sandpiper (*C. melanotos*), dunlin (*C. alpina*), buff-breasted sandpiper (*C. subruficollis*), long-billed dowitcher (*Limnodromus scolopaceus*), red-necked phalarope (*Phalaropus lobaus*), and red phalarope (*P. fulicarius*). Shorebirds of interest are described below.

Phalaropes

Red phalarope and red-necked phalarope are among the most common ACP breeding shorebird species (Saalfeld et al., 2013; Bart et al., 2012). Phalaropes are unique among shorebirds in that rather than probing in soils while walking, they forage by swimming in nearshore and offshore waters. They primarily eat plankton but do not dive and are restricted to surface foraging. Red and red-necked phalaropes are found in the Beaufort Sea during the open-water season, and are ecologically similar to each other, appearing in mixed flocks, (Kuletz, 2011; Kuletz et al., 2015). Mean Colville River Delta first arrival date for red-necked phalarope is currently May 29 (Ward et al., 2016). Phalaropes are non-territorial, polyandrous breeders that tend to nest in wet tundra on the ACP, and timing of nest initiation may be particularly dependent on snow melt for these species (Liebezeit et al., 2014). In the marine environment, phalaropes are common from pelagic waters to within a few meters of shore. Due to their reliance on zooplankton, their distribution is patchy and variable; because they are tied to a moving prey source, they may be encountered throughout the Beaufort Sea in varying concentrations. They are more common in pelagic Beaufort Sea waters in summer than fall (Kuletz et al., 2015), and about 100 phalaropes were recorded in the Sivulliq study area (Figure 3-14) in September (Morgan, Day, and Gall, 2012). Some indications of apparent local population decline at individual Arctic sites have been reported for red-necked phalaropes (Andres et. al., 2012).

Sandpipers and other Shorebirds

As noted above, numerous species of sandpipers and other shorebirds nest on the ACP, and many of these use habitat in the immediate vicinity of the Proposed Action Area. Several years of Prudhoe Bay area nest searches found nest densities of semipalmated sandpiper and pectoral sandpiper were rivaled only by Lapland longspur (*Calcarius lapponicus*), a landbird (Streever and Bishop, 2014). Nests of stilt sandpiper, long-billed dowitcher, and dunlin were also regularly found. American golden-plover, ruddy turnstone, and buff-breasted sandpiper were less common but also present. Of the nesting birds found during the Prudhoe Bay surveys ruddy turnstone, often preferring sparsely vegetated coastal salt marsh habitat, is the rarest breeder with an estimated ACP population of 3,400. Across the ACP the breeding population of semipalmated sandpipers in wetlands is estimated at 19.3 mi^2 in their preferred wetland habitat and greater than 1,300,000 overall. Pectoral sandpipers are estimated to nest at densities as high as 11.6 mi^2 and number over 1,000,000 (Bart et al, 2012; Saalfeld et al., 2013).

Buff-breasted sandpiper uniquely among North American shorebirds uses a lek mating system, whereby the male defends (sometimes only briefly and in succession with other males) a relatively small territory he uses only to display and attract females, providing no other resources. The females lay and brood elsewhere in the area. The lek may remain active for days or weeks, but most of the time is not a location to which birds return to from year to year (Lanctot, pers. comm., 2016; Lanctot and Laredo, 1994). Individual male buff-breasted sandpiper lek behavior and siting can be somewhat opportunistic and adaptable, however, and some lek sites, including near the Endicott Road appear to have been used by the species for multiple years (Lanctot and Weatherhead, 1997; Lanctot et al., 1998; R. Lanctot, pers. comm., 2016). Lekking males tend to use non-patterned ground near streams (Lanctot and Slater, 1992), dissimilar to much of the Proposed Project Area, and no leks have been identified in the Proposed Project Area. The Buff-breasted Sandpiper Conservation Plan (Lanctot et. al, 2010), notes that the population, estimated at 40,000 on the ACP (Bart et al, 2012) has apparently substantially declined and is categorized as Near Threatened by the International Union for Conservation of Nature (IUCN)/BirdLife International. Most recently, it has also been categorized as a Bird of High Conservation Concern (HCC) in the U.S. Shorebirds of Conservation Concern – 2016 (U.S. Shorebird Conservation Plan Partnership, 2016). Factors that led to these designations were a small and declining population and relatively small nonbreeding area within which birds concentrate in South America. American golden-plover, dunlin, pectoral sandpiper, and semipalmated sandpiper are also on the 2016 list of HCC. The ACP breeding subspecies of dunlin (*C.a. Arcticola*) has reportedly declined substantially in recent decades (Andres et. al., 2012).

Post-breeding, at least 20 species of shorebirds use the ACP coastline as staging for and stopovers on southbound migrations (Taylor et al., 2010). The Beaufort Sea coastal river deltas and other littoral habitats are important migratory stopovers for many species—thousands to hundreds of thousands of birds per species (Bart et al., 2012; Taylor et al., 2010; Brown et al., 2007; Churchwell et al., 2016). Semipalmated sandpiper, dunlin, and red-necked phalarope were the most common species observed in the Sagavanirktok River Delta vicinity in late July and August of 2005 and 2006 (Taylor et al., 2010). Brown et al. (2012) proposes that the Sagavanirktok River and Kadleroshilik River function together with the larger Alaskan Beaufort Sea coastal deltas like the Colville River Delta as part of a complex habitat web within which each smaller site is important at various times in preparing shorebirds for their southbound migration.

Landbirds

A variety of landbirds (e.g., raptors and owls, passerines, fowl or game birds) occur in the Proposed Action Area. Some of these are top predators in terrestrial and shoreline areas with which they are associated. A few species occur in the area year-round. Some are significant because they are common breeders in the Proposed Action Area. Finally, many landbird species migrate over the Proposed Action Area, including over marine waters.

Besides owls, a few raptor species breed on the ACP and may be seen in low numbers in the Proposed Project Area. These include Northern harrier (*Circus cyaneus*), rough-legged hawk (*Buteo lagopus*), and Peregrine falcon (*Falco peregrinus*), which all prey to some extent on other birds. They are territorial breeders, occur on the ACP only during the breeding season, and occasionally nest on oil field infrastructure.

Common raven (*Corvus corax*) is expected to occur in the Proposed Action Area coastal and terrestrial zones. This large passerine is a generalist scavenger and also a predator on the young and eggs of other birds during the breeding season. Ravens are attracted to landfill food sources and occur year-round on the ACP (Saalfeld, Hill, and Lanctot, 2013). Geese, duck, and ptarmigan have been among the types of avian remains identified in a study of raven diet on the Prudhoe Bay oilfields, approximately 25 miles to the west of the Proposed Project Area (Powell and Backensto, 2009). Ravens prefer to breed on cliffsides and other elevated areas. Only in recent decades, as communication and oil field infrastructure increased, have ravens noticeably expanded their breeding range onto the relatively flat-featured ACP. Both the number of raven sightings during the winter Audubon Christmas Bird Count, and the number of raven nests in summer have increased over the recent years of study (1987 to 2012 and 2004 to 2014, respectively) on the Prudhoe Bay oil fields (including existing artificial drilling islands Endicott SDI and Northstar) (Bishop and Streever, 2016).

Another landbird predator likely to occur in the Proposed Action Area coastal zone year-round is snowy owl (*Bubo scandiacus*). Snowy owl is an important Arctic predator on small mammals, especially lemmings, and the young of other birds during breeding season. Therrien, Gauthier, and Bêty (2011) describe how they should be considered a marine species with their common venturing out over the pack ice. Gall and Day (2012) report a short-eared owl (*Asio flammeus*) at the Burger prospect in the Chukchi Sea in August 2009, at least 60 miles from shore. Seven snowy owls were observed in July around Foggy Island Bay, including six associated with Tigvariak Island (Dau and Bollinger, 2012). Ptarmigan species, particularly rock ptarmigan (*Lagopus mutus*) which prefer open tundra and breed in alpine and Arctic tundra, are common fowl on the ACP year-round.

Several species of passerine birds (also called songbirds) breed in Arctic habitats in the U.S., Canada, and Russia, and migrate across the Beaufort Sea to and/or from their wintering grounds. Two common breeders on the ACP include Lapland longspur and snow bunting (*Plectrophenax nivalis*). Like all Alaskan ground-nesting passerines, the nests of these small birds are camouflaged and easily overlooked, despite their abundance. They both arrive on the ACP breeding grounds early in spring, snow bunting being one of the first Colville River Delta arrivals with a current mean arrival date of April 17 (Ward et al., 2016).

Passerines interact with at-sea oil and gas industry vessels, often hundreds of miles from land. Arctic passerine migrations are usually nocturnal and have not generally been well-studied, but it is well-known that these long-distance flights are occurring both for species that winter in North America ("New World" migrants), as well as some that breed and/or winter on other continents (commonly referred to as "Old World" migrants). Passerine flights in the Arctic are sometimes "off-course" migrants, and other times very large flocks. Over 40 percent of the bird encounters recorded on drilling and support vessels during 2012 and 2015 exploration drilling in the Chukchi Sea were passerines, including three species of Old World migrants – Arctic warbler (*Phylloscopus borealis*), northern wheatear (*Oenanthe oenanthe*), and yellow wagtail (*Motacilla tschutschensis*), American pipit (*Anthus rubescens*), yellow warbler, (*Dendroica* [*Setophaga*] *petechia*), Swainson's thrush (*Catharus ustulatus*), dark-eyed junco (*Junco hyemalis*), rusty blackbird (*Euphagus carolinus*), a "sparrow" (Family *Passeridae*), four birds described as "warblers" (a vague term that could be applied to any number of small perching birds), and nine other individuals that were not or could not be identified to species but were (based on photographs) probably passerines (Shell, 2012 and 2015). Given the large proportion of passerines and multiple numbers of strikes far from shore in adjacent Arctic waters, many of the passerine species are expected to also fly in or near the Proposed Action Area.

3.2.4 Marine Mammals and Acoustic Environment

This section provides information on the acoustic environment and marine mammal species that may be present in or near the Proposed Action Area, including those that may be impacted by vessel transit from Dutch Harbor. This includes species currently listed as threatened or endangered, or as candidate species under the ESA. Threatened and endangered marine mammal species described include bowhead, fin, humpback, and right whales; bearded seals, Steller sea lions, sea otters, and polar bears. Fin, humpback, blue, sperm, and right whales; Steller sea lions, and sea otters, though considered extralimital to the immediate environment surrounding the Proposed Action, may be encountered by vessel traffic in transit from Dutch Harbor.

Other species of marine mammals occurring in the Beaufort Sea include beluga whales, gray whales, Pacific Walrus, and spotted and ringed seals.

Minke, humpback, fin, and killer whales, harbor porpoises, and ribbon seals regularly occur in the Chukchi Sea but not in the Beaufort Sea. Narwhals and hooded seals are considered extralimital to the Proposed Action Area and will not be discussed in this FEIS.

3.2.4.1 Acoustic Environment

The underwater and terrestrial acoustic environment is particularly important to marine mammals since they use noise to navigate, find prey, communicate, and detect disturbances or threats. While cetaceans typically rely on underwater acoustics, pinnipeds and polar bears perceive noises in and out of the water, such as when individuals are hauled out, spy-hopping, or traveling across the sea ice as is the case with polar bears.

In the Beaufort Sea, natural sources of marine sound include wind stirring the surface of the ocean, storms, ice movements, and animal vocalizations and noises (including whale calls and echolocation clicks). The frequency and magnitude of noise from each of these producers can differ dramatically within and among years as a result of variation in the seasonal presence of the sound sources. Existing human sources of sound in the Beaufort Sea include vessels (motor boats used for subsistence and local transportation, commercial shipping, research vessels, etc.); navigation and scientific research equipment (e.g., benthic trawls); airplanes and helicopters; human settlements; military activities; and offshore industrial activities. Burgess and Greene (1999) measured the overall ambient sound in the Beaufort Sea in September 1998 to be approximately 63 to 133 decibels root mean square (dB_{RMS}).

3.2.4.1.1 Physical Environment Sound Sources

The Proposed Action Area is covered by sea ice during much of the year (see Section 3.1.2.4, Sea Ice). Sea ice can both produce substantial amounts of ambient noise and act as a damper (Richardson et al., 1995). Particularly in very shallow water, ice reduces the transmission efficiency of low frequency sounds (Blackwell and Greene, 2001). Temperature changes can result in cracking; cracking ice produces sounds across a broad range of frequencies, typically from 100 Hertz (Hz) to 1 kilohertz (kHz) and can vary as much as 15 dB within 24 hours in response to diurnal changes in air temperature (USDOI, BOEM, 2011). Greene (1981) documented frequencies from 4 to 200 Hz produced by ice deformation. The types of sea ice (e.g., broken, shorefast) and its movement, as well as air temperature and wind speed all influence the ambient sound levels ice produces (Richardson et al., 1995). Ambient sound levels in the Proposed Action Area are lower in winter. At frequencies less than 50 Hz, Greene (1997) found the difference between summer and winter ambient sound levels in the area was approximately 10 dB.

Wind and waves are a dominant source of ambient noise during the open-water season (Greene and Moore, 1995). Wind, wave, and precipitation noise originating close to the point of measurement dominate frequencies from 500 Hz to 50 kHz (Richardson et al., 1995). Ambient noise levels are greater in the marginal ice zone, due in large part to wave action against the ice edge and because of the breaking up and movement of ice floes (Milne and Ganton, 1964). Greene (1998) used seafloor recorders that measured sounds at frequencies between 20 and 5,000 Hz to measure open-water ambient underwater sound levels in Stefansson Sound near the Proposed Action Area. The median sound pressure level measured over 44 days was 97 dB_{RMS} based on samples of sounds averaged over 30 seconds; the 5^{th} and 95^{th} percentiles were 78 and 110 dB_{RMS}, respectively. The values reported in Greene (1998) are consistent with measurements collected during acoustic monitoring of a seismic survey near the Proposed Action Area in the summer of 2008, which yielded ambient sound levels at frequencies from 10 to 450 Hz with 5^{th} and 95^{th} percentile levels of 70 and 100 dB_{RMS}, respectively (Aerts et al., 2008). The most recent ambient sound measurements for Foggy Island Bay, measured during the 2015 open-water season, showed median levels of 96 to 98 dB_{RMS}; 10 percent of the time the sound levels exceeded 104 dB_{RMS} to 108 dB_{RMS} (Frouin-Mouy, Zeddies, and Austin, 2016).

Biological Sound Sources

Marine mammals can contribute to the background sounds in the acoustic environment of the Beaufort Sea; frequencies and levels are highly dependent on seasons. For example, source levels of bearded seal songs have been estimated to be up to 178 dB_{RMS} at 1 m (Ray et al., 1969; Stirling, 1983; Richardson et al., 1995; Thomson and Richardson, 1995). Ringed seal calls have a source level of 95-130 dB_{RMS} at 1 m, with the dominant frequency under 5 kHz (Stirling, 1973; Cummings et al., 1986; Thomson and Richardson, 1995). Bowhead whales in western Greenland waters produced songs of an average source level of 185±2 dB_{RMS} at 1 m centered at a frequency of 444 ±48 Hz (Roulin et al., 2012).

Existing Human-Generated Sound Sources

Levels of anthropogenic (human-caused) sound can vary dramatically depending on the season, type of activity, and local conditions. In the U.S. Beaufort Sea, primary sources of anthropogenic sound are vessels and oil and gas exploration, development, and production activities. Anthropogenic noise levels in the Beaufort Sea region are higher than the Chukchi Sea due to the oil and gas developments of the nearshore and onshore regions of the North Slope, particularly in the vicinity of Prudhoe Bay. Noise levels from open-water oil and gas exploration activities in the U.S. Beaufort Sea have been measured since 2006 as required by regulatory permits (2015 Hilcorp EIA, Section 3.5.2).

Vessels. Vessel traffic and associated noise is limited primarily to late spring, summer, and early autumn at the present time. The types of vessels operating in the vicinity of the Proposed Action Area include barges, skiffs with outboard motors, icebreakers, tourism, scientific research vessels, and vessels associated with oil and gas (e.g., seismic vessels, crew-transfer vessels). Shipping sounds are often at source levels of 150 to 190 dB_{RMS} at 1m (USDOI, BOEM, 2011). Shipping traffic is mostly at frequencies from 20 to 300 Hz (Greene and Moore, 1995). Sound produced by smaller boats typically is at a higher frequency, around 300 Hz (Greene and Moore, 1995). In shallow water, vessels more than 6.2 miles away from a receiver generally contribute only to background sound levels (Greene and Moore, 1995). Measured noise from vessels associated with a 2008 seismic survey for the Proposed Action Area decayed to levels of 120 dB_{RMS} SPL within ranges less than 0.2 miles from the vessels and decayed to levels of 100 dB_{RMS} SPL at ranges less than 0.6 miles (Aerts et al., 2008). The daily average sound attributable to passing vessels during geohazard surveys in Foggy Island Bay from July 6 to September 22, 2015 was approximately 138 dB_{RMS} sound exposure level (SEL) (24 hours) at 1,640 feet from the end of the offshore survey line, and approximately 154 dB_{RMS} SEL at 3.1 miles from the end of the offshore survey line (Frouin-Mouy, Zeddies, and Austin, 2016). In both cases the range of sound energy from vessels could almost encompass the range of average daily SEL; meaning that when one or more vessels were present, vessel-associated noise could dominate the nearby ambient soundscape. Sound levels were typically higher farther offshore and the differences in acoustic energy attributable to passing vessels indicates that vessel noise likely accounts for most of the difference in ambient sound energy levels between nearshore and offshore portions of the survey area (Frouin-Mouy, Zeddies, and Austin, 2016).

Oil and Gas Activities. Industrial activities that introduce sound into the environment include geophysical seismic surveys, and oil and gas exploration, development, production, and decommissioning activities, including construction of, and travel on, ice-roads and other on-ice activities that occur throughout the winter.

Two-dimensional (2D) seismic surveys have been conducted in the Beaufort Sea since the late 1960s. Seismic surveys vary, but a typical deep 2D or three-dimensional (3D) seismic survey using airgun arrays comprised of multiple guns would emit sound at frequencies of about 10 Hz to 120 Hz, and pulses can contain some sound energy up to 500 Hz to 1 kHz (Greene and Moore, 1995). Seismic airgun sound waves are directed downwards, but can project sound pulses horizontally that can be detected many miles away (Greene and Richardson, 1988; Greene and Moore, 1995). Analysis of sound associated with seismic operations in the Beaufort Sea and central Arctic Ocean during ice-free conditions also documented propagation distances up to 807.8 miles (Richardson, 1998, 1999; Thode et al., 2010). While seismic energy does have the capability of propagating for long distances, it generally decreases to a level at or below the ambient noise level at a distance of 6.2 miles from the source (Richardson, 1998, 1999; Thode et al., 2010). Aerts et al. (2008) documented that distant airgun sounds from unrelated surveys were detectable within the Proposed Action Area.

Greene and Moore (1995) summarized that typical signals associated with vibroseis sound source used for on-ice seismic surveys sweep from 10 to 70 Hz, but harmonics extend to about 1.5 kHz.

In state waters of the Beaufort Sea, there are three operating oil production facilities (Northstar, Oooguruk, Nikaitchug) on manmade gravel islands and two production facilities on a manmade peninsula/causeway. Much of the production noise from oil and gas operations on gravel islands is substantially attenuated within 2.5 miles and often not detectable beyond 5.8 miles away (NMFS, 2014). Studies conducted as part of a monitoring program for the Northstar project (a drilling facility located on an artificial island in the Beaufort Sea) indicate that in one of the 3 years of monitoring efforts, the southern edge of the bowhead whale fall migration path may have been slightly (2 to 3 miles) further offshore during periods when higher sound levels were recorded; there was no significant effect of sound detected on the migration path during the other two monitored years (Richardson et al., 2004). Evidence indicated that deflection of the southern portion of the migration in 2001 occurred during periods when there were certain vessels in the area and did not occur as a result of sound emanating from the Northstar facility itself (USDOI, BOEM, 2011).

Other Sound Sources. Aircraft traffic associated with research and oil and gas activities occurs in the Beaufort Sea in all seasons. The level and duration of sound received underwater from aircraft depends on altitude and water depth (NMFS, 2014). Received sound level decreases with increasing altitude. For a helicopter operating at an altitude of 1,000 feet, there were no measured sound levels at a water depth of 121 feet (Greene, 1985).

Acoustic systems may be used in the Arctic by researchers, military personnel, or commercial vessel operators. These include high-resolution geophysical equipment, ADCPs, mid-frequency sonar systems, and navigational acoustic pingers (LGL, 2005, 2006). These active sonar systems emit transient sounds that vary widely in intensity and frequency (USDOI, BOEM, 2011).

3.2.4.2 Cetaceans

Beluga, bowhead, and gray whales are the only cetaceans that are likely to occur in the Proposed Action Area. The other whales described herein are those that may be encountered by vessels in transit from Dutch Harbor. The NMFS Stock Assessment Reports (SAR) and species-specific web sites contain up-to-date and detailed information on the status, distribution, abundance, and life history of each of the cetacean species mentioned in this document. The newest SARs for these species (Muto et al., 2016; Carretta et al., 2015, Allen and Angliss, 2015) are available at: http://www.nmfs.noaa.gov/pr/sars/species.htm. Web sites updated by NMFS with information specific to these species can be found at http://www.fisheries.noaa.gov/pr/species/mammals/. In addition, updated information on marine mammals can also be found in the NMFS 2016 Arctic Environmental Impact Statement (EIS) for the effects of oil and gas activities in the Arctic Ocean (NMFS, 2016a).

3.2.4.2.1 Beluga Whale

Population and Status

Two stocks (subpopulations) of beluga whales occur in the Beaufort Sea: the Beaufort Sea (BS) and Eastern Chukchi Sea (ECS) stocks (Allen and Angliss, 2015). These stocks were tentatively identified by their summer distributions (Frost and Lowry, 1990; Richard, Martin, and Orr, 2001), and were later confirmed genetically (O'Corry-Crowe et al., 1997, 2002, 2010). Beluga whales in Alaska appear to follow one of two life history strategies: migratory and nonmigratory. Migratory stocks such as the ECS and BS use shallow nearshore and deepwater offshore habitats (Hazard, 1988; Frost and Lowry, 1990).

The current minimum population estimate for beluga whales in the ECS stock is 20,752 individuals based on aerial surveys (Lowry et al. 2017), and the current minimum population estimate for beluga whales in the BS stock is 20,752 individuals based on surveys completed in 1992 (Allen and Angliss, 2015). Trend data from the Mackenzie River Delta indicate the BS stock is at least stable or increasing (Harwood and Kingsley, 2013 in Allen and Angliss, 2015). All populations of beluga whales are protected under the Marine Mammal Protection Act (MMPA) but neither the BS nor ECS stock is listed under the ESA.

Distribution ECS

Beluga whales are found throughout seasonally ice-covered Arctic and subarctic waters of the Northern Hemisphere (Gurevich, 1980), and are closely associated with open leads and polynyas in ice-covered regions (Hazard, 1988). Depending on season and region, beluga whales may occur in both offshore and coastal waters (Figure 3-18 and Figure 3-20). The distribution of beluga whales in Alaska is discontinuous from Yakutat Bay to Cook Inlet to Bristol Bay. The area from Bristol Bay northward and eastward to Canada is used by belugas; the Bering and Chukchi seas are used year-round, and the Beaufort Sea is used in summer (Frost and Lowry, 1990).

Both ECS and BS beluga whale stocks winter in the southern Chukchi Sea and Bering Sea (Suydam et al., 2001; Miller, Elliott, and Richardson, 1998; Muto et al., 2016) however, there is some evidence that the stocks may use separate wintering locations (Citta et al., 2016). Migration north through the Chukchi Sea and east through the Beaufort Sea is stock-specific, with BS migration occurring in spring and ECS in summer.

Satellite telemetry data indicate that summering BS belugas tagged in the Mackenzie River Delta (Canada) stayed in the Canadian Beaufort Sea for the entire month of July and most of August, in an area from the delta east into Amundsen Gulf and north to Viscount Melville Sound (Richard, Martin, and Orr, 2001). Beluga whales migrating in the fall from the Canadian Beaufort Sea transit the U.S. Beaufort Sea in a dispersed pattern, along the southern edge of the pack ice over the continental shelf break, to reach western Chukchi Sea waters primarily during September (Richard, Martin, and Orr, 1997; 2001). During this time, pods can number 500 to 1,000 individuals (Lowry, 1994; Citta and Lowry, 2008). Occasionally, a few appear in coastal areas and river deltas.

Belugas in the ECS Stock calve, feed, and molt in June and July near Kasegaluk Lagoon, between Cape Lisburne and Icy Cape, Alaska (Frost and Lowry, 1990; Frost, Lowry, and Carroll, 1993; Suydam et al., 2001). ECS belugas tagged in Kasegaluk Lagoon have been tracked in July through November from 130ºW to 176.5ºW and north to 81ºN (Suydam et al., 2001; Sudam, Lowry, and Frost, 2005; Citta et al., 2013). This suggests that belugas sighted during aerial surveys in the northeastern Chukchi Sea and western Beaufort Sea from June through August are likely ECS belugas (Hauser et al., 2014). However, during the return migration in September and October, BS belugas overlap with ECS belugas in the western Beaufort Sea (Hauser et al., 2014).

Distribution of belugas may be impacted by age and sex. Analysis of mitochondrial DNA indicates that beluga whale adults in the western North American stocks are stratified by age (O'Corry-Crowe et al., 1997). Older adult males tend to disperse more (O'Corry-Crowe et al., 1997; Suydam, Lowry, and Frost, 2005). These patterns are supported by a study on movement patterns of tagged ECS belugas in Kasegaluk Lagoon, near Point Lay (Suydam, Lowry, and Frost, 2005). Although belugas of all ages and both sexes were most often found in water deeper than 656 feet along and beyond the continental shelf break, adult males moved farthest away from shore and remained there longest, females moved the shortest distance, and immature males showed intermediate movement (Suydam, Lowry, and Frost, 2005). BS belugas tagged in the eastern Beaufort Sea also showed age and sex differences in their habitat use; females with calves and younger males selected open-water habitats near the mainland and older males selected closed sea ice cover in and near the Arctic Archipelago (Losteo et al., 2006).

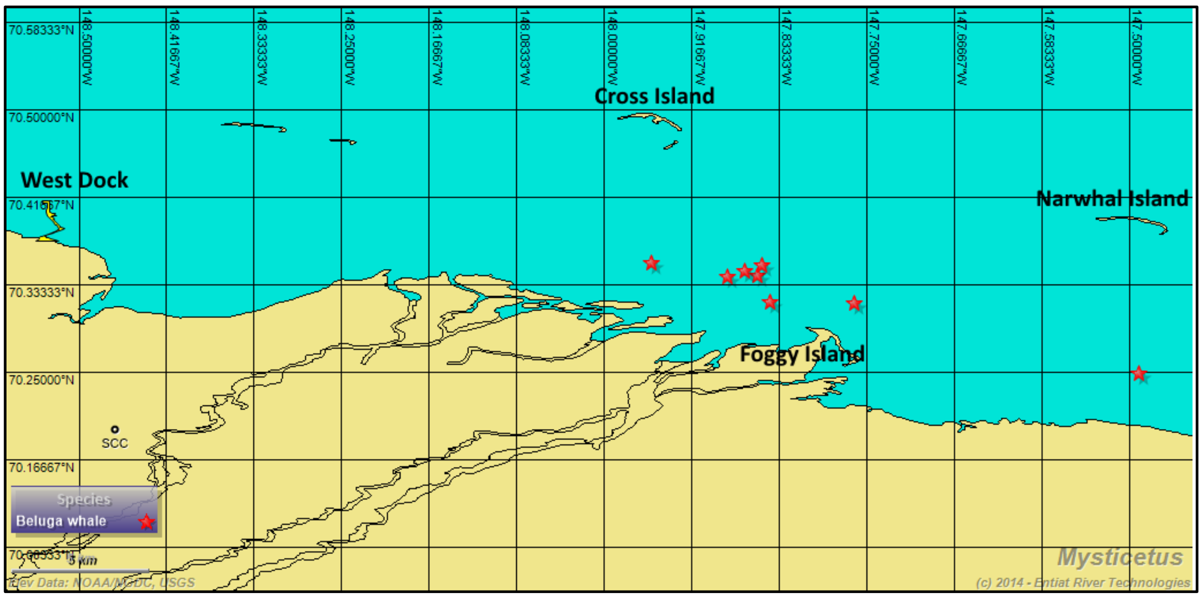

Figure 3-15 **Liberty Area Beluga Whale Sightings – 2014**
Locations of beluga whale sightings made by Protected Species Observers (PSOs) from vessels during the Liberty 2014 Survey (Smultea et al., 2014).

In interviews summarizing Traditional Ecological Knowledge (TEK), beluga whale hunters in the eastern Chukchi and northern Bering seas also indicated that groups composed of different age and sex classes of belugas migrated at different times, and thus arrived at harvest areas (e.g., Escholtz Bay) at different times. First, subadult belugas migrated along the ice edge in spring, females with calves and young whales followed, and large males migrated along the ice edge last (Huntington et al., 1999). Hunters reported that tidal movements of belugas in and out of Escholtz Bay were led by large adult males (Huntington et al., 1999). Data on age composition and sex ratio of beluga whales in Alaska are scant and age composition may vary by geographic area.

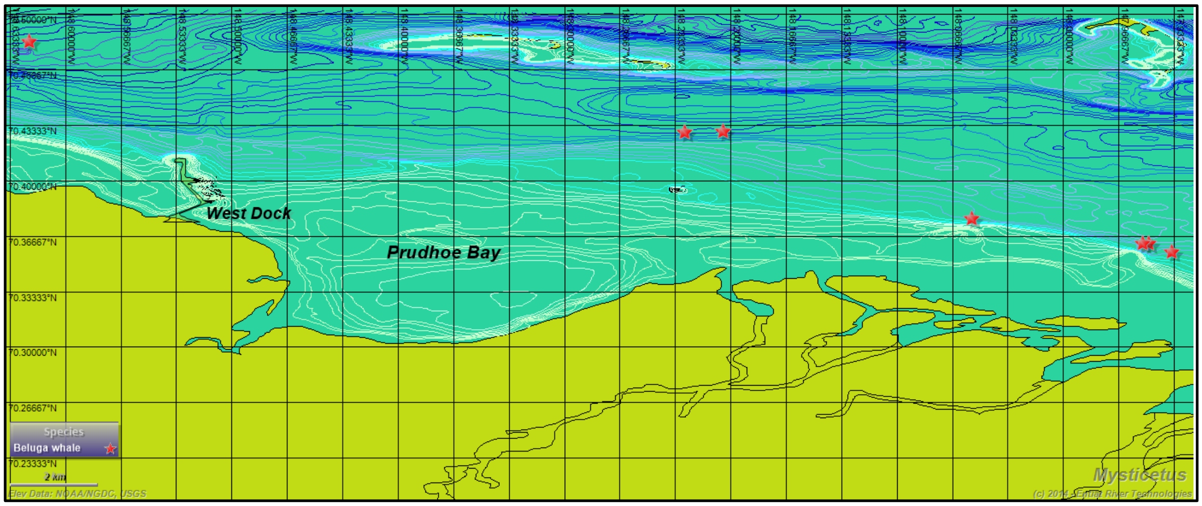

Figure 3-16 Beluga Whale Locations
Locations of beluga whale groups seen by Protected Species Observers during the 2014 BPXA seismic survey (Lomac-MacNair et al., 2015).

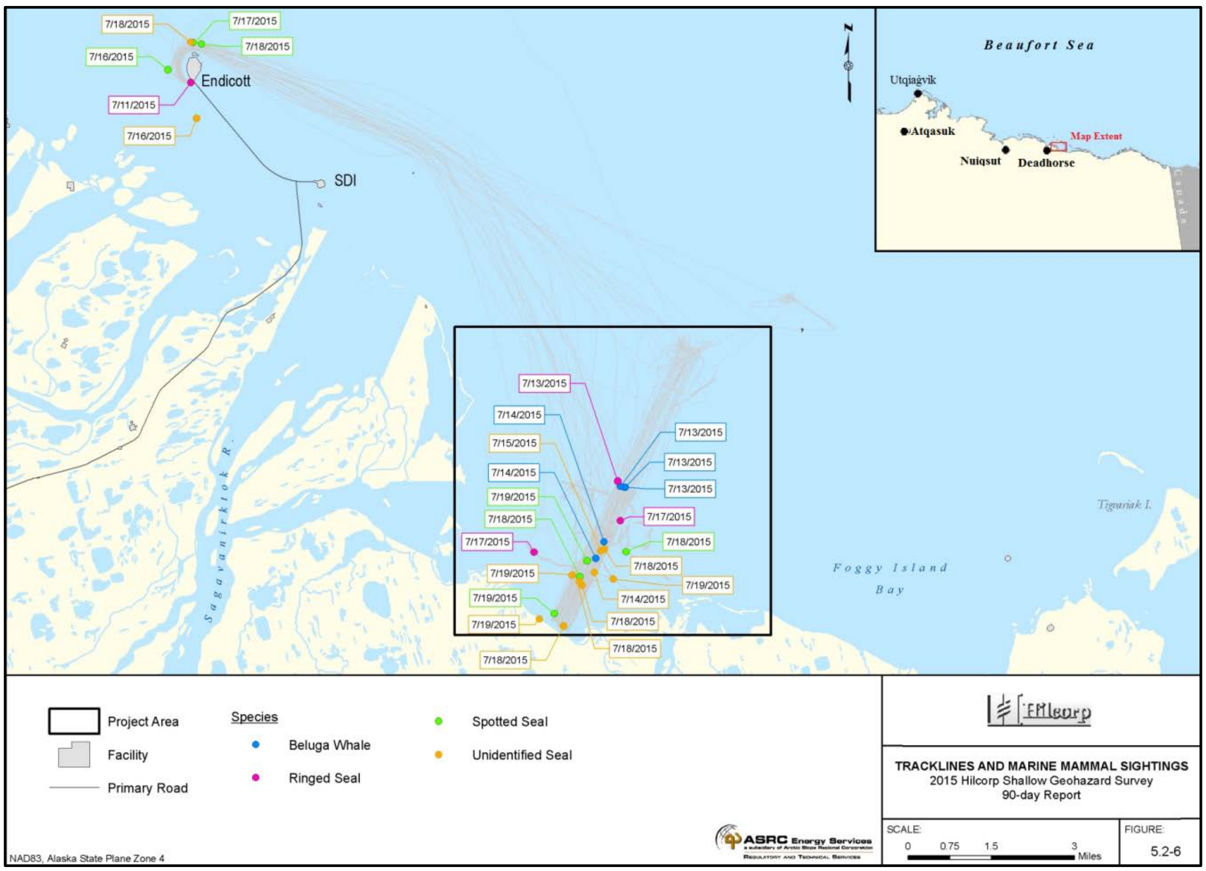

Figure 3-17 Foggy Island Bay Beluga Whale Sightings – 2015
Locations of beluga whales (blue dots) seen by Protected Species Observers in Foggy Island Bay during the 2015 HAK geohazard surveys (Cate et al., 2015).

During the 2014 open-water season, BPXA conducted a two-dimensional (2D) high-resolution (HR) shallow geohazard survey followed by a seabed sonar mapping survey in the Proposed Action Area. Marine mammal monitoring surveys were conducted in association with this operation. The surveys began on July 16 and were completed by August 30, 2014. During that time, 8 groups of approximately 19 individual beluga whales, 5 of which were juveniles, were seen in the area (Figure 3-15 and Figure 3-16); some of these were considered re-sights (Smultea et al., 2014).

BPXA also conducted a marine mammal monitoring survey during their 3D ocean bottom sensor seismic operations in the North Prudhoe Bay area during the 2014 open-water season (beginning July to mid-September). The survey location was approximately 30 miles west of the Proposed Action Area. During the survey, 7 groups of approximately 15 individual beluga whales were observed (Figure 3-16), including 3 calves; some of these were considered re-sights (Lomac-MacNair et al., 2015).

HAK conducted a marine mammal monitoring survey in 2015 during their open-water season shallow geohazard and strudel scour survey operations in the Proposed Action Area (U.S Beaufort Sea). Observations for marine mammals were conducted July 9 through July 19, 2015. Five beluga observations were made in Foggy Island Bay (Figure 3-17) though it was thought this was the same beluga seen on multiple occasions (Cate et al., 2015).

Aerial surveys for marine mammals have occurred annually from 1979 to 2015 in the summer and fall in the western Beaufort Sea. These surveys are currently known as the Aerial Surveys of Arctic Marine Mammals (ASAMM) project, funded by BOEM and conducted by NOAA. While ASAMM surveys were not conducted in the Proposed Action Area during this time, ASAMM surveys noted that most belugas are observed along the continental shelf (Figure 3-18). Beginning in 2016, NOAA conducted surveys inside the barrier islands, where the proposed LDPI is located. While no belugas were observed in the vicinity of the proposed LDPI, belugas have been seen immediately north of the Proposed Action Area and seaward of the barrier islands (Figure 3-19). In general, beluga distribution in the ASAMM survey area, south of 72°N, has remained consistent over the past 30 years (Clarke et al., 2015a).

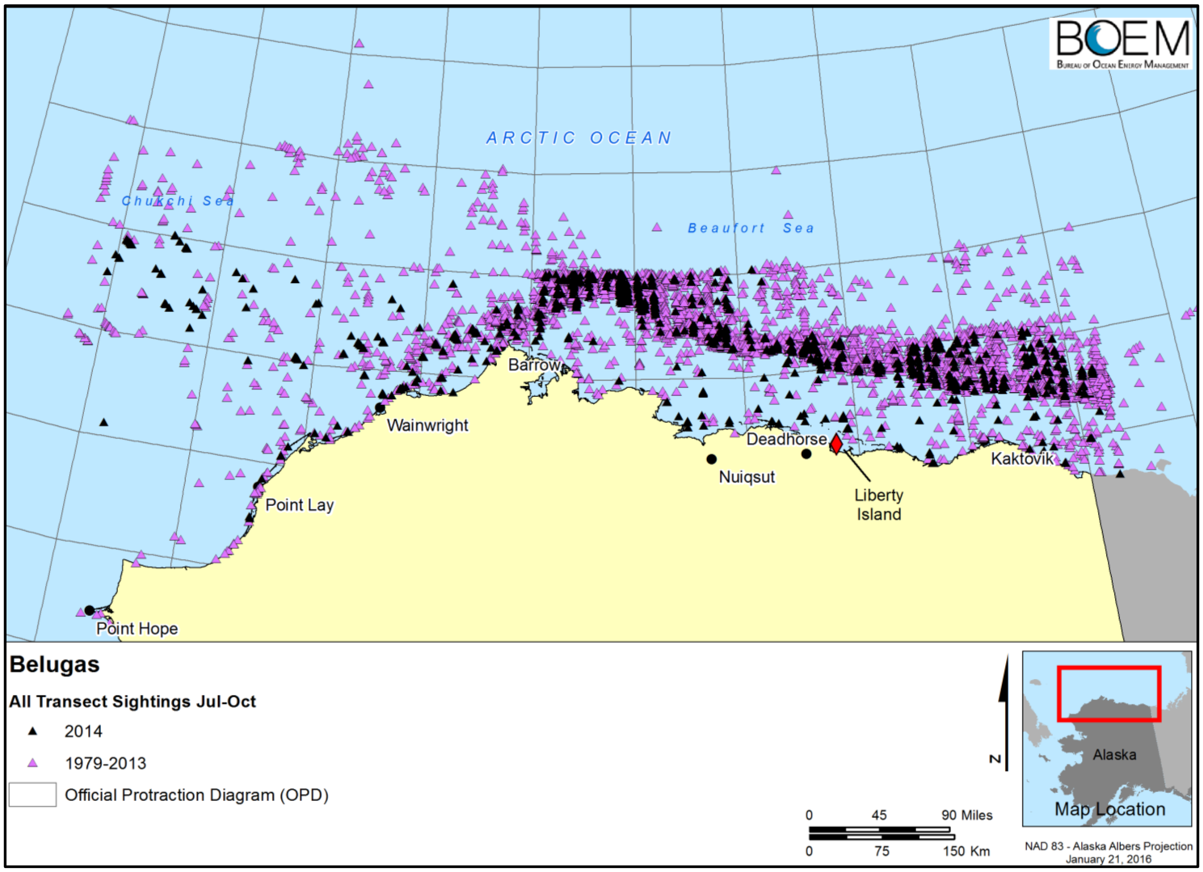

Figure 3-18 Belugas Seen in the U.S Arctic during ASAMM Surveys 1979-2014

The 2014 (July through October) survey data gathered by ASAMM found that beluga distribution in the western Beaufort Sea in summer and fall was centered over the continental slope and Barrow Canyon, north and west of the Proposed Action Area, with a few more sightings than usual in shallow nearshore areas (Figure 3-19). Beluga sightings were scattered across the western Beaufort Sea slope, although a few were seen seaward of barrier islands (Clarke et al., 2015a; Figure 3-18). Although belugas are not usually seen inshore of barrier islands, industry operating approximately 30 miles west of the Proposed Action Area have documented occasional presence of beluga within the barrier islands (Lomac-MacNair et al., 2015).

Kuletz et al. (2015) examined seasonal spatial patterns in seabird and marine mammal distribution in the eastern Chukchi and western Beaufort seas to identify biologically important pelagic areas. To identify marine mammal hotspots, data from the ASAMM surveys from mid-June through late October of 2007 through 2012 were used. Hotspots for belugas occurred in both the Chukchi and Beaufort seas. They found that the locations of hotspots varied among species but often were located near underwater canyons or over continental shelf features and slopes. Shared hotspots were characterized by strong fronts caused by upwelling and currents, which may have high densities of euphausiids (krill) in summer and fall. Belugas were distributed more widely than bowhead whales and had higher relative abundance in summer than in fall. No hotspots were identified close to or in the Proposed Action Area.

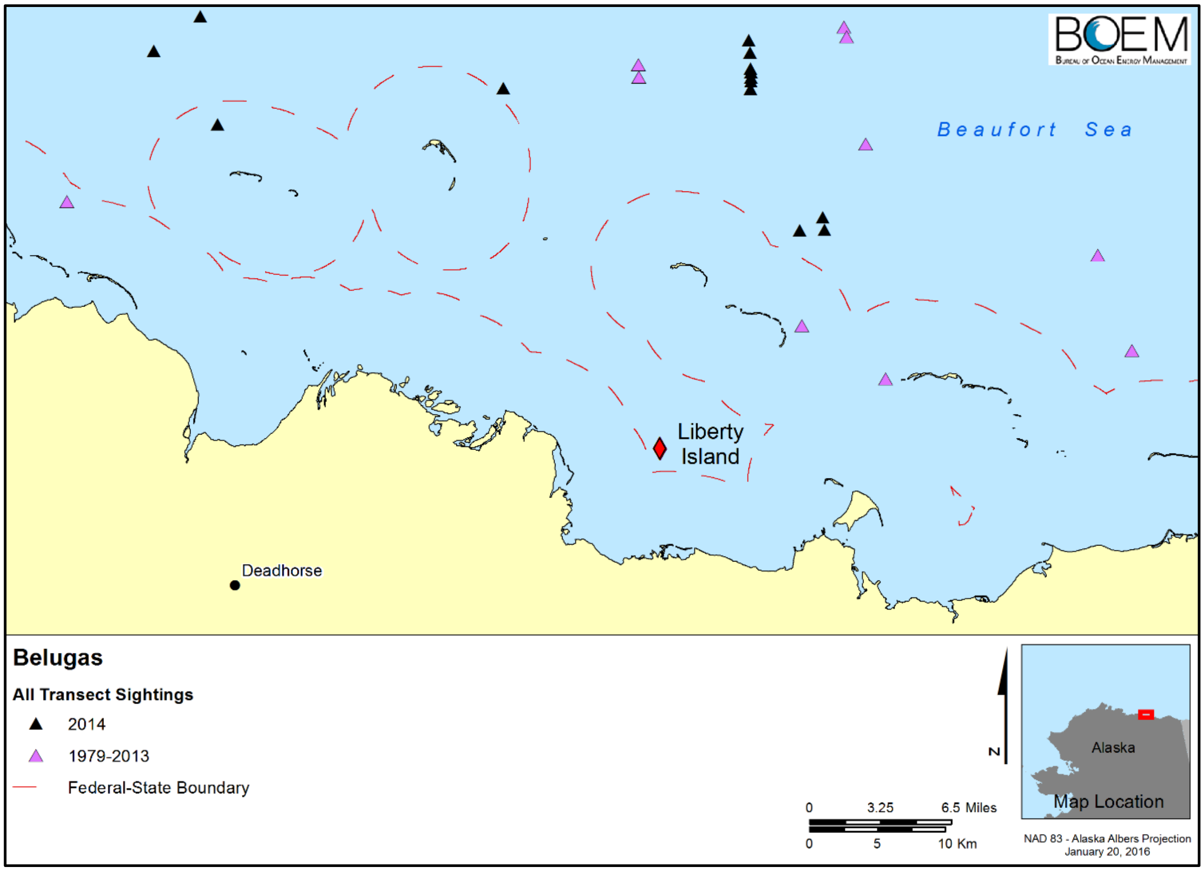

Figure 3-19 Belugas near the Proposed Action Area during ASAMM Surveys 1979-2014

Clarke et al. (2015b) evaluated Biologically Important Areas (BIAs) for belugas in the U.S. Arctic region and identified three. Both the spring (April through May) and fall (September through October) migratory corridor BIAs for belugas are far north of the Proposed Action Area because sightings of belugas from aerial surveys in the western Beaufort Sea are primarily on the continental slope, with relatively few sightings on the shelf (Clarke et al., 2015b). Clarke et al. (2015b) also identified one combined BIA for belugas important for both reproduction and feeding – between Cape Lisburne and Icy Cape in the Chukchi Sea. No reproductive and feeding BIAs were identified in the Beaufort Sea for belugas.

From the data discussed above, beluga whale occurrence in the Proposed Action Area is considered very limited. However, a few beluga whales would be expected to be found within the Proposed Action Area during a given open-water season.

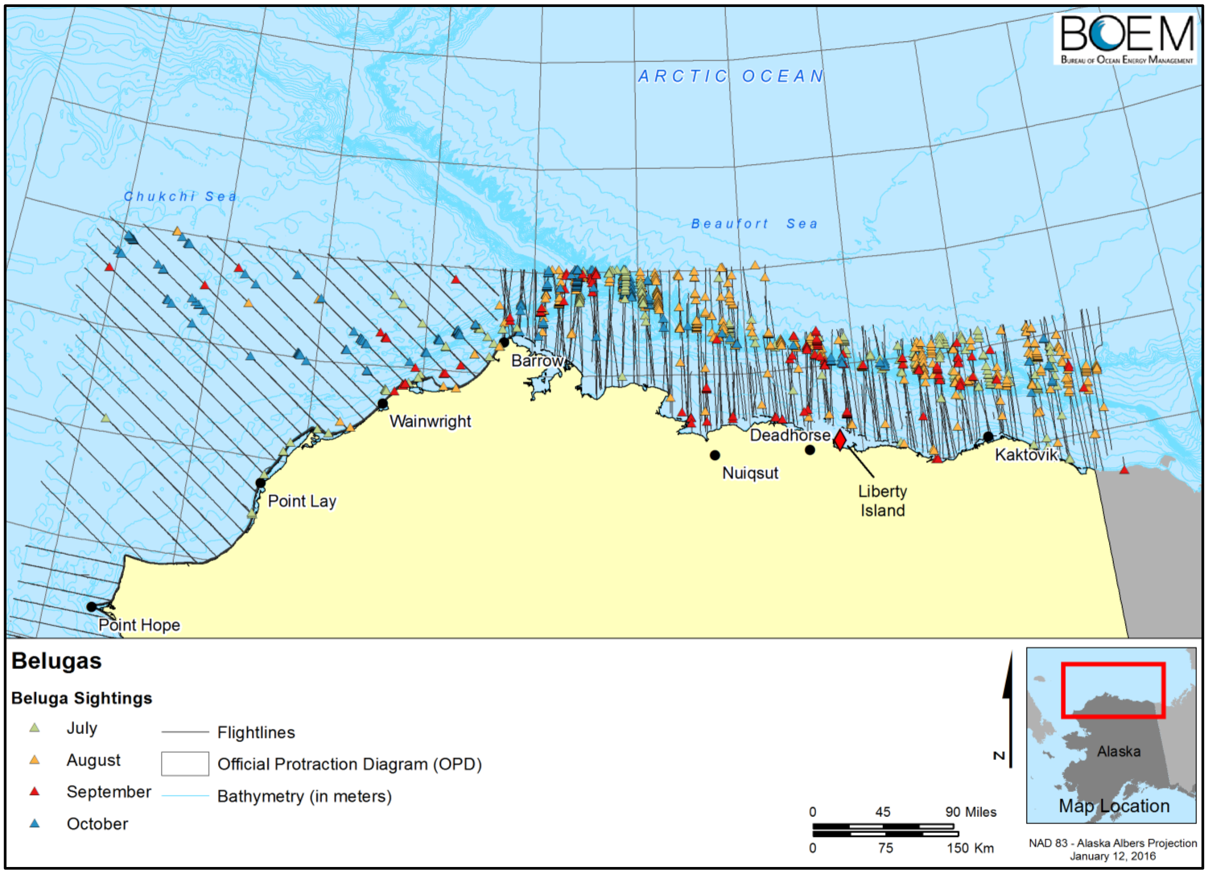

Figure 3-20 Belugas Seen in the U.S Arctic during 2014 ASAMM Surveys by Month

Life History

Conception most likely occurs in early spring while belugas are at their wintering areas or during the spring migration, as early as mid-March to early June (Brodie, 1971; Sergeant, 1973; Burns and Seaman, 1985; Brown Gladden, Ferguson, and Clayton, 1997). However, O'Corry-Crowe et al. (1997) indicate that mating occurs in the Eastern Beaufort stock between April and July. Adult male beluga whale behavior in mating seasons is consistent with a polygamous mating system in which males compete directly for access to females (O'Corry-Crowe et al., 1997). The overall sex ratio of beluga whales in Alaska is 1:1; however, subsampling of the dataset used in the sex ratio study showed large deviations in sex ratio by area (Burns and Seaman, 1985).

Beluga whales may live more than 60 years (Burns and Seaman, 1985). Female belugas may reach reproductive maturity between 4 and 10 years of age, and males may reach reproductive maturity between 8 and 15 years of age (Nowak, 1991 in NMFS, 2008; Suydam, 1999; Lockyer et al., 2007; NMFS, 2008). Gestation lasts 14 to 14.5 months, with single calves born in late spring or early summer (NMFS, 2008). Beluga whale calves may nurse for up to 2 years. Older calves and subadults may, however, remain closely associated with mothers much longer than 2 years (O'Corry-Crowe et al., 2002).

Beluga whales change color from gray to white as they mature, reaching white coloration between ages 12 and 17 (Brodie, 1971; Sergeant, 1973), although Burns and Seaman (1985) reported gray females up to 21 years of age. McGuire et al. (2008) photo-identified 10 gray beluga whale mothers with calves in Cook Inlet. Because this color change appears not to occur at a standard age and may not indicate reproductive maturity, age-class (individuals of the same age range) for belugas is typically inferred from a combination of relative body size and coloration.

The beluga whale is a highly social species that exhibits substantial variation in geographic movement patterns and in group structure (O'Corry-Crowe et al., 1997). They typically migrate, hunt, and interact together. Nowak (1991) reported an average group size of 10 animals, although they may occasionally form larger groups, during migrations (Huntington, 1999). Native hunters have stated that beluga whales form family groups (Huntington, 2000). Behavior of groups of belugas, such as seasonal movements and occurrence of aggregations, may differ by age and sex of group members, group size, and environmental variables (e.g., tides, prey distribution, predation) (Hazard, 1988; O'Corry-Crowe, 2009).

The smaller toothed cetaceans, such as belugas, produce sounds across some of the widest frequency bands that have been observed in animals (Southall et al., 2007). Their social sounds are generally in the range audible to humans, from a few hundred Hz to several tens of kHz, but specialized clicks used in biosonar (echolocation) systems for prey detection and navigation extend well above 100 kHz (Southall et al., 2007).

Beluga whales also have a well-developed sense of directional hearing. They can hear across a large range of frequencies, from about 40 to 75 Hz to 80 to 150 kHz (Richardson, 1995). Their hearing is most acute at middle frequencies, between about 10 and 75 kHz (Fay, 1988; Richardson, 1995). Therefore, beluga whales are grouped in the mid-frequency cetacean hearing group with an estimated auditory bandwidth of between 150 Hz to 160 kHz (Southall et al., 2007) and in the boxcar frequency range of 150 Hz to 160 kHz (NMFS, 2016b). Sound reception is through the lower jaw, which is hollow at its base and filled with fatty oil. Sounds are conducted through the lower jaw to the middle and inner ears, and then to the brain (NMFS, 2008).

Beluga whales use echolocation for directional voice and hearing capabilities (Penner, Turl, and Au, 1986). Their ability to emit and receive signals off the water's surface and to detect targets in high levels of ambient noise and backscatter enable the animals to navigate through heavy pack ice, as well as locate areas of ice-free water and possibly even find air pockets under the ice (Turl, 1990). If a noise source between a beluga and its target is too high to use straight-line echolocation, the beluga can redirect and bounce its echolocating beam off the water's surface. This ability to alter its emitted pulses in a different direction allows the beluga to successfully locate its target in the presence of other noise sources (Penner, Turl, and Au, 1986). Dive profiles indicate belugas may use sound while diving to locate cracks in the ice above (Martin, Smith, and Cox, 1998).

Observations of beluga whales in captivity led to a conclusion that they have rather good visual capabilities (Pilleri, 1982; Marino and Stowe, 1997). However, laboratory investigations suggest that their visual acuity is slightly less than that of other marine odontocetes (Mass and Supin, 2002). Their retinas contain both rod and cone cells, so they are believed to see color (Dawson, 1980). Recent immunocytochemical, physiological, and molecular genetic data, however, demonstrate an absence of blue-sensitive cones in the eyes of whales and seals, indicating cone monochromacy and, hence, serious deficits in—or even the absence of—color vision (Griebel and Peichl, 2003).

Diet and Feeding

Belugas have been known to hunt individually and in a group cooperatively. During foraging, belugas may be able to maintain communication with others over areas of 984 to 1,640 feet (Bel'kovich and Sh'ekotov, 1992). Foraging usually begins with a deliberate movement synchronized with acoustic localization of prey. Short periods of rapid swimming then follow, accented by sudden changes of direction. Belugas echolocate throughout this entire sequence of activities to orient themselves and catch their prey (Bel'kovich and Sh'ekotov, 1990).

Belugas in the Beaufort and Chukchi seas appear to eat a variety of fish and invertebrates. A study looking at stable isotope and trace element status of subsistence-hunted beluga whales in both the BS and ECS stocks found the species occupied a higher trophic level than both bowhead and gray whales but did not eat fish exclusively and that both pelagic and benthic foods are important components of their diet (Dehn et al., 2006). Another study using stable isotopes found Arctic cod was a key prey item in the summer diet of beluga whales in the eastern Beaufort (Loseto et al., 2009). Size related dietary differences suggested larger sized beluga preferred offshore Arctic cod, whereas smaller sized beluga appeared to feed on prey in their near shore habitats that included near shore Arctic cod. The presence of Arctic cod groups in shallow near shore and deep offshore habitats may facilitate the behavioral segregation of beluga habitat use as it relates to their size and resource requirements (Loseto et al., 2009). Seaman, Lowry, and Frost (1982) found belugas ate a variety of fish and invertebrates when stomach contents from 119 beluga whales from six locations in the Bering and Chukchi seas were examined. However, 90 to 100 percent of stomachs analyzed by Seaman, Lowry, and Frost (1982) contained invertebrates. Huntington et al. (1999) also described the diet of belugas in the nearshore areas of the eastern Bering Sea, Kotzebue Sound, and the eastern Chukchi Sea to include a variety of prey items, but primarily fish. Quakenbush et al (2015) documented stomach contents obtained from subsistence-harvested and stranded belugas in Alaska, between 1954 and 2012. Of these, 62 were from the BS stock collected between 1983 and 2003 at Point Hope and Diomede, and 67 were from the ECS stock collected between 1983 and 2010 near Point Lay and Point Barrow (Quakenbush et al., 2015). The diet of beluga whales in the Beaufort Sea consists of fish, especially Arctic cod (*Boreogadus saida*), and invertebrates, especially shrimp, echiurids, polychaetes, and cephalopods (Quakenbush et al., 2015).

Mortality

Killer whales and polar bears are the only known nonhuman predators of beluga whales (Smith, 1985; Sheldon et al., 2003; Loseto et al., 2006; O’Corry-Crowe 2009). Although polar bear predation on beluga whales does not appear to be an important contributor to beluga mortality, polar bears have been observed stalking belugas in shallow waters as well as making successful kills of calves and subadult whales in deeper waters (Smith and Sjare 1990). Killer whale predation of belugas has been observed in Arctic and subarctic waters range wide (as cited in Sheldon et al., 2003), and western Alaska (Lowry, Nelson, and Frost, 1987; Frost, Russell, and Lowry, 1992; George and Suydam, 1998). An increase in the occurrence of killer whales at high latitudes (Clarke et al., 2013), and a longer open-water period with less sea ice cover may offer more opportunities for orcas to attack belugas in the future. Some believe orcas avoid sea ice because their large dorsal fin could compromise their ability to surface for air (Matthews et al., 2011). Likewise, some believe belugas are more efficient at moving in ice and can use sea ice as a refuge from killer whale attacks (Ferguson, Kingsley, and Higdon, 2012; Fergusson, Higdon, and Westdal, 2012).

The most recent subsistence harvest numbers for the BS stock by Alaska Native hunters show an annual average take of 65.6 belugas landed during the 5-year period between 2008 and 2012, based on reports from Alaska Beluga Whale Committee (ABWC) representatives and on-site harvest monitoring (Allen and Angliss, 2015). The most recent subsistence harvest numbers for the BS stock by Canadian Inuvialuit subsistence hunters show an annual average take of 100 belugas landed during the 5-year period between 2005 through 2009 based on reports from the Fisheries Joint Management Committee and on-site harvest monitoring (Allen and Angliss, 2015). Thus, the mean estimated subsistence take in Canadian (2005 through 2009) and U.S. (2008 through 2012) waters from the BS beluga stock is 166 (100 + 65.6) whales.

The most recent subsistence harvest numbers for the ECS stock by Alaska Native hunters show an annual average take of 57.4 belugas landed during the 5-year period between 2008 and 2012 based on reports from ABWC representatives and on-site harvest monitoring (Allen and Angliss, 2015).

Three different commercial fisheries that could have interacted with beluga whales from the ECS stock were monitored for incidental take by fishery observers during 1990 through 1997: Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries. Observers did not report any mortality or serious injury to beluga whales incidental to these groundfish fisheries (Allen and Angliss, 2015). In the nearshore waters of the southeastern Chukchi Sea, substantial efforts occur in gillnet (mostly set nets) and personal-use fisheries. Although a potential source of mortality, there have been no reported beluga whale takes as a result of these fisheries (Allen and Angliss, 2015). Likewise, there have been no reported beluga whale takes as a result of fisheries in the BS stock (Allen and Angliss, 2015).

Ship strikes, especially from small fast boats, have been identified as a threat to belugas (NMFS, 2008; Carter and Nielsen, 2011). Between 1983 and 2012, a total of 222 beluga carcasses from the St. Lawrence Estuary (Canada) population were examined for causes of death. It was found that 4 percent died as a result of ship/boat strikes (Lair, Martineau, and Measures, 2014). There is limited data in Alaska on mortality of belugas due to boat strikes. Although no mortality due to strikes has been definitely confirmed in Alaska, it is suspected; i.e. observations of Cook Inlet beluga whales with propeller scars and Cook Inlet belugas washed ashore dead with wide, blunt marks suggesting a ship strike as the cause of the injury (NMFS, 2008). The rapid reduction in sea ice due to global climate change has precipitated a surge of commercial activities in the Pacific Arctic, including increases in shipping. These increased shipping activities add risk to belugas in the Arctic, via increased likelihood of mortality or injury by ship strikes.

Climate Change

Evidence indicates the Arctic climate is rapidly changing, resulting in reductions in sea ice (ACIA, 2004; Johannessen et al., 2004). Such changes could affect beluga whales, which may be sensitive to changes in Arctic weather, sea surface temperatures, or ice extent, and the concomitant effect on prey availability. Laidre et al. (2008) and Heide-Jørgensen (2010) concluded belugas are probably less sensitive to climate change than other Arctic cetaceans after considering their wide distribution and flexible behaviors.

Losses in sea ice could allow marine predators, such as killer whales, to penetrate into the Beaufort Sea for longer distances, increasing the risks of predation on belugas; however, most belugas prefer feeding in deep water near the shelf break, and are capable of diving to 2,950-foot depths in the Canadian Basin (Hauser et al., 2015; Marin and Smith, 1992), while Miller et al. (2010) recorded the maximum dive depth for a killer whale at 833 feet. Hauser et al. (2015) noted Arctic cod, a major prey item for belugas, were most prevalent at the 656- to 984-foot depth in the Western Beaufort Sea – the depths most belugas dive. Recent evidence for declining growth, body condition, and blubber thickness suggests that ecosystem changes may be affecting belugas through reduced availability or quality of prey (Harwood et al., 2014, 2015).

Considering the link between sea ice quantity and quality, and Arctic cod whose existence is linked to sea ice, losses in sea ice extent and thickness would likely have adverse effects on beluga body condition, unless the belugas demonstrate the ability to switch to other prey species. If salmon or whitefish become more prevalent in the Beaufort Sea in the future, some of the effects on Arctic cod could be offset, but to what degree remains speculative at present. Thus, future effects of climate changes on beluga whales and their habitat could result in less, or more feeding opportunities, depending upon how the populations of prey species respond to the new environmental conditions. This in turn would affect the physical and behavioral state of belugas, as well as most population parameters.

The spread of disease and parasites has also been suggested as a potential threat to Arctic marine mammals by emigration/immigration events between different marine mammal populations, abetted by sea ice losses, but only in a general context. The true potential for the spread of pathogens between different stocks of beluga whales remains speculative.

3.2.4.2.2 Bowhead Whale

Population and Status

Bowhead whale stocks occur in Arctic and sub-Arctic waters off eastern and western Canada, western Greenland, offshore waters of Spitsbergen (Norway), Alaska, Chukotka (Russia), and the Sea of Okhotsk. The International Whaling Commission (IWC) recognizes four stocks of bowhead whale for management purposes (Allen and Angliss, 2015). The Western Arctic stock (also known as the Bering-Chukchi-Beaufort stock) is the largest, and the only stock to inhabit U.S. waters (Allen and Angliss, 2015). It is also the only bowhead stock within the Proposed Action Area.

All stocks of bowhead whales were severely depleted during the intense commercial whaling that started in the early 16th century near Labrador (Canada) and spread to the Bering Sea in the mid-19th century (Allen and Angliss, 2015). Woodby and Botkin (1993) reported a minimum worldwide population estimate of 50,000 bowhead whales prior to the onset of commercial whaling, with 10,400 to 23,000 in the Western Arctic stock (dropping to less than 3,000 at the end of commercial whaling). Consequently, the bowhead whale was listed as endangered under the ESA and as depleted under the MMPA. Despite these designations, the Western Arctic stock of bowheads has been increasing (Allen and Angliss, 2015). Based on concurrent passive acoustic and ice-based visual surveys, George et al. (2004) reported that the Western Arctic stock of bowhead whales increased at a rate of 3.4 percent from 1978 to 2001, during which time abundance doubled from approximately 5,000 to approximately 10,000 whales. Schweder et al. (2009) estimated the yearly growth rate to be 3.2 percent between 1984 and 2003 using a sight-resight analysis of aerial photographs. Based on concurrent passive acoustic and ice-based visual surveys, Givens et al. (2013) reported that the Western Arctic stock of bowhead whales has increased at a rate of 3.7 percent from 1978 to 2011, during which time abundance tripled from approximately 5,000 to approximately 16,000 whales. These whale numbers are also correlated with increases in body condition for whales in the Western Arctic stock (George et al., 2015). It has been hypothesized that sea ice loss has positive effects on secondary trophic production within the bowhead summer feeding areas perhaps increasing the body condition and abundance of the whales (George et al., 2015a).

The minimum population estimate for the Western Arctic stock of bowhead whales is 13,796 based on ice-based counts, acoustic locations, and aerial transect data collected during bowhead whale spring migrations past Point Barrow, Alaska (Allen and Angliss, 2015) suggesting this stock may be approaching its carrying capacity (Brandon and Wade, 2004; 2006). There is no critical habitat designated for the bowhead whale under its ESA designation.

Distribution

Bowhead whales have a circumpolar distribution in high latitudes in the Northern Hemisphere, and range from 54º to 85ºN latitude. The Western Arctic bowhead whale stock generally occurs in seasonally ice-covered waters, generally north of 60°N and south of 75°N in the western Arctic Basin (Bering, Chukchi, and Beaufort seas) (Braham, 1984; Moore and Reeves, 1993; Rugh et al., 2003). They live in pack ice and shallow continental shelf waters for most of the year, typically wintering at the southern limit of the pack ice, or in polynyas (large, semi-stable open areas of water within the ice). They spend most of the summer in relatively ice-free waters (Figure 3-25). While most bowhead whales occur offshore, increasing numbers of animals have been observed in nearshore, shallow areas in the past few years (Clarke et al., 2015a) and their historic distribution patterns may be changing.

There is a general pattern of year-round movements by the Western Arctic bowhead whale population (Figure 3-21). They have a generalized (with some variability) migration route and feeding and wintering areas. In general, the majority of the Western Arctic stock migrates annually from wintering areas (December to March) in the northern Bering Sea, through the Chukchi in spring (April through May), to the Beaufort Sea where they spend much of the summer (June through

September) before returning again to the Bering Sea in fall (October through December) to overwinter (Allen and Angliss, 2015).

During spring migration, bowhead whales typically migrate through spring lead systems along the coast of Alaska, generally in the zone between the shorefast ice and mobile pack ice far offshore to feeding areas in the Beaufort Sea (Quakenbush, Small and Citta, 2013; Allen and Angliss, 2015). The spring migratory corridor between the Bering Strait and Cape Bathurst in the Amundsen Gulf (Canada) has been relatively distinct and consistent over time (Quakenbush, Small and Citta, 2013).

During the summer, bowhead whales feed throughout the Beaufort Sea. Historically they have largely aggregated in the Canadian Beaufort Sea and Barrow Canyon (U.S.) in deep water, where upwellings concentrate prey species, although some whales remain in the eastern Chukchi and western Beaufort seas (Ireland et al., 2009; Clarke et al., 2011a; Quakenbush, Small and Citta, 2013). However, in the last several years there has been a change in areas used by bowheads for feeding to nearshore, shallow regions (Clarke et al., 2015a). This shift may have occurred because of changes in food availability for the whales associated with changes in wind patterns and oceanic upwelling (Citta et al., 2015; Clarke et al., 2015a).

Fall migration takes place in pulses or aggregations of whales out of the Beaufort Sea (Moore and Reeves, 1993). Iñupiat whalers report that smaller whales precede large adults and cow-calf pairs on the fall migration (Braham, Krogman, and Carroll, 1984, as reported in Moore and Reeves, 1993). Satellite tagging of bowhead whales between 2006 and 2012 showed that the fall migratory corridor between Hershel Island (Canada) and Point Barrow (Alaska) has been relatively distinct and consistent over time (Quakenbush, Small and Citta, 2013). However, the fall migratory corridor between Point Barrow and the Bering Strait is more variable (Quakenbush, Small and Citta, 2013). This may be related to prey availability, which is also related to the timing of whale movements.

Fall migrating whales typically reach Cross Island in September and October, although some whales might arrive as early as late August. Satellite tracking data (Quakenbush, Small, and Citta, 2010; 2013) from 2006 to 2012 and passive acoustic monitoring (Moore, Stafford, and Munger, 2010) indicated most bowhead whales pass Point Barrow in September and October. After passing Point Barrow, the migration paths of individual bowhead whales fan out across the Chukchi Sea with some heading towards Wrangel Island (Russia) and then the coastal waters of Chukotka (Russia) where it is believed they feed; others travel across the Chukchi Sea south of Hanna Shoals toward the Russian coast (ADF&G, 2009; Ireland et al., 2009a; Quakenbush, Small and Citta, 2010; 2013; Citta et al., 2012; 2015). After leaving the coastal waters of Chukotka, whales then move south through the Bering Strait to the Bering Sea to winter (ADF&G, 2009; Ireland et al., 2009a; Quakenbush, Small and Citta, 2010; 2013; Citta et al., 2012).

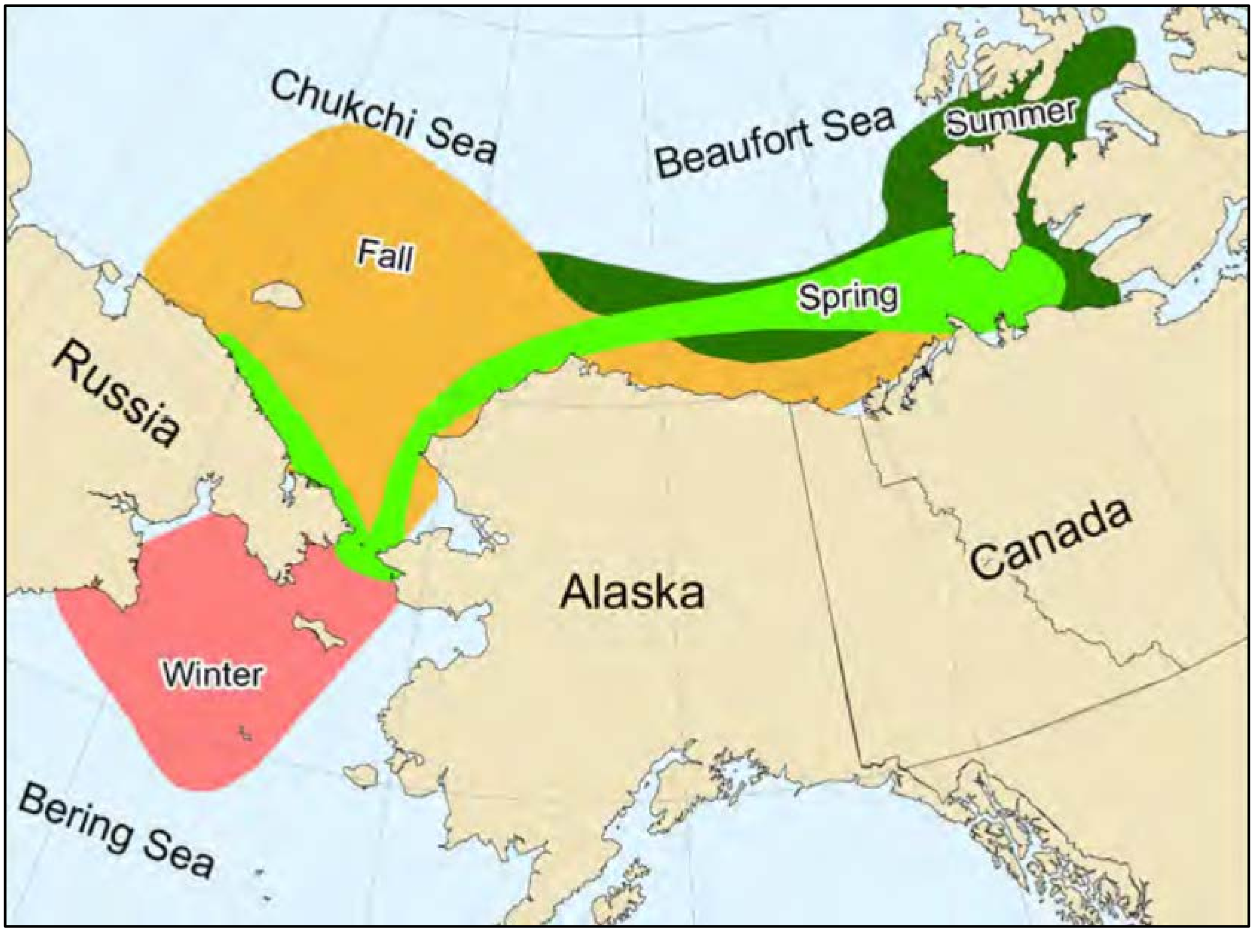

Figure 3-21 Migration Route: Summer and Wintering Areas – Western Arctic Bowhead
Source: Quakenbush, Small and Citta (2013)

In 1997 aerial surveys flown by BPXA near the Proposed Action Area showed that the primary fall migration route of bowhead whales was offshore of barrier islands (BPXA, 1998), outside the Proposed Action Area. No bowheads were seen in the Proposed Action Area; however, a few bowheads were observed in lagoon entrances between the barrier islands and in the lagoons immediately inside the barrier islands.

During the 2014 open-water season, BPXA conducted a 2D HR shallow geohazard survey followed by seabed sonar mapping surveys in the Proposed Action Area. In association with this operation, marine mammal monitoring surveys were conducted. The surveys began on July 16 and were completed by August 30, 2014. During that time, no bowheads were seen in the Proposed Action Area (Smultea et al., 2014). However, bowhead whales were observed during the 2014 ASAMM surveys near the Proposed Action Area seaward of barrier islands on four days during the BPXA surveys: July 20, and August 2, 6, and 17 (Smultea et al., 2014).

BPXA also conducted a marine mammal monitoring survey during their 3D ocean bottom sensor seismic operations in the North Prudhoe Bay area during the 2014 open-water season (July to mid-September). The survey location was in the U.S. Beaufort Sea approximately 30 miles west of the Proposed Action Area. No bowheads were seen during the survey (Lomac-MacNair et al., 2015). However, bowheads were observed during the 2014 ASAMM surveys in the region further from the BPXA survey area (Clarke et al., 2015a).

In 2015, HAK conducted a marine mammal monitoring survey during their shallow geohazard and strudel scour survey operations in the Proposed Action Area during the open-water season.

Observations for marine mammals were conducted from July 9 through July 19, 2015. No observations of bowhead whales were made in Foggy Island Bay during the survey (Cate et al., 2015).

From 1979 to 2015 aerial surveys for marine mammals have occurred annually in the summer and fall in the western Beaufort Sea and are currently known as the ASAMM project, funded by BOEM and conducted by NOAA. ASAMM surveys found most bowhead whales occur offshore, although some animals have been observed in nearshore areas in the past few years (Clarke et al., 2013; 2014; 2015a). However, few were observed near the Proposed Action Area during ASAMM surveys since they began (Figure 3-22).

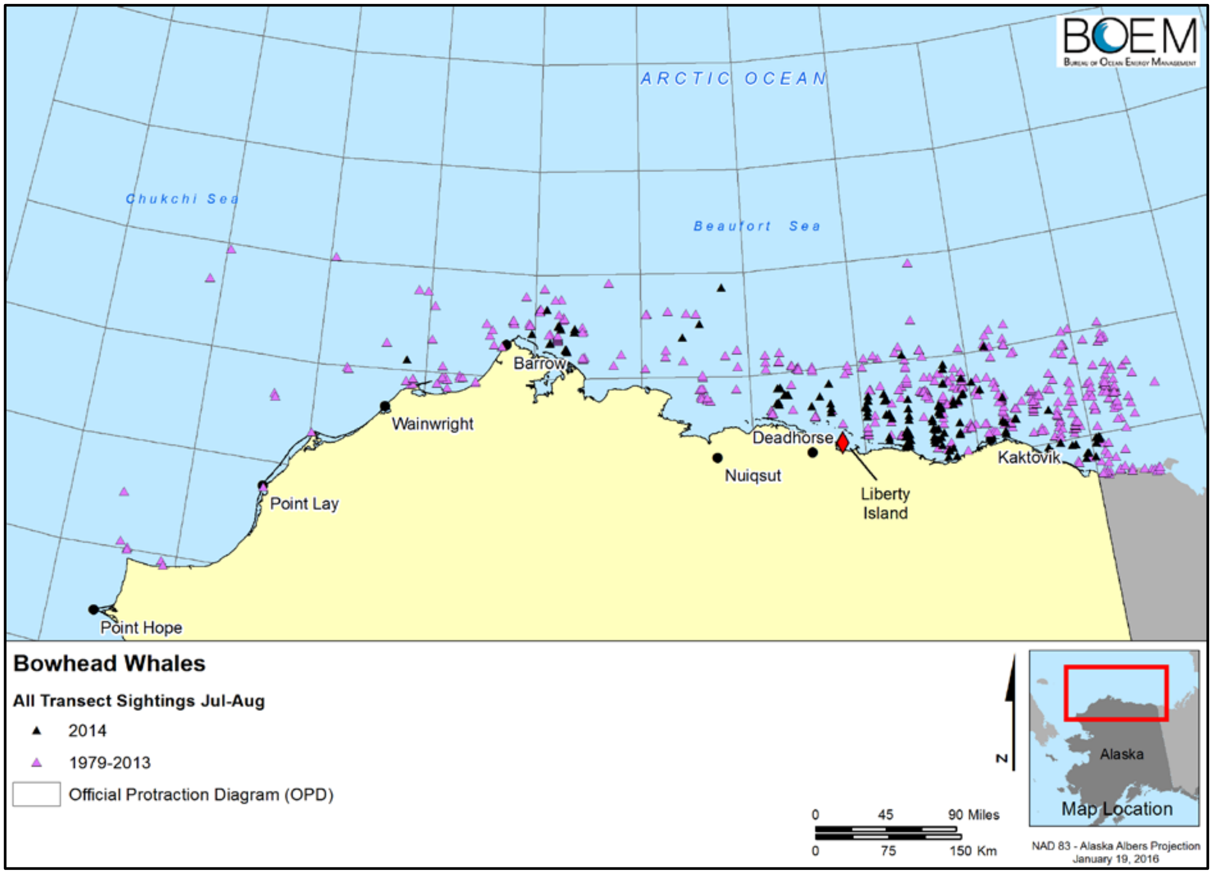

Figure 3-22 ASAMM Bowhead Sightings, U.S. Arctic, July through August, 1979-2014

During the ASAMM 2014 surveys, bowhead whales were seen every month flown (July through October) in the western Beaufort Sea (Clarke et al., 2015a). They were seen in two areas in late July: on the outer continental shelf and slope (167- to 6,562-foot depth) primarily north of Camden Bay, and nearshore east of Point Barrow (Figure 3-23). In August, bowhead whales were observed across the western Beaufort Sea in both outer and inner shelf waters (Figure 3-24). Distribution in September was primarily on the inner shelf (less than 165-foot depth) from approximately 140°W to 157°W, with hundreds of whales observed within 3.1 miles of barrier islands between 146°W and 148.5°W (Figure 3-24). Bowhead whales were seen in very shallow (less than 165-foot depth) nearshore waters of the Alaskan Beaufort Sea between 143°W and 156°W in August and September, including areas in Camden Bay, between Flaxman Island and Oliktok Point, Alaska; in Harrison Bay, Alaska; and between Cape Halkett and Point Barrow (Figure 3-24). In September there was an area of high relative abundance just outside the barrier islands from northeast of Deadhorse to Flaxman Island (Figure 3-24). Bowhead whales were not seen inside barrier islands (Clarke et al., 2015a; Figure 3-24). Bowhead whales in October were observed primarily from 146°W to 157°W; a few whales were seen east of 146°W and several were seen in Barrow Canyon (Figure 3-24). The closest bowheads came to the Proposed Action Area in 2014 was in the fall, north of Foggy Island Bay outside of the barrier islands (Figure 3-23).

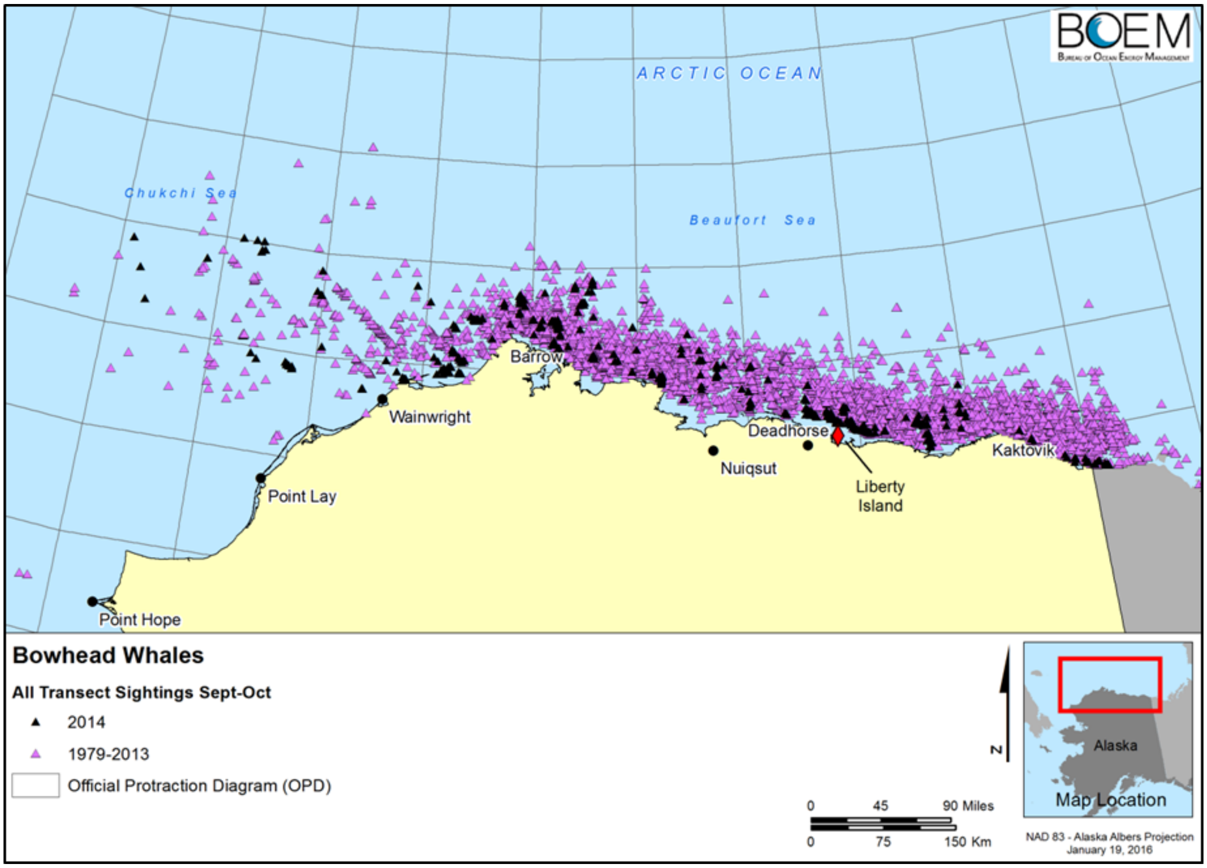

Figure 3-23 ASAMM Bowhead Sightings, U.S. Arctic, September through October 1979-2014

A study to look at core-use areas used by the Western Arctic bowheads between 2006 and 2012 using tagged whales identified six core-use areas but did not identify one within or near the Proposed Action Area (Citta et al., 2015). The nearest core-use area was Point Barrow (Citta et al., 2015).

Kuletz et al. (2015) examined seasonal spatial patterns in seabird and marine mammal distribution in the eastern Chukchi and western Beaufort seas to identify biologically important pelagic areas. To identify marine mammal hotspots, data from the ASAMM surveys from mid-June through late October of 2007 through 2012 were used. They found that the locations of hotspots varied among species but often were located near underwater canyons or over continental shelf features and slopes. Shared hotspots were characterized by strong fronts caused by upwelling and currents, which may have high densities of euphausiids in summer and fall. Bowhead whales were distributed throughout the northeastern Chukchi and western Beaufort seas in both summer and fall but hotspots occurred near Barrow Canyon and along the Beaufort Sea shelf and slope. Relative abundance for bowhead whales was lower and hotspots were distributed farther from shore in summer than in fall. In both seasons, all hotspots were located in the western Beaufort Sea. In summer, hotspots occurred near the mouth of Barrow Canyon, over the outer shelf between Oliktok Point and Prudhoe Bay, and between the 164- and 656-foot isobaths near Demarcation Point. There was one hotspot near shore in Camden Bay, resulting from two sightings of one animal each. In fall, hotspots were grouped over the continental shelf from the mouth of Barrow Canyon to Cape Halkett, north of Oliktok Point, off Point Thomson, and near Demarcation Point. No hotspots were identified in the Proposed Action Area; the closest was over the outer shelf between Oliktok Point and Prudhoe Bay in the summer and off Point Thomson in the fall.

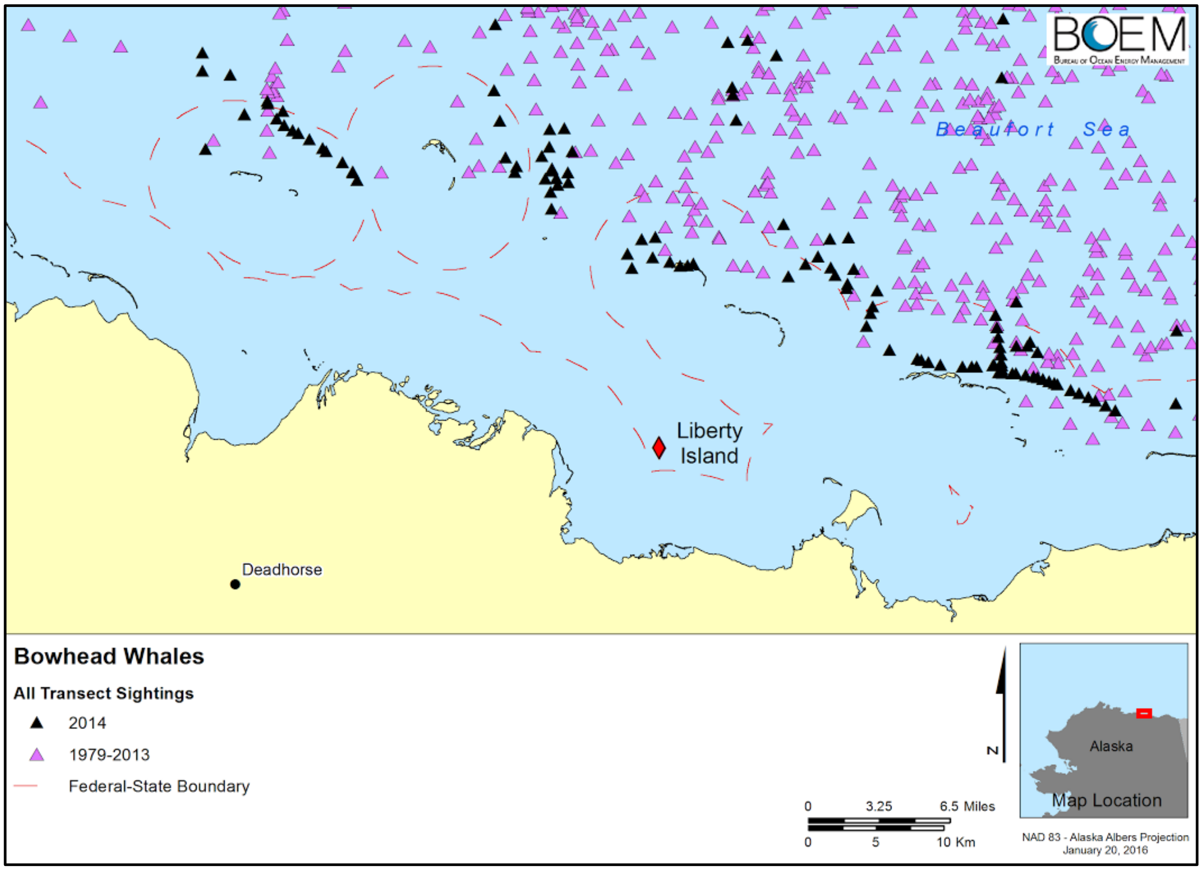

Figure 3-24 Bowhead Whales Seen Near Liberty during ASAMM Surveys 1979-2014

Clarke et al. (2015b) evaluated BIAs for bowheads in the U.S. Arctic region and identified nine. The spring (April through May) migratory corridor BIA for bowheads is far offshore of the Proposed Action Area, while the fall (September through October) migratory corridor BIA (western Beaufort on and north of the shelf) for bowheads is further inshore and closer to the Proposed Action Area but is not within it. Clarke et al. (2015b) also identified four BIAs for bowheads that are important for reproduction and encompassed areas where the majority of bowhead whales identified as calves were observed each season; none of these reproductive BIAs were within the Proposed Action Area and only two BIAs came close. Finally, three bowhead feeding BIAs were identified. Only the September-October feeding BIA (bowheads feeding on the western Beaufort continental shelf, out to approximately the 164-foot isobaths) came close to the Proposed Action Area but did not overlap.

For observations of bowhead whales by Iñupiat whalers near the Proposed Action Area please see Section 3.3.3.

Bowhead whale occurrence in the Proposed Action Area is considered very limited given the barrier islands that separate the Proposed Action from the offshore Beaufort Sea. In addition, the shallow water depths between the barrier islands and the shoreline, especially around the Proposed Action Area, would likely preclude bowhead feeding. From the collective information, few bowhead whales would be expected to be found within the Proposed Action Area.

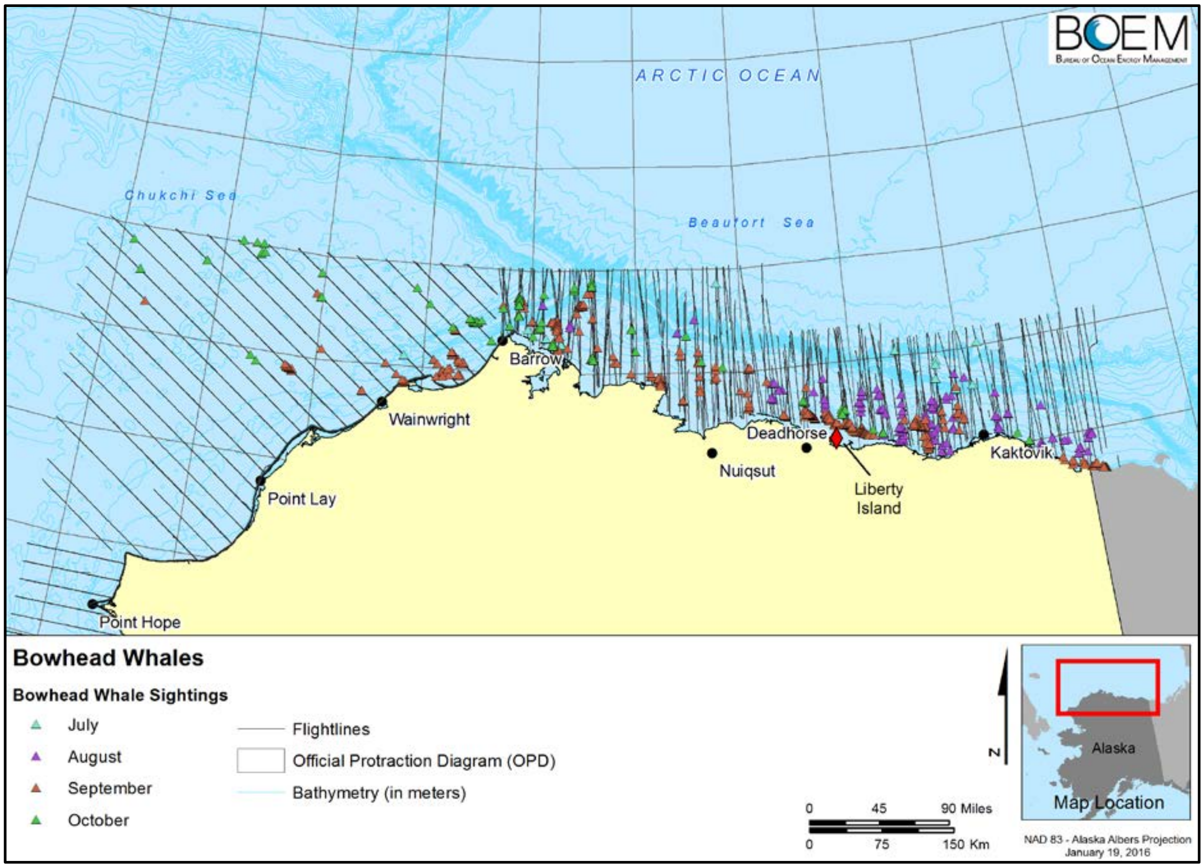

Figure 3-25 Bowhead Whales Seen in the U.S Arctic during 2014 ASAMM Surveys *(plotted by month)*

Life History

Bowhead whales are large baleen whales distinguished by a dark body, white chin, and lack of a dorsal fin. Most mating occurs in late winter and spring in the Bering Sea, although some mating occurs as late as September and early October (Koski et al., 1993; Reese et al., 2001). The conception date and length of gestation (13 to 14 months) suggests that calving is likely to occur in mid-May to mid-June, when whales are between the Bering Strait and Point Barrow (BOEM, 2011). The calving interval is about 3 to 4 years. Juvenile growth is relatively slow. Bowheads reach sexual maturity at about 15 years of age (39 to 46 feet long) (Nerini et al., 1984). Growth for both sexes slows markedly at about 40 to 50 years of age (George et al., 1999). The lifespan of bowhead whales is thought to exceed 100 years (George et al., 1999; George and Bockstoce, 2008). Given the life history of bowhead whales and gestational constraints on minimum calving intervals (e.g., Reese et al., 2001), and assuming that adult survival rates based on aerial photo-ID data (Zeh et al., 2002; Schweder et al., 2009) and age-at-maturity have remained stable, the trend in abundance implies that the population has been experiencing relatively high annual calf and juvenile survival rates. This is consistent with documented observations of native whalers around St. Lawrence Island, who have reported not only catching more pregnant females but also seeing more young whales than during earlier decades (Noongwook, Huntington, and George, 2007). Although the sample size of harvested mature females was small for 2014, the pregnancy rate was consistent with the long-term average of about 33 percent (George et al., 2004; George et al., 2011; Suydam et al., 2015).

Bowhead diving behavior is situational (Stewart, 2002). Calves dive for very short periods and their mothers tend to dive less frequently and for shorter durations. Feeding dives tend to last from 3 to 12 minutes and may extend to the relatively shallow bottom in the Beaufort Sea. “Sounding” dives average between 7 and 14 minutes.

The bowhead whale usually travels alone or in groups of 3 to 4 individuals. However, in 2009, researchers observed 297 individual bowheads aggregated near Point Barrow and a group of 180 were also seen feeding and milling (Clarke et al., 2011b).

The large whales such as bowheads generally produce low-frequency sounds in the tens of Hz to the several kHz band, with a few signals extending above 10 kHz (Southall et al., 2007). Bowhead whales are among the more vocal of the baleen whales (Clark and Johnson, 1984). These sounds appear to serve predominantly social functions (Würsig and Clark, 1993), including reproduction and maintaining contact with offspring (Würsig et al., 1989), but they may also play some role in spatial orientation (Southall et al., 2007). Bowhead whales in western Greenland waters produced songs of an average source level of 185 ±2 dB_{RMS} at 3 feet centered at a frequency of 444 ±48 Hz (Roulin et al., 2012). Given background noise, this allows bowhead whales an active space of 25 to 130 miles (Roulin et al., 2012).

Most bowhead sounds are distinctly different from sounds produced by other marine mammals endemic to the sub-Arctic and Arctic habitats. As a result, monitoring for the occurrence of bowhead sounds is a very effective mechanism for detecting their presence throughout the year (Clark et al., 2015). Bowheads mainly communicate with low frequency sounds. Most underwater calls are at a fairly low frequency and easily audible to the human ear. Vocalization is made up of moans of varying pitch, intensity, and duration, and occasionally higher-frequency screeches. Bowhead calls have been distinguished by Würsig and Clark (1993): pulsed tonal calls, pulsive calls, high frequency calls, low-frequency, and frequency modulated (FM) calls (upsweeps, inflected, downsweeps, and constant frequency calls). However, no direct link between specific bowhead activities and call types was found. Bowhead whales have been noted to produce a series of repeating units of sounds up to 5,000 Hz that are classified as songs, produced primarily by males on the breeding grounds (Delarue, 2011). It appears that bowhead whale singing behavior differs from that of other mysticetes in that multiple songs are sung each year (Johnson et al., 2014).

Bowhead whales have well-developed capabilities for navigation and survival in sea ice. Bowhead whales are thought to use the reverberations of their calls off the undersides of ice floes to help them orient and navigate (Ellison, Clark, and Bishop, 1987; George et al., 1989). This species is well adapted to ice-covered waters and can easily move through extensive areas of nearly solid sea ice cover (Citta et al., 2012). Their skull morphology allows them to break through ice up to 7 inches thick to breathe in ice covered waters (George et al., 1989).

Bowhead whales are grouped among low frequency functional hearing baleen whales (Finneran and Jenkins, 2012, Ciminello et al., 2012; Southall et al., 2007; NMFS, 2016b). Inferring from their vocalizations, bowhead whales should be most sensitive to frequencies between 20 Hz to 5 kHz, with maximum sensitivity between 100 and 500 Hz (Erbe, 2002). Bowhead whale songs have a bandwidth of 20 to 5,000 Hz with the dominant frequency at approximately 500 Hz and duration lasting from 1 minute to hours. Pulsive vocalizations range between 25 and 3,500 Hz and last 0.3 to 7.2 seconds (Clark and Johnson, 1984; Wursig and Clark, 1993; Erbe, 2002). While there is no direct data on hearing in low-frequency cetaceans, the functional hearing range is anticipated to be between 7 Hz to 35 kHz (Watkins, 1986; Au et al., 2006; Southall et al., 2007; Ciminello et al., 2012; Finneran and Jenkins, 2012; NMFS, 2016b).

Bowhead whales appear to have good lateral vision. Recognizing this, whalers approach bowheads from the front or from behind, rather than from the side (Rexford, 1997; Noongwook et al., 2007). In addition, whalers wear white parkas on the ice so that they are not visible to the whales when they surface (Rexford, 1997).

Olfaction may also be important to bowhead whales. Recent research on the olfactory bulb and olfactory receptor genes suggest bowheads not only have a sense of smell, but that it is better developed than in humans (Thewissen et al., 2011). The authors suggest that bowheads may use their sense of smell to find dense aggregations of krill upon which to prey.

Diet and Feeding

Bowheads are filter feeders, filtering prey from the water through baleen (Lowry, 1993). They feed throughout the water column, including bottom feeding as well as surface skim feeding (Würsig et al., 1989). Skim feeding can occur when animals are alone or may occur in coordinated echelons of over a dozen animals (Würsig et al., 1989). Bowhead whales typically spend a high proportion of time on or near the ocean floor. Even when traveling, bowhead whales visit the bottom on a regular basis (Quakenbush et al., 2010). Laidre, Heide-Jorgensen, and Nielsen (2007) and others have identified krill concentrated near the sea bottom and bowhead whales have been observed with mud on heads and bodies and streaming from mouths (Mocklin, 2009).

The most common prey species found in the stomachs of harvested bowheads are small shrimp-like crustaceans such as euphausiids, copepods, mysids, and amphipods (Moore, Stafford, and Munger, 2010; Lowry, Sheffield, and, George, 2004). Euphausiids and copepods are thought to be their primary prey since other crustaceans (isopods [a group of crustaceans that includes woodlice, sea slaters and their relatives] and decapods [a group of crustaceans that includes crayfish, crabs, lobsters, prawns and shrimp]), and fish constitute minor fractions of their stomach contents. Carbon-isotope analysis of bowhead baleen indicates a significant amount of feeding occurs in wintering areas (Schell, Saupe, and Haubenstock, 1987). The stomach contents of one bowhead harvested in the northern Bering Sea indicated that the whale had fed entirely on benthic organisms, predominantly gammarid amphipods and cumaceans (not copepods, euphausiids, or other planktonic organisms) (Hazard and Lowry, 1984).

Concentrations of zooplankton appear necessary for bowhead whales and other baleen whales to feed efficiently to meet energy requirements (Kenney et al., 1986; Lowry, 1993). It is estimated that a 60-ton bowhead whale eats 1.5 tons of krill each day. Estimated rate of consumption is 50,000 individual copepods, each weighing about 0.004 g, per minute of feeding time (BOEM, 2011). George et al. (2015a) found that there has been an overall increase in Western Arctic bowhead whale body condition over the last 25 years. The significant long-term increase in body condition is correlated with reductions in sea ice and other environmental factors, which may be associated with higher production in the Pacific Arctic marine ecosystem favoring increases in water column invertebrates (George et al., 2015a). The abundance of Western Arctic bowheads has also increased markedly over the last 25 years suggesting bowheads may be one of the ‘winners’, at least short-term, in climate change processes because of their feeding habits.

Western Arctic bowhead whales feed in the Chukchi and Beaufort seas but this varies in degree among years, individuals, and areas (see Clark et al 2011a, b, 2012, 2013, 2014, and 2015). It is likely that bowheads feed opportunistically where oceanographic conditions produce locally abundant food (Carroll et al., 1987). Based on decades of ASAMM survey data, other aerial surveys, ice-based observations, passive acoustic monitoring, and satellite telemetry, Clarke et al. (2015b) identified three bowhead feeding BIAs in the U.S. Arctic region: 1) Barrow Canyon in May; 2) Smith Bay to Point Barrow, generally shoreward of the 66-foot isobaths, from August to October; and 3) the western Beaufort continental shelf, out to approximately the 164-foot isobaths, in September to October.

None of the bowhead feeding BIAs are in the Proposed Action Area. Historically, the nearest feeding areas of particular consequence are in the vicinity of Barrow Canyon (Sheldon and Mocklin, 2013) and a small feeding area slightly north of Bodfish Island (Clarke et al., 2012, 2013). However, in the last several years there has been a change in areas used by bowheads for feeding (Clarke et al., 2015a). In 2014, bowhead whales were observed feeding and milling during summer months in the western Beaufort Sea primarily at water depths less than 164 feet, although some feeding whales were recorded in deeper water (328 to 1,640 feet) (Clarke et al., 2015a). Some of these shallow areas, including in Camden Bay and nearshore between Prudhoe Bay and Flaxman Island, are not areas where feeding bowhead whales have commonly been seen in past years (Clarke et al., 2015a). Most (82 percent) of the feeding whales in these areas were within the 66-foot isobath; 52 percent were at less than the 33-foot depth (Clarke et al., 2015a). This shift may have occurred because of changes in food availability for the whales associated with changes in wind patterns and oceanic upwelling (Citta et al., 2015; Clarke et al., 2015a). This trend toward shallow, nearshore feeding by bowhead whales may, at some point in the future, overlap with the Proposed Action Area.

Mortality

From 1964 through the early 1990s, at least 36 unexplained deaths of bowhead whales were reported in Alaska, Norway, Yukon, and Northwest Territories (Philo et al., 1993). Bowhead whales have no known natural enemy other than killer whales. The frequency of attacks by killer whales upon the Western Arctic stock of bowhead whales is assumed to be low but may be increasing (George et al., 1994; George et al, 2015b). Of 195 whales examined from the Alaskan subsistence harvest from 1976 to 1992, only 8 (4.1 percent) had been wounded by killer whales. Also, hunters on St. Lawrence Island found 2 small bowhead whales (less than 30 feet) dead as a result of killer whale attacks (George et al., 1994). A more recent study of bowhead found that of 378 bowheads harvested by Alaska Native Peoples between 1990 and 2012, 30 whales (7.9 percent) had scarring “rake marks” consistent with killer whale injuries and another 10 had possible injuries. Plus, in 2013 a stranded bowhead was confirmed killed by an orca 30 miles south of Point Barrow and another stranded bowhead was suspected killed by an orca in the fall of 2015 (North Slope Borough, 2015). Most bowheads over 56 feet show evidence of killer whale predation attempts, particularly in the decade since 2002. Only 1 to 2 percent of small bowheads showed such injuries probably because most young animals have less ‘exposure’ time to killer whales compared to adults plus calves that are attacked are more likely to be killed.

George et al. (2015b) found killer whale attacks on bowheads in Alaska were statistically more frequent from 2002 to 2012. This increase is also consistent with findings on Eastern Canada-Western Greenland bowheads by Reinhart et al. (2013) indicating a dramatic increase in rake marks on bowhead from 1986 to 2012 where 10.2 percent of bowhead whales bore rake marks from killer whales. Reasons for this increase might include better reporting and/or sampling bias, increase in killer whale population size, an increase in occurrence of killer whales at high latitudes (Clarke et al., 2013), and a longer open-water period offering more opportunities to attack bowheads (George et al., 2015b).

Bowhead whales have been targeted by subsistence whaling for at least 2,000 years (Stoker and Krupnik, 1993). Subsistence harvest is regulated by quotas set by the IWC and allocated by the Alaska Eskimo Whaling Commission (AEWC). Bowhead whales are harvested by Alaska Native Peoples in the Beaufort, Bering, and Chukchi seas. Alaska Native subsistence hunters take approximately 0.1 to 0.5 percent of the population per annum, primarily from 11 Alaska communities (Philo, Shotts, and George, 1993; Suydam et al., 2011).

Inuit peoples in Canada and Russia are also known to take whales from this stock. Hunters from the western Canadian Arctic community of Aklavik harvested one whale in 1991 and one in 1996. Twelve whales were harvested by Russian subsistence hunters between 1999 and 2005 (Allen et al., 2014). No catches for Western Arctic bowheads were reported by either Canadian or Russian hunters for 2006 to 2007 or by Russia in 2009, but two bowheads were taken in Russia in 2008, and in 2010 (IWC, 2012; Allen et al., 2014). In 2014, 38 bowheads were landed by Alaska Native Peoples, which is similar to the average (41.6) for the previous 10 years (2004 to 2013) (Suydam et al., 2015).

Some additional mortality may be due to human-induced injuries, including embedded shrapnel and harpoon heads from hunting attempts, rope and net entanglement in harpoon lines, and entanglement in commercial fishing gear (Philo, Shotts, and George, 1993; George et al., 2015). Several cases of rope or net entanglement have been reported from whales taken in the subsistence hunt (Philo, Shotts, and George, 1993). There are no observer program records of bowhead whale mortality incidental to commercial fisheries in Alaska. However, some bowhead whales have historically had interactions with crab pot gear. From 1993 to 2012, there have been at least 14 reports of bowheads actively entangled with man-made line and/or commercial fishing gear attached; 7 were stranded dead, 4 were seen swimming, and 3 were harvested for subsistence (George et al., 2015b; Sheffield et al., 2016). At least 4 of these entanglement events were confirmed as commercial pot gear. NMFS Alaska Region stranding reports also document 3 bowhead whale entanglements between 2001 and 2005. In 2003, a bowhead whale was found dead in Bristol Bay entangled in line around the peduncle and both flippers; the origin of the line remains unknown. In 2004, a bowhead whale near Point Barrow was observed with fishing net and line around the head. A dead bowhead whale found floating in Kotzebue Sound in July 2010 was entangled in crab pot gear similar to that used in the Bering Sea crab fishery (Allen and Angliss, 2015). During the 2011 spring aerial survey of bowhead near Point Barrow, 1 entangled bowhead was photographed (Mocklin et al., 2012).

George et al. (2015b) found 12 percent of bowheads harvested between 1990 and 2012 showed entanglement scars from fishing gear. The frequency of entanglement scars was highly correlated with body length—about 50 percent of large bowheads (more than 56 feet) exhibit gear scars while whales less than 30 feet rarely showed such scars. In the George et al., (2015b) study, male bowhead whales had significantly higher rates of line entanglement scars than females. That higher entanglement scar rate may be due to their observed greater longevity and therefore prolonged exposure to entanglement risk. It is thought most of these entanglement scars are from fishing/crab gear, probably from the Bering Sea.

Bowhead whales are among the slowest moving of whales, which may make them particularly susceptible to ship strikes, although records of strikes on bowhead whales are rare (Laist et al., 2001; George et al., 2015b). About 2 percent of the bowhead whales taken by Alaskan Natives bore scars from ship strikes (George et al., 2015b). Few whales showing scars from ship strikes may be due to relatively low levels of commercial ship traffic in the Pacific Arctic, and/or these types of injuries may result in higher mortality. Until recently, few large ships have passed through most of the bowhead whale’s range, but this situation may be changing as northern sea routes become more navigable with the decline in sea ice. This increase in vessel presence could result in an increased number of vessel collisions with bowhead whales.

Climate Change

Climate change is a major concern for bowhead whales, as it is for other Arctic marine mammals. Climate projections show a pronounced warming over the Arctic, with accelerated sea ice losses as described in Section 3.1.6 with some of the greatest changes occurring in the Beaufort Sea. Laidre et al. (2008) concluded bowhead whales are moderately sensitive to climate, while George et al. (2006) found bowhead body condition was better in years having light sea ice cover. Collectively this information, along with the growing bowhead population, and good calf production, suggests a resilience or possible affinity to longer open water seasons with less sea ice.

If ocean acidification and sea ice losses shift the Beaufort Sea to more of a pelagic system, there may be an increase in fishes or other prey species in the water column where bowheads mostly feed. Such conditions could favor bowhead feeding, and overall health; however, longer periods of time with less sea ice might eventually open the Beaufort Sea to incursions by killer whales which could prey on bowheads. Considering the numbers of killer whales observed in the Chukchi Sea to date, most likely the killer whale predation would not have a profound numerical impact on bowhead whales as long as the population size of the stock remains high.

Another potential benefit of decreasing sea ice cover in the Beaufort Sea could include emigration of individual whales from the bowhead population in the Beaufort Sea to populations in the Atlantic, which are much smaller. Such events could add needed genetic diversity to other bowhead whale stocks without risk to the Western Arctic stock of bowhead whales.

The spread of disease and parasites has also been suggested as a potential threat to Arctic marine mammals by such emigration/immigration events, abetted by sea ice losses, but only in a general context. The true potential for the spread of pathogens between different stocks of bowhead whales remains speculative.

3.2.4.2.3 Gray Whale

Population and Status

There are currently two formally recognized North Pacific populations of gray whales: the Western Pacific subpopulation (also known as the Western North Pacific [WNP] or the Korean-Okhotsk population) that is critically endangered according to the IUCN Red Book but shows signs of slow recovery, and the Eastern Pacific population (also known as the Eastern North Pacific [ENP] or the California-Chukchi population) which has recovered from exploitation (whaling) after more than 70 years of protection and was removed from listing under the ESA in 1994 (Swartz , Taylor, and Rugh, 2006). Gray whales from the ENP are the only ones that may be seen in the Proposed Action Area (Carretta et al., 2015).

Recent abundance estimates for the ENP gray whale population have ranged between 17,000 and 20,000 (Swartz, Taylor, and Rugh, 2006; Rugh et al., 2008; Punt and Wade, 2012). For stock assessment purposes, NMFS currently uses a minimum population estimate of 20,990 animals (Carretta et al., 2017). Between 1999 and 2000, an unusually large number of gray whales stranded along the coast from Mexico to Alaska (Gulland et al., 2005), and many scientists thought the population had reached carrying capacity. In spite of this, the ENP population appears to be generally increasing, and Carretta et al. (2014) reported that the ENP gray whale population has now recovered to levels seen prior to the Unusual Mortality Event (UME) of 1999 to 2000.

Distribution

Most of the ENP stock of gray whales spends its summer feeding in the northwestern Bering Sea, and in the Chukchi Sea (Rice and Wolman, 1971; Berzin, 1984; Nerini, 1984), migrating to winter and calve in the waters of Baja California. Gray whales prefer areas with little or no ice cover and spend most of their time in water less than 200 feet deep (Moore and DeMaster, 1997).

The ENP stock migrates along the U.S. west coast on both their northward and southward migration. This species makes the longest annual migration of any mammal; 9,321 to 12,427 miles roundtrip (Jefferson, Webber, and Pitman, 2008; Jones and Swartz, 2009). The migration connects summer Arctic and north Pacific feeding grounds with winter mating and calving regions in temperate and subtropical coastal waters. Winter grounds extend from central California south along Baja California, the Gulf of California, and the mainland coast of Mexico.

Gray whale migration along the U.S. west coast can be loosely categorized into three phases (Rugh, Shelden, and Schulman-Janiger, 2001; 2008). Beginning in the fall, whales start the southward migration from summer feeding areas to winter calving areas. The southbound phase includes all age classes as they migrate primarily to the nearshore waters and lagoons of Baja, Mexico, mainly following the coast, and occurs from October through March. The southbound trip averages two months in length. The northward migration to the feeding grounds occurs in two phases. The first phase consists mainly of adults and juveniles that lead the beginning of the northbound migration from late January through July, peaking in April through July. Newly pregnant females go first to maximize feeding time, followed by adult females and males, then juveniles (Jones and Swartz, 2009). The second phase consists primarily of cow-calf pairs which begin their northward migration later (February to July) remaining on the breeding grounds longer to allow calves to strengthen and rapidly increase in size before the northward migration (Jones and Swartz, 2009; Herzing and Mate, 1984).

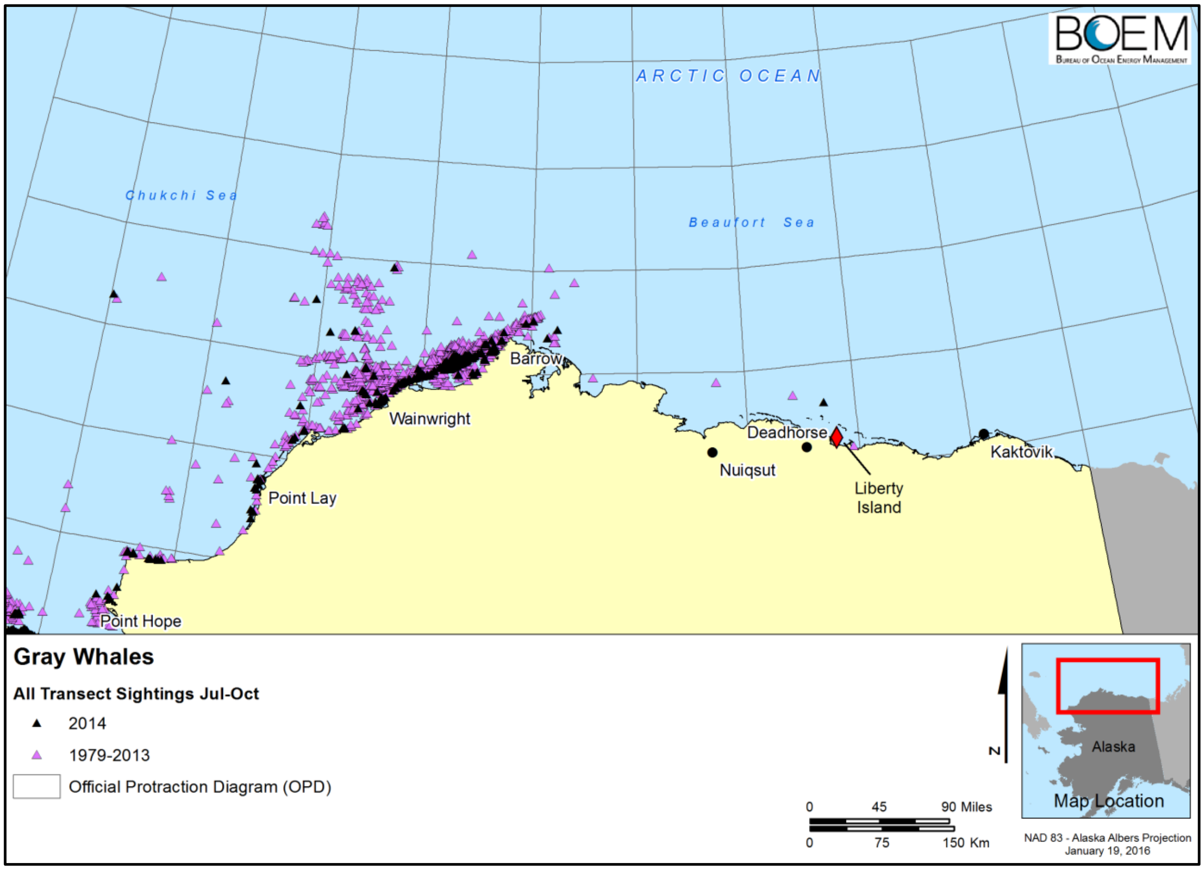

Figure 3-26 Gray Whales Seen in the U.S. Arctic during ASAMM Surveys 1979-2014

Gray whales are generalist feeders mostly foraging on benthic prey in shallow continental shelf waters. The narrow continental shelf in the Beaufort Sea provides suboptimal feeding habitat for large numbers of gray whales, hence their presence in the Beaufort is very low east of Barrow Canyon; they rarely venture past 155.8ºW (Clarke et al., 2015a).

During marine mammal monitoring associated with exploration activities around the Hammerhead and Torpedo ARCO drilling sites, Hall et al. (1994) found several gray whales north west of Camden Bay about 13-25 miles from the coast.

During the 2014 open water season, BPXA conducted a 2D HR shallow geohazard survey followed by seabed sonar mapping survey in the Proposed Action Area. In association with this operation, marine mammal monitoring surveys were conducted. The surveys began on 16 July and were completed by 30 August 2014. No grey whales were seen in the survey area (Smultea et al., 2014).

BPXA also conducted a marine mammal monitoring survey during their 3D ocean bottom sensor seismic operations in the North Prudhoe Bay area during the 2014 open-water season (beginning July to mid-September). The survey location was approximately 30 miles west of the Proposed Action Area. Again, no grey whales were seen during the survey (Lomac-MacNair et al., 2015).

In 2015, HAK conducted a marine mammal monitoring survey during their shallow geohazard and strudel scour survey operations in the Proposed Action Area during the open-water season.

Observations for marine mammals were conducted July 9 through July 19, 2015. No observations of gray whales were made during the survey (Cate et al., 2015).

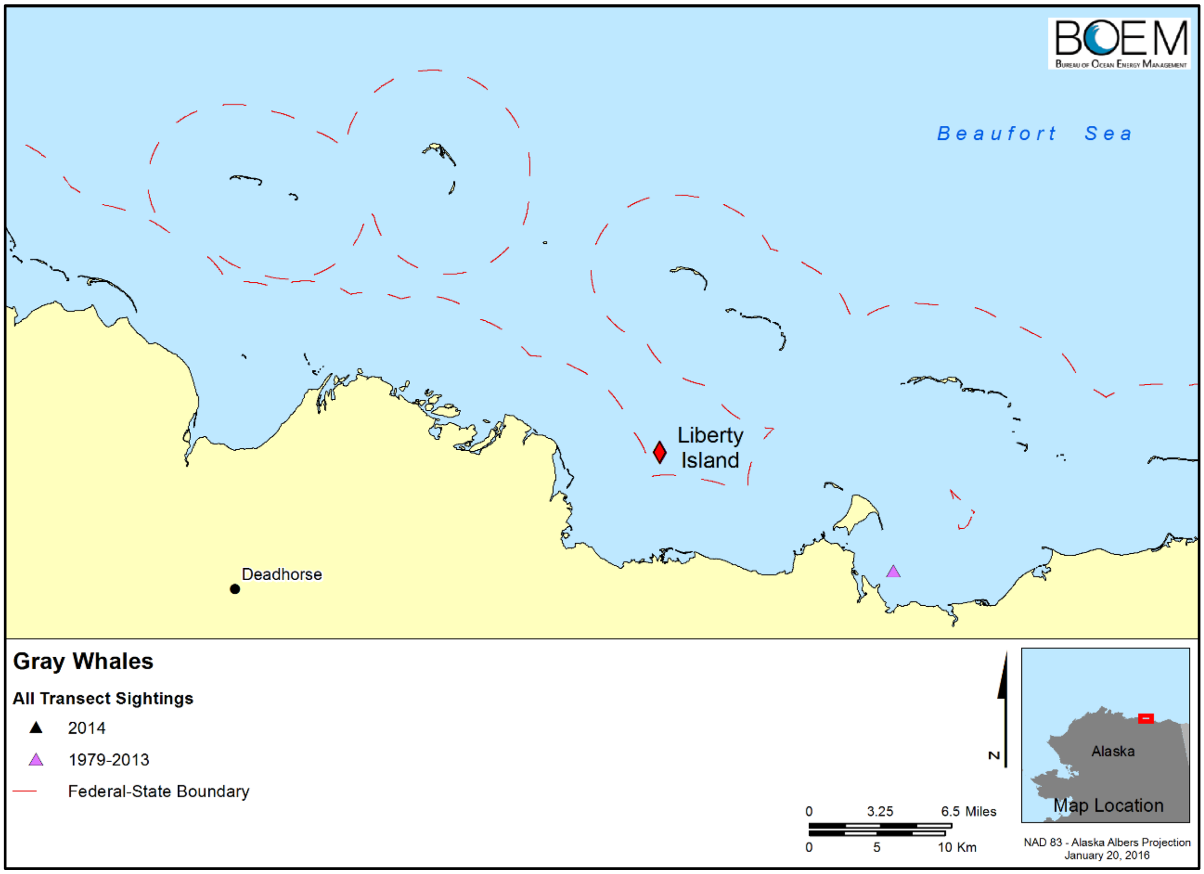

Figure 3-27 Gray Whales Seen near Liberty during ASAMM Surveys 1979-2014

Aerial surveys for marine mammals have occurred annually in the summer and fall in the western Beaufort Sea from 1979-2015; these are currently known as the ASAMM project, which is funded by BOEM and conducted by NOAA. ASAMM surveys have documented that gray whale distribution commonly extends eastward to 155.8ºW. Few whales have been sighted by ASAMM in the Beaufort Sea (Figure 3-26). The easternmost live gray whale sighting by ASAMM occurred in 2014 (Figure 3-26 and Figure 3-27); it was observed swimming nearshore, immediately north of Cross Island (147.9ºW; over 20 miles northwest of Foggy Island Bay and the Proposed Action Area, about 300 kilometers east of their normal range (Clarke et al., 2015a). The remaining gray whale sightings in the Beaufort Sea have occurred since 1997 and total 20 whales (Clarke et al., 2015a). Those sightings occurred offshore in Barrow Canyon, north of Dease Inlet, at the mouth of Smith Bay, north of Harrison Bay, and north of Gwydyr Bay. Most Beaufort gray whales were swimming, resting, diving, or milling, although five gray whales were feeding (Clarke et al., 2015a). None were seen alive in the Proposed Action Area although a dead gray whale was located in 1988 just to the south of Tigvariak Island.

One gray whale was taken by hunters at Cross Island in 1933 (Maher, 1960). One gray whale was sighted just west of Barter Island in the fall of 1997 (Marquette and Braham, 1980). Six gray whales have been sighted in the Canadian Beaufort Sea; three in 1980 during extensive aerial surveys for bowheads whales (Rugh and Fraker, 1981) and three in 2014 during a research cruise (Clarke et al., 2015a). One female gray was tagged with a tracking device near Atkinson Point in September 2009; this whale traveled west across the Beaufort Sea (Quakenbush, Small and Citta, 2013).

Kuletz et al. (2015) examined seasonal spatial patterns in seabird and marine mammal distribution in the eastern Chukchi and western Beaufort seas to identify biologically important pelagic areas. To identify marine mammal hotspots, data from the ASAMM surveys from mid-June through late October of 2007 to 2012 were used. They found that the locations of hotspots varied among species but often were located near underwater canyons or over continental shelf features and slopes. Shared hotspots were characterized by strong fronts caused by upwelling and currents, which may have high densities of euphausiids in summer and fall. Gray whales were distributed throughout the northeastern Chukchi Sea and into the western Beaufort Sea only as far east as Dease Inlet. In both summer and fall, high relative abundance and hotspots occurred in the nearshore zone from near Wainwright to the mouth of Barrow Canyon. In fall, additional hotspots occurred in Hope Basin. No hotspots were identified close to or in the Proposed Action Area.

Clarke et al. (2015b) evaluated BIAs for gray whales in the U.S. Arctic region and identified two; one for feeding and one for reproduction both in the Chukchi Sea. No BIAs were identified for gray whales in the Beaufort Sea.

The occurrence of gray whales in the Beaufort Sea is not new and does not seem to be a range expansion; however, because gray whales are opportunistic feeders, their distribution and density in the Beaufort Sea may change in the future if foraging habits shift. To date, there have been no sightings of gray whales in the Proposed Action Area. From the collective information documenting only a handful of gray whales in the Beaufort Sea and the shallow water depths and substrate (i.e. Boulder Patch) of the Proposed Action Area, it is unlikely gray whales would be found within the Proposed Action Area.

Life History

Gray whales can grow to about 50 feet long, and weigh approximately 80,000 pounds. Females are slightly larger than males. The average and maximum life span of gray whales is difficult to ascertain although one female was estimated at 75 to 80 years old after death (Jones and Swartz, 2002). Gray whales become sexually mature between 6 and 12 years, at an average of 8 years old. Female gray whales usually give birth every 2 to 3 years. Females give birth to a single calf after 12 to 13 months of gestation. Newborn calves are approximately 14 to 16 feet long, and weigh about 2,000 pounds. Calves are weaned at about 8 months, after they have journeyed with their mothers back to the northern feeding grounds. Calves are born dark gray and lighten as they age to brownish-gray or light gray.

Gray whales are frequently observed traveling alone or in small, unstable groups, although large aggregations may be seen on feeding and breeding grounds. Similar to other baleen whales, long-term bonds between individuals are rare. Feeding gray whales are usually alone or in small groups but normally in near proximity to relatively high numbers (10s to 100s) of foraging conspecifics. Feeding behavior is often characterized by predictable surface-dive-respiration patterns.

The large whales, such as grays, generally produce low-frequency sounds in the tens of Hz to the several kHz band, with a few signals extending above 10 kHz (Southall et al., 2007). These sounds appear to serve predominantly social functions, including reproduction and maintaining contact, but they may also play some role in spatial orientation (Southall et al., 2007) and a boxcar frequency range of 7 Hz to 35 kHz (Finneran and Jenkins, 2012, Ciminello et al., 2012; NMFS 2016b). Gray whales are not typically known for making a wide range of sounds, but they do make some fairly simple vocalizations. Their calls are described as knocks, grunts, and pulses (Fish, Sumich, and Lingle, 1974; Edds-Walton, 1997). As many as seven different kinds of sounds are produced by gray whales, ranging from less than 100 Hz to more than 3,000 Hz. However, most of them are concentrated between about 300 and 900 Hz (Fish, Sumich, and Lingle, 1974; Edds-Walton, 1997). The hollow-sounding knocking sounds, most commonly recorded on summer feeding grounds, are relatively quiet compared with some of the sounds produced by other baleen whales. Pulses may be repeated in series of 2 to 30 and are more common during the winter when the whales are breeding and most vocal. Individual gray whales may be able to communicate with one another with their low frequency calls over distances of a mile or more.

Gray whales are grouped in the low-frequency cetacean hearing group with an estimated auditory bandwidth of between 7 Hz to 22 kHz (Southall et al., 2007) and a boxcar frequency range of 5 Hz to 30 kHz (Finneran and Jenkins, 2012, Ciminello et al., 2012). There is contrasting data on what frequencies gray whales are most sensitive to. Gray whale hearing may be better at 3 kHz, 6 kHz, and 9 kHz than at lower frequencies (Ridgeway and Carder, 2001). However, behavioral data for free-ranging gray whales in breeding lagoons suggests they are most sensitive to tones between 800 Hz and 1,500 Hz (Dahlheim and Ljungblad, 1990).

The visual acuity of the gray whale is a little worse than, but comparable to, that in some other cetaceans like minke whale and common bottlenose dolphin, and close to that in harbor porpoise (Mass and Supin, 1997). This suggests that visual abilities of the gray whale are comparable with those of dolphins which actively use their vision and demonstrate fine image recognition (Mass and Supin, 1997).

Diet and Feeding

Gray whales are opportunist and generalist feeders (Dunham and Duffus, 2001; Feyrer and Duffus, 2011) that are primarily restricted to shallow continental shelf waters for bottom foraging. Their primary prey include swarming mysids, tube-dwelling amphipods, and polychaete worms in the Bering and Chukchi seas, but they also consume red crabs, baitfish, and other food (crab and fish larvae, amphipods, fish eggs, cephalopods, megalops, etc.) (Reilly et al., 2008). Nelson et al. (1993) noted that in the Chukchi Sea, within areas where gray whales were observed feeding off Wainwright, amphipod species observed included *Ampelisca macrocephala*, *A. estrichti*, *Byblis gaimardi*, *Aty1us bruggeni*, *Ischyrocerus*, *Protomedeia spp.*, *Grandifoxus*, and *Erichthonius*, with amphipods comprising 24 percent of the biomass (Feder et al., 1989).

Gray whales tend to use recurring feeding areas in Alaska. Primary feeding areas include the eastern Chukchi, some shoal areas, and the western Chukchi from Wrangel Island to the Bering Strait, but they may be found throughout the Chukchi Sea in shallow waters over the continental shelf. Stoker (1990) studied one of the gray whale high-use areas—the central Chirikov Basin between St. Lawrence Island and the Bering Strait—and found gray whales disturb at least 6 percent of the benthos each summer while consuming more than 10 percent of the yearly amphipod production. Gray whale feeding areas offshore of northern Alaska are characterized by low species diversity, high biomass, and the highest secondary production rates reported for any extensive benthic community (Rugh et al., 1999). According to Highsmith and Coyle (1992), gray whales rely on rich benthic amphipod populations in the Bering and Chukchi seas to renew fat resources needed to sustain them during their winter migration to and from Baja California.

ASAMM aerial surveys conducted annually during open-water season in the Beaufort and Chukchi seas have documented a gray whale foraging hotspot in the northeastern Chukchi Sea that typically extends from Icy Cape to Point Barrow shoreward of Barrow Canyon on the continental shelf (Clarke et al., 2015a). However, since gray whales are rarely seen in the Beaufort Sea, no feeding areas have been identified there.

At this time, the narrow continental shelf in the Beaufort Sea provides suboptimal feeding habitat for large numbers of gray whales (Clarke et al., 2015a). However, benthic-dominated ecosystems of the Bering and Chukchi seas may become pelagic-dominated as global climate change continues and multi-year sea ice continues to melt (Grebmeier et al., 2006). As these changes occur, gray whales, with their flexible foraging strategy, may shift their foraging habits and habitats to continue to target the most abundant and dense food sources as they did during the Pleistocene (Pyenson and Lindberg, 2011). It is possible more gray whales would travel to the Beaufort Sea to take advantage of new prey resources in the future.

Mortality

Predation by killer whales on gray whales has been recognized for some time: for example, Rice and Wolman (1971) noted that 18 percent of gray whales examined at a California whaling station showed evidence of being attacked by killer whales. Jefferson, Stacey, and Baird (1991) and Ford and Reeves (2008) summarized numerous accounts of gray whales being attacked and sometimes killed by killer whales. Most of these attacks occurred on the northbound gray whale migration and were concentrated in California near Monterey Bay and on the west coast of Vancouver Island. Matkin et al. (2007) found the diet of transient killer whales in the eastern Aleutians (Alaska) in spring was primarily gray whales as they transited north to their summer feeding grounds. During spring northbound migration of gray whales, Barrett-Lennard et al. (2011) also documented attacks by transient killer whales that aggregate annually as gray whales past Unimak Island, at the western end of the Alaska Peninsula, to their summer feeding grounds in the Bering and Chukchi seas. All gray whales migrating between the Pacific Ocean and Bering Sea pass through the Unimak Island area, where they are vulnerable to predation by the aggregating orcas. Attacks were conducted by groups of three to four killer whales, which attempted to drown their prey. Gray whales generally tried to move into shallow water along the shoreline when attacked; if they succeeded in reaching depths of three meters or less, attacks were abandoned. Kills occurred in waters from 49 to 246 feet deep or were moved into such areas after death. After some hours of feeding, the carcasses were usually left, but were re-visited and fed on by killer whales over several days.

Less is known about killer whale predation on the gray whales' primary feeding areas in the northern Bering and Chukchi seas, although reports by Ljungblad and Moore (1983) and Melnikov and Zagrebin (2005) indicate that it occurs in both areas. In the Bering Sea north of St. Lawrence Island, Alaska, 16 killer whales were observed for 90 minutes as they approached and then chased gray whales (Ljungblad and Moore, 1983). In the coastal waters of Chukota Peninsula, Russia, native peoples recorded killer whales preying on gray whales during the open water season (Melnikov and Zagrebin, 2005). A killer whale predatory attack on a gray whale calf was documented by the Arctic Whale Ecology Study (ARCWEST) near Wainwright in September 2013 (Clarke et al., 2015a).

Most predatory attacks are on gray whale calves or yearlings and are quickly abandoned if calves are aggressively defended by their mothers (Jefferson, Stacey, and Baird, 1991; Ford and Reeves, 2008; Barrett-Lennard et al., 2011). The importance of this predation to gray whales has not been fully evaluated, but there is increasing evidence that predation may be a significant mortality factor. Preliminary estimates suggest predation by transient killer whales may be responsible for mortalities amounting to 35 percent of the average annual calf production of ENP gray whales (Barrett-Lennard et al., 2005), but there is substantial uncertainty about assumptions underpinning this estimate. Nonetheless, as the transient killer whale population continues to expand in the Arctic due to diminishing ice the potential for impact on gray whales is likely to increase.

Gray whales began to receive protection from commercial whaling by the League of Nations in the 1920s, by the government of Mexico, and then later by the IWC at its inception in 1946. However, hunting of the WNP continued for many more years. After changing the status of the recovered species to sustainable harvest, the IWC set annual quotas for gray whale harvests from the ENP for aboriginal subsistence. Subsistence hunters in Russia and the United States have traditionally harvested whales from the ENP stock in the Bering Sea, although only the Russian hunt has persisted in recent years (Huelsbeck, 1988; Reeves, 2002). In 2012, the IWC approved a 6-year quota (2013-2018) of 744 gray whales, with an annual cap of 140, for Russian and U.S. (Makah Indian Tribe in Washington State) native peoples. The U.S and Russia have agreed that the quota will be shared with an average annual harvest of 120 whales by the Russian Chukotka people and 4 whales by the Makah

Indian Tribe. Total takes by the Russian hunt during the past 5 years were 130 in 2008, 116 in 2009, 118 in 2010, 128 in 2011, and 143 in 2012 (Carretta et al., 2015).

Most data on human-caused mortality and serious injury of gray whales are from strandings, including at-sea reports of entangled animals alive or dead (Carretta et al., 2015). Strandings represent only a fraction of actual gray whale deaths (natural or human-caused), as reported by Punt and Wade (2012), who estimated that only 3.9 percent to 13.0 percent of gray whales that die in a given year end up stranding and being reported. From 2008 to 2012 there were 26 human-caused deaths and serious injuries of ENP gray whales from fishery-related and marine debris (Carretta et al., 2015). Although four of these cases were in Alaska, none were in the Arctic. This is unsurprising given the remote locations and also that Alaska gillnet fisheries largely lack observer programs, including those in Bristol Bay known to interact with gray whales.

Ship strikes are also a source of mortality for gray whales. Near shore industrialization and shipping congestion throughout the migratory corridors of the ENP gray whale stock represent risks by increasing the likelihood of exposure to pollutants and ship strikes. From 2008 to 2012 there were 13 ENP gray whale serious injuries and deaths attributed to vessel strikes, none of which were in Alaska (Carretta et al., 2015). Additional mortality from ship strikes probably goes unreported because the whales either do not strand or do not have obvious signs of trauma.

Climate Change

Bluhm and Gradinger (2008) examined the availability of pelagic and benthic prey in the Arctic and concluded that pelagic prey is likely to increase while benthic prey is likely to decrease in response to climate change. Ocean acidification could reduce the abundance of shell-forming organisms (Fabry et al., 2008, Hall-Spencer et al., 2008), many of which are important in the gray whales' diet (Nerini 1984). Bluhm and Gradinger (2008) also noted marine mammal species exhibiting trophic plasticity (such as gray whales which feed on both benthic and pelagic prey) would better adapt to changing Arctic conditions.

Changes in sea ice cover are likely to affect gray whales, most likely through range expansion and the possibility of gray whales recolonizing habitat of the extinct Atlantic gray whale in the Atlantic Ocean (Meade, and Mitchell, 2012; Alter Rynes and Polumbi, 2007). The recent range expansion and continued growth of the Eastern Pacific gray whale stock supports this hypothesis (Rugh et al., 2001), as do separate gray whale sightings in the Mediterranean Sea in 2010 (Scheinin et al., 2011) and off the Namibian coast in 2013 (Elwen and Gridley 2013).

The spread of disease and parasites has also been suggested as a potential threat to Arctic marine mammals by emigration/immigration events between different marine mammal populations, abetted by sea ice losses, but only in a general context.

3.2.4.3 Cetaceans in the Bering and Chukchi Seas

Cetaceans that may be encountered during the limited vessel traffic associated with this project from Dutch Harbor to Foggy Island Bay are described below.

3.2.4.3.1 Blue Whale

Blue whales were listed as endangered under the ESA in 1970 (35 FR 8495, June 2, 1970). Blue whales are listed as endangered on the IUCN Red List of Threatened Animals (IUCN, 2012). They are also protected by the Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora (also known as the Washington Convention) and are listed as “depleted” under the MMPA. Critical habitat has not been designated for blue whales.

Blue whales in the North Pacific probably exist in two sub-populations: the eastern North Pacific and central North Pacific stocks (Muto et al., 2016). In the North Pacific Ocean, blue whales range from

Kamchatka to southern Japan in the west and from the Gulf of Alaska and California south to Costa Rica in the east. They occur primarily south of the Aleutian Islands and the Bering Sea. The Central stock appears to feed in summer in the southwest of Kamchatka, south of the Aleutians, and in the Gulf of Alaska. In winter, they migrate to lower latitudes in the western Pacific and, less frequently, in the central Pacific, including Hawaii.

Blue whales are only present in Alaska waters during their non-breeding season and would be found in the open waters near the Aleutian Islands and the Bering Sea. Blue whales in these waters may be of one of two stocks, the eastern North Pacific or central North Pacific stock (Muto et al., 2016). In the Gulf of Alaska and off the coast of British Columbia, only 15 sightings occurred from 1997 to 2009 (Calambokidis et al., 2009; cited in NMFS, 2011g). Few, unreliable, sightings occurred as far north as the Chukchi Sea. Alaska populations of blue whales are believed to travel north in the spring to access the higher-density zooplankton blooms and south toward Hawaii in the fall to take advantage of warmer waters for breeding (Reeves et al., 1998; NMFS, 2006a). No blue whales are expected in the Beaufort Sea.

Important documents for this species can be found at: http://www.fisheries.noaa.gov/pr/species/mammals/whales/blue-whale.html. They include the recovery plan for the blue whale, published on July 1998 (NMFS, 1998) and the SARs for the Central North Pacific blue whale (NMFS, 2014) and the Eastern North Pacific blue whale (NMFS, 2015). NMFS is also planning to update the recovery plan for the blue whale (77 FR 22760).

In the North Pacific, blue whales prey mainly on *Euphausia pacifica* and secondarily on *Thysanoessa spinifera*. While other prey species, including fish and copepods, may be part of the blue whale diet, these are not likely to contribute significantly.

The most recent estimate for blue whales inhabiting the North Pacific Basin is approximately 2,500 individuals (IWC, 2007).

3.2.4.3.2 Fin Whale

The fin whale population is estimated to have ranged from 42,000 to 45,000 before whaling began (Ohsumi and Wada, 1974). Muto et al. (2017) provides a provisional minimum population estimate of 1,036 for the portion of the Northeast Pacific Stock of fin whales found west and north of the Kenai Peninsula. They are presently listed as endangered under the ESA, and depleted by NMFS (Muto et al., 2017). Though rare, fin whales are widespread throughout temperate oceans of the world and into the Arctic Ocean.

Presently, small numbers of fin whales seasonally inhabit areas within and near the Chukchi Sea, the extreme northern edge of their range, during summer. Based on observations and passive acoustic detection, on direct observations from monitoring and research projects of fin whales by industry, and the federal government, fin whales are considered consistent, but uncommon visitors to the Chukchi Sea during summer (NMFS, 2015b). They were recorded each autumn from 2007 to 2010 using bottom-mounted hydrophones in the Chukchi Sea (Delarue et al., 2013) and in ship surveys in the summer and early fall of 2009, 2012, and 2013 (Aerts et al., 2014). The growing body of such observations suggest they may be re-occupying habitat used prior to their population decimation from commercial whaling. In the Bering Sea, fin whales may be present during summer in greater numbers than in the Chukchi Sea (Muto et al., 2017; Moore et al., 2002; Zerbini et al., 2006).

Although there may be some degree of specialization, most individuals probably prey on both invertebrates (including crustaceans and squid) and fish, depending on availability (Watkins et al., 1984; Edds and Macfarlane, 1987). There appears to be variation in the predominant prey of fin whales in different geographical areas depending on local abundance of prey species (NMFS, 2010). Perry, DeMaster and Silber (1999a: p. 49) reported fin whales “depend to a large extent on the small euphausiids and other zooplankton” and fish. Fin whales aggregate where prey densities are high

(Piatt and Methven, 1992; Moore, Stafford, and Dahlheim, 1998) chiefly in areas with high phytoplankton production and along ocean fronts (Moore, Stafford, and Dahlheim, 1998).

3.2.4.3.3 Humpback Whale (Western North Pacific Stock)

The humpback whale ESA listing final rule (81 FR 62259, 8 September 2016) established 14 Distinct Population Segments (DPSs) with different listing statuses, and among the ESA-listed stocks was the Western North Pacific Stock. Other humpback whale stocks, such as the Central North Pacific Stock and the Mexican Stock, use summer habitat that partially overlaps with summer habitat used by the Western North Pacific Stock, and since NMFS cannot presently manage one portion of an MMPA stock as ESA-listed and another portion of a stock as not ESA-listed, they consider the Western North Pacific Stock to be endangered and depleted for MMPA management purposes (Muto et al., 2017).

Individuals from the Western North Pacific Stock, where the minimum population estimate is 865 individuals, could occur in the Bering Sea and possibly in parts of the Chukchi and Beaufort seas (Muto et al., 2017).

Although once considered extralimital in the area, small numbers of humpback whales seasonally inhabit areas within and near the Chukchi Sea, the extreme northern edge of their range, during the open water period. A few have been observed in the northeastern Chukchi Sea during monitoring for seismic surveys (Funk et al., 2011, Bisson et al., 2013a), during aerial surveys in the Chukchi Sea (Clark et al. 2011a and b, Clarke et al. 2015, Clarke et al. 2017), and during shipboard surveys (Aerts et al., 2011; Aerts et al., 2014). When seen, they usually occur in extremely low numbers.

Humpback whales are general feeders compared to some other baleen whales that may be more selective in their prey. In the Northern Hemisphere, prey includes euphausiids (krill), copepods, juvenile salmonids (*Oncorhynchus spp*.), Arctic cod (*Boreogadus saida),* walleye pollock (*Theragra chalcogramma),* pollock (*Pollachius virens)*, pteropods, and cephalopods (Johnson and Wolman, 1984; Perry, DeMaster, and Silber, 1999b).

3.2.4.3.4 Sperm Whale

Sperm whales (*Physeter microcephalus*) are large odontocete whales that occur in the north Pacific Ocean and into parts of the Bering Sea. They were targeted by illegal Soviet whaling in the latter half of the 20th century (Ivashchenko et al., 2013, 2014) and by the Japanese into the late 1960s (Ivashchenko and Clapham, 2015). Though a reliable abundance estimate for the North Pacific stock is not available, an analysis by Kato and Miyashita (1998) suggested that approximately 102 sperm whales persisted in the western portion of the north Pacific Ocean. They are listed as endangered under the ESA of 1973, and therefore designated as depleted under the MMPA (Muto et al., 2017).

In the North Pacific Ocean, sperm whales are distributed widely, with the northernmost boundary extending from Cape Navarin (62°N) to the Pribilof Islands (Omura, 1955). During summer males are mostly found in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands (Kasuya and Miyashita, 1988, Mizroch and Rice, 2013, Ivashchenko et al., 2014).

Acoustic surveys detected the presence of sperm whales year-round in the Gulf of Alaska, although they appear to be more common in summer than in winter (Mellinger et al., 2004a). These seasonal detections are consistent with the hypothesis that they move to higher latitudes in summer and to lower latitudes in winter (Whitehead and Arnbom, 1987). Sighting surveys conducted by the Alaska Fisheries Science Center’s Marine Mammal Laboratory (MML) from 2001 to 2010 found sperm whales were the most frequently sighted large cetacean in the coastal waters around the central and western Aleutian Islands during the summer (MML, unpubl. data), and acoustic surveys detected them year-round in the Gulf of Alaska, but most often in summer (Mellinger et al., 2004a). Likewise, marking data show extensive movements throughout the North Pacific and along the U.S. west coast into the Gulf of Alaska and Bering Sea/Aleutian Islands region (Muto et al., 2017). Collectively, these data indicate sperm whales could occur in ice-free areas of the Bering Sea, especially during summer. A variety of study results analyzed by NMFS (Muto et al., 2017) concluded at least a portion detected by surveys likely traveled great distances to reach summer feeding areas in the North Pacific Ocean and the Bering Sea.

3.2.4.3.5 Minke Whale

Minke whales could occur in the Bering Sea and Chukchi seas (Muto et al. 2017). Provisional population estimates of up to 2,020 individuals were calculated for the Bering Sea shelf.

Minke whales are believed to be migratory summer residents of the Chukchi and Bering seas, and move south of the Bering Sea to overwinter. A few have been observed in the northeastern Chukchi Sea during monitoring for oil and gas activities (Funk et al., 2011, Bisson et al., 2013a), during aerial surveys in the Chukchi Sea (Clark et al. 2011a and b, Clarke et al. 2015, Clarke et al. 2017), and during shipboard surveys (Aerts et al., 2011; Aerts et al., 2014). Occasional sightings in the Chukchi Sea suggest their presence is less common in the Chukchi than in the Bering Sea. They are believed to be much more common in the Pacific, Indian, and Atlantic oceans.

Minke whales are filter feeders who use lunge-feeding strategies to capture and eat euphuasiids, copepods, sand-lance, and larger schooling fishes such as herring, pollock, and salmon (Guerrero and Peluso, 2018).

3.2.4.3.6 North Pacific Right Whale

North Pacific right whales are considered the rarest of all large whale species and among the rarest of all marine mammal species. They were listed as endangered under the precursor to the ESA in 1970 (35 FR 18319, 1970) as the “northern right whale. The northern right whale was listed as two separate endangered species by NMFS in 2006 (71 FR 38277, 2006) – the North Pacific right whale and the North Atlantic right whale. As these were considered new listings, NMFS designated critical habitat (73 FR 19000, 2008) for the species, as required by the ESA. Because the North Pacific right whale is listed as endangered under the ESA it is, by default, considered depleted under the MMPA. There are two stocks of the North Pacific right whale, western and eastern.

Records of sightings, captures, and strandings show that the North Pacific right whale historically ranged throughout the northern Pacific Ocean, north of latitude 35°N, with important concentrations in the Gulf of Alaska (GOA), eastern Aleutian Islands, southcentral Bering Sea, Okhotsk Sea, and coastal Japan (Braham and Rice, 1984; Clapham et al., 2004; Shelden et al., 2005). The eastern population of North Pacific right whales used major feeding grounds that covered virtually the entire GOA, waters adjacent to the Aleutian Islands, and much of the Bering Sea south of 60°N (Clapham et al., 2004; Scarff, 1986; Shelden et al., 2005).

North Pacific right whales have been observed since 1969 in the summer ranging from the subarctic Bering Sea and Sea of Okhotsk in the north to Hawaii and Baja California in the south (Allen and Angliss, 2011). Sightings that occurred as far south as Hawaii and Mexico are probably extralimital (Brownell et al., 2001). While the current range of North Pacific right whales is likely considerably smaller than their historical range, there have not been sufficient survey efforts throughout their historical range to determine which, if any, areas have been abandoned or not yet rediscovered (Clapham et al., 2004). Acoustic surveys and additional sightings confirm North Pacific right whales in the southeastern Bering Sea from May into December, and in the Gulf of Alaska in August and September (Munger et al. 2003, cited in Clapham et al., 2006; Waite et al., 2003; Mellinger et al., 2004b, cited in Wade et al., 2011). These whales are drawn to areas where prey populations congregate and seem to prefer the middle to outer portion of the continental shelf in water depths between 164 and 262 feet but are also known to be present in deeper waters ranging from 820 to 5,577 feet (Allen and Angliss, 2011).

Right whales are typically found individually or traveling in small slow-moving groups. No calving grounds have been identified for the North Pacific right whale (Scarff, 1986). The species' migratory patterns are also unknown, though seasonal patterns are apparent in historical data, with whales summering in the GOA and Bering Sea (Braham and Rice, 1984; Scarff, 1986; Clapham et al., 2004; Shelden et al., 2005). As noted by Clapham et al. (2006), there are very few winter observations of right whales in the North Pacific.

Critical habitat was designated for the eastern North Pacific right whale in 2008 (73 FR 19000, 2008) within the GOA and Bering Sea. The sole primary constituent element of critical habitat for this species is aggregations of copepods (specifically *Calanus marshallae*, *Neocalanus cristatus*, and *N. plumchris*) and the euphausiid *Thysanoessa raschii*, in areas of the North Pacific Ocean in which eastern North Pacific right whales are known or believed to feed. Critical habitat encompasses two areas designated based on simple geographic coordinates where eastern North Pacific right whales have been consistently sighted in spring and summer, indicating feeding areas with suitable prey densities. Both critical habitat areas are completely within waters of the United States and its Exclusive Economic Zone (EEZ).

3.2.4.4 Ice Seals

3.2.4.4.1 Environmental Perceptions

Sound

Though seals have good low-frequency hearing, they lack the highly developed auditory and sound production abilities of Odontocete cetaceans (Supin et al., 2001). Seals generally depend on vision and tactile senses to locate and capture prey (Reidman, 1990) and avoid hazards. Underwater audiograms for ice seals suggest that they have very little hearing sensitivity below 1 kHz; but hear underwater sounds at frequencies up to 60 kHz; and make calls between 90 Hz and 16 kHz (Richardson et al., 1995a). NMFS (2016b) assessed the audible noise range for phocid seals as occurring between 50 Hz to 86 kHz. Their hearing thresholds for Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS) for impulse and continuous noises are reflected in Table 3-8.

Table 3-8 Impulse and Continuous Noise TTS and PTS Thresholds for Phocid Seals

Noise Type	TTS	PTS
Impulse Noise	212 dB Peak SPL; 170 dB SEL	218 dB Peak SPL; 185 dB SEL
Continuous Noise	199 dB SEL_{cum}	219 dB SEL_{cum}

Source: NMFS (2016b)

Physical

Beyond their acoustic abilities, seals have extremely well-developed, highly innervated facial vibrissae with extremely sensitive active-touch receptors within their facial whisker pads. For example, a single vibrissa of the ringed seal typically contains 10 times the number of nerve fibers in one vibrissa of a land mammal. The vibrissa are structurally distinctive from those of land mammals (Hyvarinen, 1987), and the facial whisker pads of bearded seals have about 1,300 nerve endings associated with each whisker, making them among the most sensitive in the animal kingdom (Marshall et al., 2006, as reported in Burns, 2009). The amount of innervation in the whisker pads of other seal species, however, should vary.

Long and sensitive vibrissae help pinnipeds detect vibrations of prey in the water, permitting them to forage in areas with very poor visibility (Stephens et at. 1973).

Pinniped vibrissae also seem to aid in navigation, such as occurred in an experiment when a spotted seal was blindfolded and was able to consistently surface in the center of a breathing hole in the ice. When the same blindfolded seal had its vibrissae restricted it tended to bump into ice near the breathing hole several times before successfully finding and using the hole (Sonafrank et at. 1983).

Montagna (1967) suggested vibrissae could also serve to gauge a seal's swimming speed though the veracity of this hypothesis has not yet been confirmed.

Vision

As with most marine mammals, seals can see well in air and underwater within certain limits (Supin et al., 2001). Seals have very large orbits with eyes that are very large in relation to their body size, and have strong visual acuity in low-light conditions because of high numbers of rod-shaped receptors that discriminate between light levels (Riedman 1990). In the terrestrial environment, seal eyes function best in bright sunlight when the pupil contracts, at least partially offsetting their nearsightedness (Riedman 1990; Lavigne et al., 1977). Experiments on captive pinnipeds found that they can see almost as well in air as in water under good to moderate lighting conditions (Schusterman and Balliet 1971; Schusterman 1972). The seal's eye, however, remains better adapted for underwater than for aerial vision and a seal's underwater visual acuity is thought to be comparable to that of a cat on land, according to Schusterman (1972).

Olfaction

When underwater, pinniped seals and most other marine mammals lack a sense of smell (their nostrils usually remain tightly closed) and a limited sense of taste. Comprehensive reviews of chemoreception in marine mammals provided by Lowell and Flanigan (1980) and Watkins and Wartzok (1985) support this assumption.

Seals have retained an acute sense of smell out of water since they spend a significant amount of their life cycle out of water and retain a need to detect terrestrial threats (Riedman and Estes 1988). The sense of smell plays an especially important role in social and reproductive events that take place on land among the pinnipeds. Pinnipeds can detect the presence of humans hundreds of feet away by scent, and often slip into the water if a person is upwind. Bearded and ringed seals can scent polar bears, and the presence of polar bears is a determining factor in haul-out selection. When bearded seals haul out onto ice, they typically orient with their noses downwind and their bodies close to the water's edge. Using this orientation, a seal can visually detect a polar bear approaching from the downwind direction, and rely on their olfactory senses to scent polar bears upwind of their location (Kingsley and Stirling 1991). At the first indication a polar bear is nearby, a seal oriented in such a way can quietly slip into the water to safety.

Yet another example of seals using olfaction may be observed among breeding bearded seals, since adult males often investigate a female's anogenital area to determine, presumably by chemoreception, if she is in estrus. The frequent practice of nose-to-nose nuzzling of mothers and pups is also an important means of mutual recognition and of conveying and receiving information via chemoreception (see e.g. Ross, 1972).

3.2.4.5 Bearded Seal

3.2.4.5.1 Population and Status

The Beringia DPS of bearded seals (*Erignathus barbatus nauticus*) occurs in Alaskan waters. They inhabit the Bering, Chukchi, and Beaufort seas and their numbers are considerably higher in the Bering and Chukchi seas than in in the Beaufort Sea, particularly during winter and early spring. In the 2010 status review, Cameron et al. (2010) estimated 125,000 bearded seals occur in the Bering Sea and 27,000 in the Chukchi Sea, with an overall estimate of 155,000 bearded seals in the Beringia DPS.

Ver Hoef et al. (2014) estimated 61,800 bearded seals occurred in the central and eastern Bering Sea during a 2007 survey. Conn et al. (2014) estimated 245,476 to 360,544 bearded seals occurred in the Bering Sea using data from a 2012 to 2013 survey that was more extensive. Both the Ver Hoef et al. (2014) and Conn et al. (2014) estimates were for the Bering Sea only and did not account for seals in the Chukchi or Beaufort seas. Bengtson et al. (2005) conducted surveys in the eastern Chukchi Sea but could not estimate abundance from their data. Early estimates of the Bering-Chukchi seas bearded seal population ranged from 250,000 to 300,000 (Burns, 1981; Popov 1976). More recently Muto et al. (2017) provided a minimum population estimate of 273,676 bearded seals in the U.S. Bering Sea. Considering the narrow amount of shelf habitat suitable for bearded seal occupancy, the numbers of bearded seals using the Beaufort Sea should be lower than what occurs in the Chukchi and Bering seas.

Cameron et al. (2010) developed a rough estimate of 3,150 year-round resident bearded seals in the Beaufort Sea that was uncorrected for submersed seals or seasonal migrants, and around 27,000 year-round resident bearded seals in the Chukchi Sea. Cameron et al. (2010) estimated the maximum density of bearded seals from Prudhoe Bay to the coast south of Kivalina at approximately 0.14 seals per square kilometer (km^2). An indication of low population densities for bearded seals is also suggested by survey results conducted near the Northstar and proposed Liberty Island sites. Aerial surveys at these sites detected 3 to 18 bearded seals and 1,911 to 2,251 ringed seals during spring in 1999 to 2001 (Moulton et al., 2000, 2001, 2003; Moulton and Elliott, 2000). Such a marked difference in the number of observed bearded versus observed ringed seals is believed to be indicative of a small bearded seal population near the Proposed Action Area, and most likely throughout the Beaufort Sea.

NMFS listed the Beringia DPS of bearded seals as threatened under the ESA on December 28, 2012 (77 FR 76740) due to sea ice and snow cover decreases in the foreseeable future which would result in population declines that threaten the survival of the bearded seal. The stock is considered depleted under the MMPA by NMFS and no critical habitat has been designated for them.

3.2.4.5.2 Distribution

Bearded seals have a circumpolar distribution ranging from the Arctic Ocean into the western Pacific (Burns, 1981), associating with pack ice, and only rarely using shorefast ice (Burns and Harbo 1972). In Alaskan waters, bearded seals occur over the continental shelves of the Bering, Chukchi, and Beaufort seas where they feed on benthic prey (Burns, 1981; Kelly, 1988). In winter, most in Alaska occur in the Bering Sea, though smaller numbers of year-round residents remain in the Beaufort and Chukchi seas mostly around lead systems and polynyas. During spring (mid-April to June), most bearded seals in the Bering Sea shift northward through the Bering Strait and into the Chukchi and Beaufort seas in tandem with the melting sea ice. Spring surveys in 1999 and 2000 found that they generally prefer areas of 70 to 90 percent sea ice cover and prefer to remain 20 to 100 nmi from the coast, with a few notable exceptions (Bengtson et al., 2000; Bengtson et al., 2005; Simkins et al., 2003). Since bearded seals mostly feed on benthic invertebrates and demersal fishes, they closely associate with areas less than 656 feet deep (Allen and Angliss, 2015). The core distribution occurs in waters less than 1,640 feet deep, and consequently there are believed to be fewer bearded seals in the Beaufort Sea and near the Proposed Action Area than in the Chukchi or Bering seas since benthic habitat is limited in the Beaufort Sea. Because of the extensive shelf size in the Chukchi Sea, the summer distribution of bearded seals in the Chukchi Sea remains large, and conversely, the narrow shelf in the Beaufort Sea supports fewer, leading to a smaller resident population in the Beaufort Sea. Water depths at the Liberty Site are approximately 19 feet deep and the sea floor is often scoured clean of benthic organisms nearer to shore and away from boulder patches. Moreover, the Proposed Action Area is surrounded by shorefast ice throughout the winter and early spring, and positioned several miles south of any lead systems making it unusable as winter habitat for bearded seals.

Bearded seals are generally solitary, tending to be widely dispersed during winter when sea ice is widespread, however they may also loosely aggregate at biologically important areas such as polynyas, lead systems, and near river mouths during winter. Most are not very selective about the type or quality of ice they use (Fay, 1974), as long as the floes are clean, and are not hummocky or highly compacted (Heptner et al., 1976; Burns and Harbo, 1977), but they usually avoid areas of continuous, thick, shorefast ice and are rarely seen in the vicinity of unbroken, heavy, drifting ice or large areas of multi-year ice. Although they prefer areas with immediate access to areas of open water, they sometimes create breathing holes similar to those of ringed seals, and bearded seals in the Canadian Arctic overwinter in areas of thick fast ice (Smith, 1981), by creating and maintaining breathing holes (Smith, 1981, Cleator and Smith, 1984). Fay (1974) reported that some individuals also use their heads to break holes in ice up to approximately 4 inches thick, and maintain those breathing holes in heavy ice conditions. In late fall and winter, as ice starts forming at the coasts and bays, seals are seen farther out to sea among areas of drifting, broken ice floes, and near open water (Heptner et al., 1976).

In the Beaufort Sea bearded seals are most numerous in shear zones where drifting pack ice interacts with, and grinds away fast ice, creating leads and other openings (Burns and Frost, 1979). The highest densities of bearded seals in the eastern Chukchi Sea in May and June occurs where pack ice areas coincide with high benthic productivity areas (Bengtson et al., 2005). Surveys in the Beaufort Sea indicate they prefer areas with open ice cover and water depths primarily of 82 to 246 feet (Stirling et al., 1977, Stirling et al., 1982), and during summer their preferred habitat is characterized by shallow waters in areas with flowing sea ice mostly with depths approximately 656 feet. Since they mostly feed on benthic organisms, bearded seals' range is also restricted to areas where seasonal sea ice occurs over relatively shallow waters and they may forage on the bottom; and although bearded seals usually associate with sea ice, young seals may be found in ice-free areas such as bays and estuaries (ADF&G, 1994).

In some areas bearded seals use the ice year-round; however, during summer they often use open-water areas in proximity to the ice front (Harwood et al., 2005; Monnett and Treacy, 2005; Kelly, 1988). At this time the most favorable habitat occurs near the widely fragmented margin of the pack ice; although they also are found in nearshore areas of the central and western Beaufort Sea during summer, especially near river mouths.

Adult bearded seals are rarely found onshore, but some adults in the Chukchi and Beaufort seas use haul-out sites ashore in late summer and early autumn until ice floes reappear at the coast (Kovacs, 2002; Burns, 1981; Nelson, 1981; Smith, 1981). However, younger bearded seals may haul out on the shorelines, spits, and islands in lagoon river systems in some areas near Wainwright, Alaska (Nelson 1981), and on islands near Point Barrow, Alaska (W. Adams, North Slope Borough, Department of Wildlife Management, July 14, 2010, pers. comm.; as reported in Cameron et al., 2010). In many of these locations, sea ice either melts completely or recedes beyond the limits of shallow waters where seals must feed (Burns and Frost, 1979, Burns, 1981).

On December 28, 2012, NMFS listed the Beringia DPS of bearded seals as threatened under the ESA (77 FR 76740) due to sea ice and snow cover decreases in the foreseeable future which would result in population declines that threaten the survival of the bearded seal. On July 25, 2014, the U.S. District Court for the District of Alaska issued a decision vacating the listing of the Beringia DPS of bearded seals as threatened. On October 24, 2016, the U.S. Court of Appeals for the Ninth Circuit reversed the judgment of the District Court. On February 22, 2017, the Ninth Circuit denied a petition for rehearing en banc. On May 12, 2017, the District Court entered final judgment wherein the Beringia DPS of bearded seals remains threatened under the ESA. The stock is also considered depleted under the MMPA by NMFS. Critical habitat has not been designated for the Beringia DPS of bearded seal.

3.2.4.5.3 Life History

Female bearded seals begin to reproduce at 5 to 6 years of age with 80 percent having delivered a pup by age 6, while males reach sexual maturity at 6 to 7 years (Kelly, 1988). Typically bearded seal females choose ice floes away from the shorefast ice zone, for birthing areas (Kovacs et al., 1996;

Fay, 1974; Burns and Frost, 1979), giving birth to a 4-foot, 75-lb pup on ice between mid-March and early May (Heptner et al., 1976, Fedoseev, 1984, Nelson, Burns, and Frost, 1984).

Most births occur during the last 1.5 weeks of April somewhere around the Bering Strait (Burns, 1981; Kovacs, 2002), and the precocial pups whelp in an advanced developmental state, with a layer of subcutaneous fat, and often having wholly or partially molted in utero (Kovacs et al., 1996) or completing their first molt before the cessation of nursing. Newborn pups frequently enter the water within minutes or hours of birth and are foraging within 1 to 2 weeks (Lydersen, 2002; Watanabe et al., 2009; Lydersen et al., 1994; Kovacs et al., 1996). Upon weaning, pups weigh 190 lbs and spend about 50 percent their time in the water, making 5+ minute dives to depths of 276 feet (Lydersen et al., 1994; Lydersen et al., 1996; Burns, 1981; Nelson, 2008). In late-May through early June females begin ovulating (Riedman, 1990), followed by a period of courtship by male bearded seals.

Males court females and display using calls – ascents, sweeps, moans, and elaborate downward trilling vocalizations that are frequency modulated and can travel up to 18 miles, bubble displays, and diving displays (Burns, 1981, 1988, 2009; VanParijs 2003; Cleator et al., 1989). Individual males use distinct songs, and may occupy the same territories over a series of consecutive years within constraints imposed by variable ice conditions, or they may show a roaming pattern (VanParijs et al., 2001, 2003, 2004). Mating calls peak during and after pup rearing (Wollebaeck, 1927; Freuchen, 1935; Dubrovskii, 1937; Chapskii, 1938), and evidence suggests these calls originate only from males. The vocalizations of male bearded seals are believed to advertise mate quality, signal competing claims on reproductive rights, or to identify territory. Recent studies in the fjords of the Svalbard Archipelago and shore leads in the Chukchi Sea of Alaska have suggested site fidelity of males within and between years supporting earlier claims that males defend aquatic territories (Cleator et al., 1989; Cleator and Stirling, 1990; Van Parijs et al., 2003; Van Parijs et al., 2004, Van Parijs and Clark, 2006, Risch et al., 2007). Males exhibiting territoriality maintain an approximately 4.6-mi^2 core area, unlike wandering males that call across several larger core areas (Van Parijs et al., 2003; Van Parijs et al., 2004; Van Parijs and Clark, 2006; Risch et al., 2007), and scars on the males suggest fighting may be involved in defending territories as well.

Copulation is followed by a 2 to 2.5 month period of delayed implantation in females, where the fertilized embryo remains in stasis, before attaching and implanting into the uterine wall. After the delay is over, an embryo completes the implantation process and begins the 8.5-month period of gestation. The total gestation period for bearded seals is from 11 to 11.5 months long, allowing a pup to be birthed during spring when environmental conditions favor a pup's survival (Burns, 1981, 1988; Burns and Frost, 1979).

In June, after whelping and breeding conclude, most bearded seals begin their annual molt spending much of their time hauled out on ice, entering water with reluctance (Kovacs et al., 2004). Some individuals may be observed molting between April and August, but the process peaks in June (Burns, 1981). Sea ice is an important requirement for the molt since it provides bearded seals with an elevated, dry platform where they can raise their skin temperature, which facilitates epidermal growth (Feltz and Fay, 1966).

The diving behavior of adult bearded seals is closely related to their benthic foraging habits and in the few studies conducted so far, dive depths have largely reflected local bathymetry (Gjertz et al., 2000, Krafft et al., 2000).

3.2.4.5.4 Diet

Bearded seal diets vary with age, location, season, and changes in prey availability (Kelly, 1988). Quakenbush et al. (2011b) found bearded seals most commonly consume invertebrates, which were found in 95 percent of stomach samples. They are mostly benthic feeders (Burns, 1981), consuming a variety of crabs, shrimp, clams, worms, and snails and other prey species, including Arctic and saffron cod, flounders, sculpins, and octopuses. They primarily feed on or near the bottom, diving to depths less than 328 feet, though are capable of going much deeper (adult dives have been recorded at 984 feet and juveniles have been recorded diving down to almost 1,640 feet (Gjertz et al., 2000). Unlike walrus that “root” in the soft sediment for benthic organisms, bearded seals “scan” the surface of the seafloor with their highly sensitive whiskers, burrowing only in the pursuit of prey (Marshall et al., 2006, 2007, 2008). Bearded seals also feed on ice-associated organisms when practicable, allowing them to live in areas with water depths considerably deeper than 984 feet if necessary. Satellite tagging indicates that adults, subadults, and to some extent pups, maintain some level of site fidelity to feeding areas, often remaining in the same general area for weeks or months at a time (Cameron, 2005; Cameron and Boveng, 2009). Diets may vary with age, location, season, and possible changes in prey availability (Kelly, 1988).

In the Bering and Chukchi seas, snow crab is the most important prey, followed by the crab, while the reverse was true farther north. Shrimp species, gastropods, and octopus are important in both the northern and southern Bering Sea and the Chukchi Sea. The diet is similar in the Beaufort Sea with the addition of Arctic cod (*Boreogadus saida*) (Burns, 1981). Antonelis et al. (1994) found that 86 percent of bearded seals examined in the central Bering Sea in early spring had fish in their stomachs. In order of importance these were capelin (*Mallotus villosus*), codfishes (*Gadidae*), and eelpouts (*Lycodes spp.*). Lowry et al. (1980) reported similar findings on percentage of the occurrence of fish in stomachs, but reported that fish as a percent of total volume was 16 percent from May through September, and dropped to 5 percent for October through April. The majority of invertebrate prey items identified in the 2000s were mysids, isopods, amphipods, and decapods (Quakenbush, 2011b). Bearded seals switch their diet to include schooling pelagic fishes when advantageous, and fish consumption by Bering Sea and Chukchi Sea bearded seals increased between the 1970s and 2000s, but not to a statistically significant degree. Sculpin, cod, and flatfishes were the dominant fish taxa consumed by bearded seals in the 2000s (Quakenbush et al., 2011b).

3.2.4.5.5 Mortality

Bearded seals are an important subsistence species for Alaskan Native hunters. The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunters’ access to seals. The ADF&G maintains a database, and the best estimate of bearded seals taken annually is 6,788 (Allen and Angliss, 2015).

Annual mortalities of bearded seals from commercial fishing activities is approximately 1.83 (2) bearded seals per year; no estimate for the Potential Biological Removal (PBR) of this species can be produced at this time (Allen and Angliss, 2015).

Bearded seals are also preyed upon by polar bears, killer whales, and potentially walruses. Polar bears attack seals while they rest on the ice; Stirling and Archibald (1977) determined bearded seals played a greater role in polar bear diets in the western Arctic than in most other areas, though many more ringed seals are killed annually by polar bears. Killer whales are believed to predate bearded seals, but only opportunistically when they encounter the seals in open water in the Bering and Chukchi seas. Bearded seal skin has been found in walrus stomachs but it is unclear whether it was an incident of walruses killing a bearded seal or scavenging a carcass. Lowry and Fay (1984) observed Pacific walruses actively killing and consuming ice seals, although mostly neonates or juveniles.

3.2.4.5.6 Climate Change

The climatic aspects of climate change were described in Section 3.1.6, suggesting the environmental conditions in the Beaufort Sea could change drastically in the future. These changes are a primary concern for Beringian DPS of bearded seals, particularly projected loss of sea ice cover, which could pose a significant threat to the persistence of these seals in the future (based on projections through the end of the 21st century) (Muto et al., 2016). Laidre et al. (2008) assessed the sensitivity of bearded seals to nine environmental variables, and found they were the most sensitive to sea ice changes, and population size and habitat specificity to a lesser degree. Available information indicates a moderate to high threat that reductions in spring and summer sea ice would result in spatial separation of sea ice resting areas from benthic feeding habitat (77 FR 76740, December 28, 2012).

NMFS (Federal Register 2012) determined it is likely reductions in the extent and timing of sea ice in the range of the Beringia DPS will occur in the foreseeable future, particularly in the Bering Sea. To adapt to this modified ice regime, bearded seals would likely have to shift their nursing, rearing, and molting areas to ice-covered seas north of the Bering Strait, where projections suggest a potential for the ice edge to retreat to deep waters of the Arctic basin. Such an event would force seals into suboptimal conditions and habitats, and likely compromise reproduction and survival.

Likewise, NMFS (Federal Register 2012) also determined reductions in sea ice suitable for bearded seal molting (greater than 15 percent ice concentration in May to June) and whelping (greater than 25 percent ice concentration in April to May) could occur.

Within the foreseeable future, the risks to the persistence of the Beringia DPS appear to be moderate (abundance and diversity) to high (productivity and spatial structure). NMFS determined the Beringia DPS is not in danger of extinction throughout all of its range, but could become so by around 2095 (USC, 2016). Consequently NMFS (Federal Register 2012) concluded the Beringia DPS of bearded seals is under no present threat from climate change, but future changes in sea ice could present an increasing threat leading to the extinction of the Beringia bearded seal DPS by around 2095.

The spread of disease and parasites has also been suggested as a potential threat to Arctic marine mammals by emigration/immigration events between different marine mammal populations, abetted by sea ice losses, but only in a general context.

3.2.4.6 Ringed Seal

3.2.4.6.1 Population and Status

Ringed seals (*Phoca hispida hispida*) in U.S. waters are considered to be from a single Alaska stock (Kelly et al., 2010; Allen and Angliss, 2015). Kelly et al. (2010) estimated over 300,000 ringed seals inhabit the Beaufort, Chukchi, and Bering seas based on information from existing surveys and studies, though this estimate is unreliable (Allen and Angliss, 2015) and seal numbers are believed to number considerably more in the Bering and Chukchi seas, particularly during winter and early spring (71 FR 9783, February 27, 2006). Bengston et al. (2005) reported an abundance estimate of 252,488 ±47,204 ringed seals in the eastern Chukchi Sea in 1999, and 208,857 ±25,502 seals in 2000; while Frost and Lowry (1981) estimated 80,000 ringed seals in the Beaufort Sea during summer and 40,000 during winter. These were minimum population estimates and fall short of the western Arctic ringed seals total population size since the estimates do not include data from the stock’s remaining geographic range. Kelly et al. (2010) estimated the Arctic ringed seal population to number over 1,000,000. However, the estimate for the U.S. Beaufort Sea has not been corrected for the number of ringed seals not hauled out at the time of the surveys (Allen and Angliss, 2015). Some authors (Amstrup, 1995) believe the Beaufort Sea population could be four times greater than the Frost and Lowry (1981) numbers. Kelly et al. (2010) placed the maximum density estimate of ringed seals at Prudhoe Bay and along the coast south of Kivalina to be 1.62 seals/km^2.

Population-trend analyses by Frost et al. (2002) for the central Beaufort Sea found a substantial decline of 31 percent in observed ringed seal densities from 1980 to 1987 and 1996 to 1999; however, Frost et al. (2002) also noted the decline may have been due to a difference in survey timing rather than an abundance decline. Spatial and temporal comparisons typically assume the proportion of animals visible remains constant between surveys; however, Frost et al. (2004) cautioned against comparing survey results because of marked between-year variation in density estimates common for ringed seal surveys. Most likely these timing differences were due to the variations in sea ice conditions and the annual molt cycles of ringed seals (Frost et al., 2004). Kelly (2005) found aerial surveys can underestimate ringed seal densities by factors of more than 13, because the proportion of seals visible during survey periods may rapidly change from day to day. Consequently comparisons of ringed seal densities between regions and between years based on aerial surveys should only account for the proportion of the population visible during each survey (i.e., appropriate correction factors would need to be used) (Kelly, 2005).

Ringed seals were listed as threatened under the ESA on December 28, 2012 (77 FR 76705), due to concern about the anticipated long-term effects of climate change on the pupping and denning habitat into the next century. Due to their listing under the ESA, they are listed as a depleted and as a strategic stock (Angliss and Outlaw, 2015).

3.2.4.6.2 Distribution

Ringed seals are the most common and widespread seal species in the Alaskan Arctic. During the fall most ringed seals in the Beaufort and Chukchi seas follow the sea ice front south into the Bering Sea where they remain until the lead systems and warming weather permit them to return to the Arctic during the spring and summer, and a much smaller portion of the Alaska stock remains in the Beaufort and Chukchi seas throughout the year. Harwood et al. (2012) tracked ringed seal migrations from the eastern Beaufort Sea to the Bering Sea and found that they made a rapid, synchronized, westward migration into the Chukchi Sea using the same migration corridor and route that bowhead whales used.

Ringed seals have a circumpolar distribution from approximately 35°N latitude to the North Pole, and they occur in all seas of the Arctic Ocean (King, 1983). In the Chukchi Sea areas of high concentrations occur between Point Lay and Cape Lisburne, Alaska; however no definitive ringed seal concentration areas have been identified in the Beaufort Sea other than in Canadian waters near Tuktoyaktuk.

Moulton et al. (2002) found the highest ringed seal concentrations occurred on stable, shorefast ice over water depths of about 33 to 66 feet in winter and spring, and Frost et al. (2004) found ringed seal densities greater with depths between 16 and 115 feet. Seals cannot overwinter in ice-covered waters shallower than 9 to 16 feet because of ice freezing to the seafloor and/or poor prey availability resulting from a limited water supply (71 FR 9785). Thus, it can be safely assumed that waters less than 16 feet deep would be poor wintering areas for ringed seals. Optimal wintering areas for ringed seals in the Beaufort Sea should occur in waters between 33 and 115 feet deep, preferably in the shorefast ice close to lead systems. Historically, the population densities of ringed seals have been substantially greater in the eastern Beaufort Sea than in the western Beaufort (Burns and Kelly, 1982; Kelly, 1988), likely due to the shallower water depths between the shore and barrier islands in the western Beaufort Sea. Ringed seal population densities tend to be greatest on areas of flat ice near the edge of the shorefast ice zone and decline away from that edge (Frost et al., 2004).

Stirling, Kingsley, and Calvert (1981) found the greatest ringed seal population densities in the Beaufort Sea in water having more than 80 percent ice cover. During summer, Simpkins et al. (2003) found ringed seals most often occurred along receding ice edges or farther north in pack ice, favoring ice floes more than 158 feet in diameter, and in the interior pack ice where sea ice concentrations exceed 90 percent.

Surveys flown from 1996 to 1999 found the highest density of seals along the central Beaufort Sea coast in Alaska occurred between Kaktovik and Brownlow Point, possibly due to a productivity of zooplankton which was about four times greater there than in other areas of the eastern Beaufort Sea (Frost et al., 2004).

In early summer, the highest densities of ringed seals in the Chukchi Sea are found in nearshore shorefast ice, pack ice (Bengston et al., 2005), lead systems, polynyas, and shear zones. This trend also appears to be true in the Beaufort Sea, based on incidental sightings of seals during aerial surveys for bowhead whales (Monnett and Treacy, 2005). During summer, they are found dispersed throughout open-water areas, though in some regions they move to coastal areas (Smith, 1987; Harwood and Stirling, 1992). In late summer and early fall, they often aggregate in open-water areas where primary productivity is thought to be high (Harwood and Stirling, 1992).

Aerts et al. (2013a) analyzed the distribution of marine mammals using data collected in 2008 to 2010, and found the distribution of seal species was due to food availability. More specifically, Aerts et al. (2013a) noted ringed seals spend 90 percent of their time foraging in the water during the summer and because of a highly flexible diet and high prey mobility, they lacked a clear distribution pattern.

The construction site for the Proposed Action lies well inside the shorefast ice zone, far from the edge of the shorefast ice, and in water depths of about 19 feet, indicating the location would be a very poor choice of winter habitat for ringed seals. Therefore, it is highly unlikely that many, if any, ringed seals would occur in the immediate vicinity of the Proposed Action during winter and early spring. Because this area is often ice free during the summer, there is a strong likelihood some ringed seals would frequent the Proposed Action Area during the ice free period as food resources permit.

Critical habitat has been proposed for the Arctic ringed seal in U.S. waters and includes:

> All the contiguous marine waters from the “coast line” of Alaska as that term has been defined in the Submerged Lands Act (“the line of ordinary low water along that portion of the coast which is in direct contact with the open sea and the line marking the seaward limit of inland waters”), 43 U.S.C. 1301(c), to an offshore limit within the U.S. Exclusive Economic Zone (EEZ). The boundary extends offshore from the northern limit of the United States-Canada land border (from the ordinary low water line of the Beaufort Sea at 141º W long.) and follows the outer extent of the U.S. EEZ boundary north and slightly northeastward; thence westerly and southwesterly; thence southerly and southwesterly to 60º31’N lat., 179º13’W long. From there it runs southeasterly to 58º22’N lat., 170º27’W long.; thence easterly to 59°N lat., 164°W long. The boundary then follows 164ºW long. due north to the coast line of Alaska southeast of Cape Avinof.

Such a designation would effectively include all marine waters within the EEZ of the United States where sea ice regularly forms during winter (Figure 3-28). The final determination for ringed seal critical habitat from the NMFS remains pending.

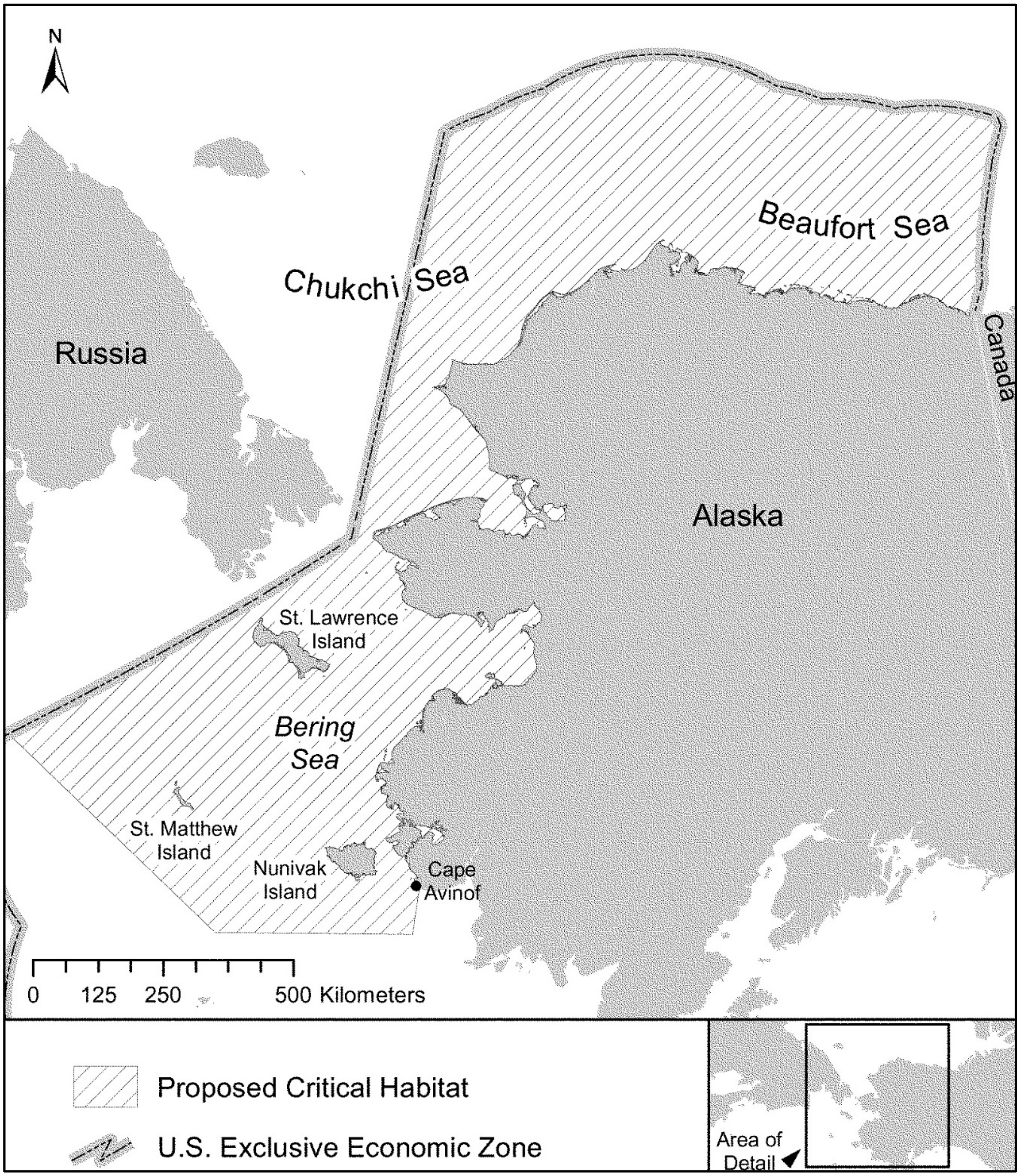

Figure 3-28 Proposed Critical Habitat for the Arctic Ringed Seal in U.S. Waters
Source: NMFS, 2015.

3.2.4.6.3 Life History

Reported mean age at sexual maturity (MAM) for ringed seal females varies in the literature from 3.5 to 7.1 years (Holst and Stirling, 2002; Krafft et al., 2006). Males likely do not participate in breeding before they are 8 to 10 years old. The average size of adults 10 years and older varies between locations and different age cohorts, but averages between 3.77 to 4.46 feet in length and 88 to 143 lbs in weight, with males being slightly larger than females (Smith, 1973; Frost and Lowry, 1981; Smith, 1987; Lydersen and Gjertz, 1987). Ringed seals are long lived, with ages close to 50 reported

(Lydersen and Gjertz, 1987), though the average lifespan is around 25 to 35 years (Smith and Walker, 1995). Reproductive rates of adult female ringed seals vary between 0.45 and 0.86 (see Reeves, 1998), with a maximum of 0.91 (Lydersen and Gjertz, 1987). Regional production rates are variable; reproductive success depends on many factors including prey availability, the relative stability of the ice, and sufficient snow accumulation prior to the commencement of breeding, etc. (e.g., Lukin, 1980; Kelly, 1988; Smith, 1987; Lydersen, 1995).

Some ringed seal behaviors remain poorly understood because they spend so much of their time out of sight in their lairs or under the sea ice (ADF&G, 1994). When submerged under the sea ice, they excavate and maintain several breathing holes throughout the winter to provide air access while hunting prey species (e.g. Arctic Cod) and to provide escape routes from polar bears and other predators (Frost et al., 2002).

A single 8.8 to 9.9 lb pup is born in the spring (March to May), with the peak of pupping occurring in early April (Frost and Lowry, 1981). Births occur in subnivean lairs excavated in the snowpacks that accumulate upwind and downwind of ice ridges (Smith and Stirling, 1975; Furgal et al., 1996), or in cavities occurring between ice chunks in pressure ridges (McLaren, 1958; Kelly, 1988). Snow depths of at least 20 to 26 inches are required for functional birth lairs, and such depths typically are found only where 8 to 12 inches or more of snow has accumulated on flat ice and then drifted along pressure ridges or ice hummocks. These lairs provide thermal protection against cold temperatures, wind chill, and some protection from predators. Shore-fast ice is the best habitat for pupping, though many ringed seals successfully whelp and rear their pups in pack ice in some areas (Wiig et al., 1999). Seal mothers move young pups between lairs within their network of lairs (usually 4 to 6 per female) if one or more lairs are compromised and older pups can travel between lairs as their swimming skills develop (Lydersen and Hammill, 1993a, b).

Reproductive rates for ringed seals are capable of approaching 95 percent annually (Smith, 1973; Burns, 1981; Quakenbush and Sheffield, 2006); however, current reproductive rates appear to be lower than the maximum recorded for this species. For example, only 69 percent of females sampled in the Bering and Chukchi seas between 2000 and 2005 were pregnant (Quakenbush and Sheffield, 2006).

After a 5 to 8 week lactation period, pups wean when approximately 44 lbs, then their mothers mate sometime between April and May (Moulton et al., 2002). Sometime after breeding activities conclude, about mid-May, they begin molting.

Molting for ringed seals occurs between mid-May to mid-July, and during this time they remain hauled out on the edge of the pack ice, or on remnant landfast ice until their old pelt dries out and sheds (Reeves, 1998). Because of the need for dry skin during the molt, ringed seals refrain from entering the water and forgo foraging activities, making the molt a particularly stressful time for this species (Ryg et al., 1990).

When not whelping, lactating, breeding, or molting, ringed seals travel widely and may occur in waters of nearly any depth, though their distribution remains strongly correlated with the presence of sea ice and with food availability (e.g. Simpkins et al., 2003, Freitas et al., 2008).

3.2.4.6.4 Diet

Most ringed seal prey is small, and selection concentrations on schooling species that form dense aggregations – in the 2- to 4-inch length range for fishes and the 0.8- to 2.4-inch length range for crustaceans. Typically, a variety of 10 to 15 prey species are found with no more than 2 to 4 dominant prey species in any given area. Fishes are generally more commonly eaten than invertebrate prey when available. Diet is determined to some extent by the seasonal availability and nutritive value of prey, with pronounced seasonal variation. Depth of water and distance from shore also factor into their diet (Lowry, Frost, and Burns, 1979; Reeves, 1998; Wathne et al., 2000). Ringed seals can consume the largest quantities of foods with the least energetic expenses where prey species are highly concentrated, such as with Arctic cod and nektonic crustaceans in some areas.

In U.S. waters, ringed seals mostly feed on Arctic cod and shrimp during fall, winter, and spring; and switch to amphipods and euphausiids during summer (Kelly, 1988; Reeves, Stewart, and Leatherwood, 1992; Lowry, Frost, and Burns, 1979). However, nearshore samples from the vicinity of the Proposed Action Area in 1978 found amphipods to be the primary food items in November (Lowry, Frost, and Burns, 1979). There are differences in the diet content for different ringed seal demographic groups though, and Arctic cod tends to become more prevalent in the diet as ringed seals mature (Dehn et al., 2007), and conversely, invertebrates often dominate the diet of young animals (Lowry et al., 1980; Holst et al., 2001).

Quakenbush et al. (2011a) provided corroborating evidence that the diet of Alaska ringed seals sampled consisted of cod, amphipods, and shrimp. Fish were consumed more frequently in the 2000s than in the 1960s and 1970s, and Arctic cod, saffron cod, sculpin, rainbow smelt, and walleye pollock were identified as the dominant fishes, while mysids, amphipods, and shrimp, were the dominant invertebrate species in ringed seal diets. Aerts et al. (2013a) also found Arctic cod was the main food source in fall and winter, while they had a tendency to prefer crustaceans in spring and summer.

Ringed seals in the eastern Beaufort Sea also have exhibited reduced reproductive output and reduced body condition between 2003 and 2005. Local fishermen in the eastern Beaufort Sea have suggested the downturn in seal body condition was related to decreases in marine productivity in the area, as evidenced by recent reductions in fishing opportunities for Arctic cod in the same areas that seals hunt (Harwood, 2005). Reduced numbers of Arctic cod probably also are a factor in reduced seal reproductive output, as successful ovulation depends on body condition (Harwood, 2005).

3.2.4.6.5 Mortality

Ringed seals are an important species for subsistence practitioners. The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. ADF&G maintains a subsistence harvest database and, as of August 2000, the mean estimate of ringed seals taken annually is 9,567, and data from 2008 to 2012 shows an annual average of 4.12 mortalities of Arctic ringed seals from commercial fishing operations in Alaska (Allen and Angliss, 2015).

Polar bear predation remains the largest source of ringed seal mortality, followed by subsistence hunting. Other sources of mortality among ringed seals include entanglements and commercial fishing, and predation from Arctic foxes, walruses, wolves, wolverines, and ravens which also occasionally kill ringed seals; all of which result in very few losses (ADF&G, 1994; 2011b; Allen and Angliss, 2013).

3.2.4.6.6 Climate Change

Ringed seal sea ice and snow habitats are believed to have been modified by the warming climate and projections suggest continued or accelerated warming in the future (Kelly et al., 2010). Climate models project ice and snow cover losses throughout the 21st century, with some variations, and increasing atmospheric concentrations of greenhouse gases are driving climate warming and increasing ocean acidification (Section 3.1.6), which affects ringed seal habitat. Such changes also threaten prey communities on which ringed seals depend. Laidre et al. (2008) analyzed life history features of ringed seals and concluded they are highly sensitive to climate.

The greatest impacts to ringed seals from climate change would manifest in less snow cover. While winter precipitation is forecasted to increase in a warming Arctic (Walsh et al., 2005), the duration of ice cover could be reduced leading to lower snow accumulation on ice (Hezel et al., 2012), particularly over their subnivean lairs. According to NMFS' climate model projections, snow cover is expected to be inadequate for the formation and occupation of lairs within this century over the Alaska stock's entire range (Kelly et al., 2010).

Without lairs, ringed seals and their pups may experience increased incidents of freezing and predation. Changes in their habitat could occur rapidly relative to their generation time which could limit adaptive responses.

The spread of disease and parasites has also been suggested as a potential threat to Arctic marine mammals by emigration/immigration events, abetted by sea ice losses, but only in a general context. The true potential for the spread of pathogens between ringed seal stocks and other species of seals remains speculative.

3.2.4.7 Spotted Seal

3.2.4.7.1 Population and Status

Muto et al. (2017) noted a spotted seal (*Phoca largha*) population estimate of 391,000 for the Alaska stock, citing Conn et al. (2014). The lower and upper limits for a Ver Hoef et al. (in review) estimate were 92,769 to 321,882 individuals. The vast majority of spotted seals occur in the Bering and Chukchi seas, with much lower numbers present in the Beaufort Sea, as evidenced by the smaller haulouts found along the Beaufort Sea coast between Oarlock Island in the eastern Colville River Delta and Smith Bay near Point Barrow.

3.2.4.7.2 Distribution

The Alaska stock of spotted seals are distributed along the continental shelf of the Beaufort, Chukchi, and Bering seas, mostly in shallow and/or nearshore waters (Shaughnessy and Fay, 1977; Lowry et al., 2000). They are mostly seen in bays, lagoons, estuaries, and nearshore waters but they also range far offshore to 72°N latitude (Shaughnessy and Fay, 1977). They are common in the coastal Alaskan waters in ice-free seasons and are not known to remain in the Beaufort Sea during the late fall and winter. They migrate south from the Chukchi Sea through the Bering Strait in October and November to overwinter in shallow areas along the ice front (Lowry et al., 1998; Lowry et al., 2000). In spring, those overwintering in the Bering Sea follow the receding sea ice, north through the Bering Strait into the Chukchi and Beaufort seas to reoccupy their seasonal coastal habitats (Shaughnessy and Fay, 1977; Simpkins et al., 2003).

Spotted seals make foraging trips from coastal haulouts lasting about 9 days, followed by a rest period of 1 to 2 days at a coastal haulout. No surveys of potential spotted seal haulouts on sea ice in the Beaufort Sea have been conducted to date due to personnel safety hazards. Known spotted seal onshore haulouts are known to exist in Smith Bay, Dease Inlet, the Colville River Delta, and historically in the Sagavanirktok River Delta, and possibly in western Camden Bay, Alaska (Huntington, 2013; Smith et al., 2010; ADF&G, 2015; NOAA, 2015; ASGDC, 2012). Some unverified accounts of spotted seals recently hauling out in the Sagavanirktok River Delta have been discussed during scoping. Haulout sizes in the Beaufort Sea tend to be much smaller than those along the Chukchi and Bering sea coasts, sometimes by one or two orders of magnitude, indicating spotted seals have a lesser presence in the Beaufort Sea than in other areas of their range.

Seals at the Beaufort Sea haulouts have historically numbered into the hundreds, even at the easternmost documented haulout on Oarlock Island. Recently, only a few tens of spotted seals have been observed at Oarlock Island. This decrease in spotted seal numbers has occurred since the 1970s, though it is possible the population declines at the Oarlock Island haulout indicates seals have shifted to other haulout locations in the Beaufort Sea. Marine mammal monitoring during BPXA's 2014 Shallow Geohazard Survey (Smultea et al., 2014) at the Liberty Site noted an estimated 80 spotted seals in the area during seismic surveying, easily making spotted seals the most commonly observed pinnipeds in the area with most occurrences south and east of Narwhal Island. A concurrent ocean bottom sensor seismic survey at the same site by BPXA found 31 percent of the marine mammal sightings were spotted seals and another 31 percent were ringed/spotted seals (Lomac-MacNair et al., 2015). This information from two concurrent marine mammal monitoring reports suggests spotted seals in the Proposed Action Area should number in the high 10s to low 100s when ice is present.

3.2.4.7.3 Life History

During spring when pupping, breeding, and molting occur, spotted seals inhabit the southern margin of the sea ice in the Bering Sea (Quakenbush, 1988; Rugh, Shelden, and Withrow, 1997). Of eight known breeding areas, three occur in the Bering Sea (Angliss and Outlaw, 2005). Pupping occurs on ice in April and May, and pups are weaned within 3 to 4 weeks. Adult spotted seals often are seen on the ice in female-pup or male-female pairs, or in male-female-pup triads. Mating occurs around the time the pups are weaned and mating pairs are monogamous for the breeding season. Spotted seals are rarely seen on the pack ice during the summer, except when the ice is very near shore.

3.2.4.7.4 Diet

Spotted seals have a flexible diet and are opportunistic predators, though schooling fish are their preferred prey (Aerts et al., 2013a; Dehn et al., 2007; Boveng et al., 2009). Boveng et al. (2009) found spotted seals are generalist feeders with a varied diet, though fishes are the main prey group in their diet, with large numbers of crustaceans and cephalopods showing up in food analyses. Dehn et al. (2007) found nitrogen isotope ratios of spotted seals indicated feeding in higher trophic levels than other ice seals and carbon isotope analyses indicated spotted seals mainly forage in the pelagic environment with much less reliance on the benthic environment when compared to bearded seals and Pacific walruses. Data from 2008-2010 led Aerts et al. (2013b) to conclude spotted seal presence in the Chukchi Sea is determined by food availability, reflecting the influence of oceanographic conditions on prey species; a conclusion that should apply to spotted seals in the Beaufort Sea too. Consequently, the site locations of Beaufort Sea spotted seal haulouts is likely due to the presence of spawning runs of whitefish and salmon more than any other single factor. Since spotted seals are shallow water divers, mostly feeding in waters less than 656 feet deep (Bukhtiyarov et al., 1984; Lowry; 1985), the amount of available feeding habitat in the Beaufort Sea will always remain limited due to the marginal extent of the continental shelf, which explains why there are much fewer spotted seals in the Beaufort Sea than in the Chukchi and Bering seas.

3.2.4.7.5 Mortality

The best estimate of the statewide annual spotted seal subsistence harvest is 5,265, and data from 2008 to 2012 shows an annual average of 1.52 spotted seal mortalities from commercial fishing operations in Alaska (Allen and Angliss, 2015). As with the analogous ringed seals, polar bear predation is the largest source of mortality, followed by subsistence hunting; other sources, such as entanglements and commercial fishing are very low (Allen and Angliss, 2013). Spotted seals are killed annually by predators such as killer whales, grizzly bears, Pacific walruses, sleeper sharks, etc., but the numbers of such losses are believed to be low since habitat preferences would make the practice of hunting ringed seals problematic for most predators other than polar bears.

3.2.4.7.6 Climate Change

Spotted seal sea ice habitat that has been modified by the warming climate should continue to change into the future (Muto et al., 2016). Though the Arctic Ocean ice extent has been shrinking during summer, winter sea ice in the Bering Sea should continue forming annually into the foreseeable future. There could be more frequent years in which ice coverage is reduced, resulting in long-term declines in ice extent, but Bering Sea spotted seals would likely continue to encounter sufficient ice to support adequate vital rates. Laidre et al. (2008) concluded spotted seals were likely to be moderately sensitive to climate change based on various life history features.

A second major concern is ocean acidification, which could alter prey and other habitat characteristics. Ocean acidification could impact spotted seal survival and recruitment through disruption of trophic regimes that are dependent on calcifying organisms; however their dietary flexibility makes such a threat less of a concern than sea ice degradation (Boveng et al., 2009). If conditions begin to favor the pelagic environment in the Beaufort Sea, they may favor spotted seals during the open-water season since adults are usually piscivorous, and pelagic foodwebs often favor fishes. Consequently there could be a greater presence of spotted seals using the Beaufort Sea and Foggy Island Bay during the open-water season; at least for as long as ocean acidity doesn’t prevent fish populations from remaining viable in the region.

The spread of disease and parasites has also been suggested as a potential threat to Arctic marine mammals by emigration/immigration events, abetted by sea ice losses, but only in a general context. The true potential for the spread of pathogens between other species of seals and spotted seals remains speculative.

3.2.4.8 Steller Sea Lion – Western U.S. Stock

The Western U.S. stock of Steller sea lions occurs in waters of Bristol Bay and the Bering Sea in Alaska, as well as in the North Pacific Ocean and along the Russian coast. The size of the western Pacific stock of Steller sea lions decreased from an estimated 220,000 to 265,000 animals in the late 1970s to less than 50,000 in 2000, and at present the minimum population estimate for the stock is 50,983 animals (Muto et al. 2017). For these reasons, the Western U.S. stock of Steller sea lions remains listed as endangered under the ESA and is designated as depleted under the MMPA (Muto et al., 2017).

Steller sea lions typically occur in coastal areas of the North Pacific and Bering Sea, including waters around Dutch Harbor, Alaska. Though Dutch Harbor sees a large amount of vessel traffic throughout the year, resident Steller sea lions are believed to have habituated to the vessel traffic and human activity. They are commonly encountered by vessels traveling in and out of Dutch Harbor and near the Pribilof Islands where large breeding rookeries occur. There is a 3 nmi no-entry zone around rookeries, but otherwise vessel traffic has a perceived low impact on the recovery of the stock (Muto et al. 2017; Page 10, Table 5).

The waters from Dutch Harbor to 150 nmi north of Dutch Harbor are designated critical habitat for Steller sea lions (58 FR 45269; 50 CFR, Chapter II, Subchapter C, Part 226.202).

3.2.4.9 Northern Sea Otter – Southwest Alaska Stock

The Southwest Stock of northern sea otters may be encountered by barges travelling from Dutch Harbor to the Proposed LDPI. On August 9, 2005, the FWS listed the Southwest Alaska Stock of northern sea otters as threatened (70 FR 46366). October 8, 2009, critical habitat for the Southwest Alaska Stock of northern sea otters was declared (74 FR 51988); this habitat occurs in nearshore marine waters around Unalaska Island ranging from the mean high tide line seaward for a distance of 328 feet, or to a water depth of 66 feet. The species is most commonly observed within the approximately 130-foot depth contour since they require frequent access to nearshore benthic foraging habitat (Reidman and Estes 1990). The most recent population size for the Southwest Alaska Stock was 54,771 with a minimum population size of 45,064 (Muto et al., 2017). Individual sea otters would likely be encountered near Dutch Harbor and Unalaska Bay, but probably not in offshore areas.

3.2.4.10 Pacific Walrus

In-depth descriptions of the status, distribution, life history, and survival of Pacific walrus populations occurring in U.S. waters including the Beaufort Sea, are provided in the FWS Status Review of the Pacific Walrus (*Odobenus rosmarus divergens*) (Garlich-Miller et al., 2011), the most recent FWS stock assessment report (USFWS, 2014), and Conference Opinions (USFWS, 2011, pages 17-20;

USFWS, 2013, pages 18-26). The following text summarizes pertinent information from these documents, which are incorporated by reference, and includes new scientific information when available.

3.2.4.10.1 Sound

Walruses produce a variety of sounds (barks, knocks, grunts, rasps, clicks, whistles, contact calls, etc. (Miller, 1985; Stirling, Calvert, and Spencer, 1987). Airborne vocalizations at reported frequencies between 10 Hz and 4 kHz (Kastelein, Postma, and Verboom, 1995; Miller, 1985; Miller and Boness, 1983; Verboom and Kastelein, 1995) accompany nearly every social interaction that occurs on land or ice. These vocalizations facilitate kin recognition, male breeding displays, recognition of conspecifics, and female mate choice (Charrier Burlet, and Aubin, 2011; Insley, Phillips, and Charrier, 2003). Walruses also vocalize extensively while underwater at reported frequencies between 200 Hz and 4 kHz. Base frequencies for most underwater walrus sounds occur at 400 Hz to 1,200 Hz (0.4 to 1.2 kHz) (Richardson et al., 1995). The purposes of underwater vocalizations are not explicitly known but are associated with breeding, swimming, and diving, and may be used to locate the bottom and identify bottom substrates associated with prey. Because of walrus grouping behavior, all vocal communications occur within a short distance (Miller, 1985). Walruses' underwater vocalizations are suspected to be detectible for only a few miles (Mouy et al., 2012) and likely do not act as long distance communication.

Presently, no walrus-specific hearing threshold criteria data exist; however, underwater audiograms for walruses show a strong similarity to those for otariids (Kastak et al., 2004, 2007 in Finneran and Jenkins, 2012). Therefore, for management and impact analysis purposes, the otariid functional hearing frequency ranges of 100 Hz to 35 kHz in water and 100 Hz to 50 kHz in air is often assumed for walruses (Finneran and Jenkins, 2012). The FWS uses the NMFS otariid acoustic thresholds as an approximate surrogate for walruses (81 FR 52276; August 5, 2016). NMFS (2016b) has assigned walruses to the 60 Hz to 39 kHz boxcar frequency range (a multi-species functional hearing range category used for their impact analyses). A few psychophysiological studies have been conducted on both captive and free-ranging walruses (Kastelein et al., 1993a, 1996, 2002). These tests suggest in-air frequency sensitivity ranges from 0.25 kHz to 8 kHz with sensitivity down to 50 dB_{RMS} at 1 kHz to 4 kHz (Kastelein et al., 1993a, 1996). An in-water audiogram of an adult male Pacific walrus showed maximum frequency sensitivity at 12 kHz (at 67 dB_{RMS}) (Kastelein et al., 2002). In-water sensitivity fell gradually below frequencies of less than 1 kHz and dropped off sharply above 12 kHz. It is generally acknowledged that walruses are sensitive to low frequency sound (less than 1 kHz) (Kastelein et al., 2002).

3.2.4.10.2 Physical

Walrus' sense of touch (i.e., mechanosensory system) has been of scientific interest because they disturb large volumes of seafloor sediments while foraging, resulting in turbid waters where visibility is greatly reduced (Ray et al., 2006). Instead of vision, walruses use their whiskers (i.e., vibrissae) to find prey items. Walrus' vibrissae have evolved to be highly sensitive (individuals can identify 0.12-inch thick objects down to a survey area of 0.06 square inches) (Kastelein and van Gaalen, 1988; Kastelein, Stevens, and Mosterd, 1990). The majority of research on walrus sensory systems has focused on hearing and touch; information from anatomical and behavioral studies provides insight into the walrus visual system but less research on the olfactory and gustation (i.e., taste) systems has been conducted (Dehnhart, 2002).

3.2.4.10.3 Vision

Concurrently, the walrus eye, while well-developed, is smaller than that of other pinnipeds and walrus visual acuity is thought to be comparatively less than that of phocids and otariids (Kastelein et al., 1993b).

3.2.4.10.4 Olfaction

Historical anatomical descriptions suggest that, compared with most terrestrial mammals, the olfactory system in pinnipeds, including walrus, is somewhat reduced (Lowell and Flanigan, 1980). However, traditional knowledge from subsistence communities and historical whaling accounts indicate that Pacific walruses are sensitive to smells and may flush from land and ice in response to odors indicative of a possible threat, such as exhaust from outboard engines of hunting vessels (Ellis, 2009; Huntington, Nelson, and Quakenbush, 2012; Huntington and Quakenbush, 2013).

3.2.4.10.5 Population and Status

Walruses in the North Pacific Ocean and U.S. portion of the Arctic Ocean belong to the Pacific subspecies. Pacific walruses are common in the Bering and Chukchi seas, with seasonal variation in distribution (Fay, 1982; Garlich-Miller et al., 2011).

The Pacific walrus population size has fluctuated markedly in response to varying levels of human exploitation (Fay, Kelly, and Sease, 1989; Fay et al., 1997; Taylor and Udevitz, 2015). Research suggests a decrease in hunting pressure facilitated rapid population growth in the 1960s (Fay, Kelly, and Sease, 1989). By the late 1970s to earlier 1980s the Pacific walrus stock likely reached or exceeded carrying capacity and limitations in food availability resulted in a population decline (Fay, Kelly, and Sease, 1989; Taylor and Udevitz, 2015). Cow-calf ratios were substantially lower in the 1980s than in the 1960s, suggesting that reproductive rates (number of female calves per reproductive female) and calf survival rates declined, leading to an aging population (Citta, Quakenbush and Taras, 2014). Recent modeling of available data suggests that by the 1990s both reproductive rates and calf survival began to increase steadily but remained lower than estimated maximums for the period prior to the 1980s decline (Taylor and Udevitz, 2015). Model results suggest that overall population growth rate also increased and then moderated, rising from 0.94 in 1985 to 0.97 in 1999 to 1.00 in 2006 (the most recent year for which data were available for analysis) (Taylor and Udevitz, 2015). Survey efforts have been hampered by large confidence intervals, bias, and variation in data collection methods that prevent confident comparisons among surveys (Gilbert, 1989; Gilbert et al., 1992). Attempts to estimate population size have been further compromised because large portions of the population may be in the water at any given time and because walruses tend to aggregate in large, closely-packed groups, both factors that make accurate counts difficult (Garlich-Miller and Jay, 2000; USFWS, 2014). The most recent population survey of Pacific walruses was conducted in 2006. Due to weather constraints, approximately 50 percent of the available walrus habitat was surveyed. The final population estimate of 129,000, with a range of 55,000 to 550,000 (Speckman et al., 2011; Muto et al., 2017) represents a minimum population estimate since it was not possible to extrapolate from the area surveyed to the entire habitat area.

3.2.4.10.6 Distribution

The FWS considers Pacific walrus to be extralimital to the Proposed Action Area.

The Pacific walrus ranges from the Bering Sea to the Chukchi Sea, occasionally ranging into the East Siberian and Beaufort seas. Walruses are social and gregarious animals. They tend to travel and haul out to rest on ice or land in densely packed groups. Group size can range from a few individuals up to several thousand animals (Gilbert, 1999; Kastelein, 2002; Jefferson, Webber, and Pitman, 2008). Pacific walrus distribution generally varies with the extent and distribution of sea ice, although localized areas of walrus activities may occur independent of the movement of ice floes (Garlich-Miller et al., 2011; Jay et al., 2010; Jay et al., 2014; Sacco, 2015).

Walruses are migratory; most animals move south into the Bering Sea with the advancing ice in autumn, and north as the ice recedes in spring (Fay, 1981, 1982; Huntington, Nelson, and Quakenbush, 2012). The spring migration usually begins in April, with most walruses moving north through the Bering Strait by late June. In the summer, most of the females and juveniles move to either the western Chukchi Sea near the Wrangel and Herald islands, or the eastern Chukchi Sea near Hanna Shoal, and several thousand (primarily adult males) aggregate and remain in the Gulf of Anadyr and in Bristol Bay. Limited numbers of walruses inhabit the Beaufort Sea during the open water season, and they are considered rare east of Point Barrow (Sease and Chapman, 1988).

Pacific walruses summering on the Russian side of the Chukchi Sea have historically used terrestrial haulouts on the Chukotka peninsula. Small haulouts have also historically occurred along the U.S. Chukchi Sea coast (Robards and Garlich- Miller, 2013). No terrestrial haulout sites occur in the Beaufort Sea.

Most walrus sightings in the Beaufort Sea are west of Cape Halkett, but walruses have been observed as far east as Kaktovik and the Canadian border (Funk et al., 2010; LGL, JASCO, and Greenridge, 2013). Walruses in the Beaufort Sea are most frequently found near the southern margins of the pack ice, although in recent years of reduced ice cover, the majority of individuals reported by industry monitoring have been more than 9 miles from the edge of the main pack ice in waters less than 164 feet deep (Funk et al., 2010; Jankowski, Patterson, and Savarese, 2009). Walruses have occasionally been documented in and near Beaufort Sea oil and gas infrastructure; walruses have hauled out on Northstar Island and Endicott Causeway and have been recorded in the waters around the Endicott and West Dock causeways (Streever and Bishop, 2014; USFWS, 2011).

3.2.4.10.7 Life History

Reproduction. Walruses have the lowest rate of reproduction of any pinniped species (Fay, 1982). Although male walruses reach puberty at 6 to 7 years of age, they are unlikely to successfully compete for females until they reach full body size at 15 years of age or older (Fay, 1982; Fay et al., 1984). Female walruses attain sexual maturity at 4 to 7 years of age (Fay, 1982; Garlich-Miller, Quakenbush, and Bromaghin, 2006).

Mating occurs primarily in January and February in broken pack-ice habitat in the Bering Sea. Breeding bulls follow herds of females and compete for access to groups of females hauled out onto sea ice. Females typically give birth to a single calf in May the following year shortly before or during the spring migration (Fay, 1982). Mothers and newborn calves stay on ice floes until calves develop sufficient energy reserves for thermoregulation. The calf is closely attended by the cow, and typically nurses for 1 to 2 years (Fay, 1982). Ovulation may be suppressed until the calf is weaned, raising the birth interval to 3 years or more (Garlich-Miller and Stewart, 1999). The low birth rate of walruses is offset in part by considerable maternal investment in offspring (Fay et al., 1997).

Molt. Adult walruses have a short, sparse, tawny pelage, and molt annually during the summer months (June through August) (Fay, 1982).

3.2.4.10.8 Diet

Pacific walruses are considered benthic specialists but consume a wide variety of prey species. Stomachs of some walrus included over 60 benthic invertebrate genera (e.g., Bluhm and Gradinger, 2008; Fay et al., 1984; Sheffield and Grebmeier, 2009). Bivalves, gastropods, and polychaete worms are the dominant prey groups (Sheffield and Grebmeier, 2009). Male and female walruses consumed essentially the same prey types (Sheffield and Grebmeier, 2009; Seymour, Horstmann-Dehn, and Wooller, 2014b), despite seasonal sexual segregation in foraging areas during summer months. Walruses will also consume other prey types including seabirds and ice seals. This is hypothesized to occur opportunistically although traditional ecological knowledge suggests that some individuals preferentially pursue higher trophic level prey.

3.2.4.10.9 Mortality

The continuing loss of sea ice habitat and harvest levels are likely the biggest stressors on the Pacific walrus population (Jay, Marcot, and Douglas, 2011).

Predation. Polar bears prey on walrus calves, and killer whales (*Orcinus orca*) have been observed killing all age classes of walruses. Predation levels are thought to be highest near terrestrial haulout sites where large aggregations of walruses can be found; however, few observations exist for off-shore environments. FWS currently does not consider predation to be a significant stressor on the Pacific walrus population (Garlich-Miller et al., 2011).

Harvest. Historically, Pacific walrus was hunted commercially throughout its range. Commercial harvest ceased in the U.S. in 1941 with the passage of the U.S. Department of Commerce regulation (1937) and the "Walrus Act" in 1941 (USFWS, 1994). Commercial harvest in Russia ended in 1991 as a result of economic collapse of the industry (Garlich-Miller and Pungowiki, 1999). Currently, walrus hunting in Alaska and Chukotka is restricted to subsistence harvest by indigenous peoples. Pacific walruses have been hunted by coastal Natives in Alaska and Chukotka for thousands of years. The FWS, in partnership with the Eskimo Walrus Commission (EWC), the Association of Traditional Marine Mammal Hunters of Chukotka, and the Qayassiq Walrus Commission, administered subsistence harvest monitoring programs in Alaska and Chukotka in 2006 through 2010. Harvest mortality over this timeframe is estimated at 3,828 to 6,119 walruses per year (USFWS, 2014). This mortality estimate includes corrections for underreported harvest and struck and lost animals.

Injury. Disturbance events can cause walruses to stampede into the water, resulting in miscarriages, injuries, and mortalities (Garlich-Miller et al., 2011; Fischbach, Monson, and Jay, 2009; USFWS, 2014). The risk of stampede-related injuries increases with the number of animals hauled out. Calves and young animals at the perimeter of these herds are particularly vulnerable to trampling injuries (Fischbach, Monson, and Jay, 2009; Udevitz et al., 2013). Injuries can also result from tusk strikes, which are common in both sexes and all age classes but are most prevalent on males during the breeding season (USFWS, 2015c).

Alaska Native hunters from St. Lawrence Island have described walruses becoming emaciated after becoming entrapped in heavy ice. It is probable that in some instances those walruses starve to death but no western science documentation of such events exists (USFWS, 2015c). Rock slides are a hazard to walruses on terrestrial haulouts and occasionally result in mortality (USFWS, 2015c). They have also tumbled down steep slopes and fallen off cliffs at some haulouts (USFWS, 2015c).

Injuries and mortalities from fisheries interactions appear to be rare; the mean number of observed mortalities during 2006 through 2010 was one walrus per year (with a range of 0 to 3 individuals) (USFWS, 2014). The FWS considers commercial fisheries related mortality to be insignificant because it is less than 1 percent of PBR (USFWS, 2014).

3.2.4.10.10 Climate Change

Most Pacific walruses remain in the Chukchi and Bering seas throughout their life. Only a few individuals or small groups move into the Beaufort Sea during summer months. For this reason, the direct and indirect effects of climate change in the Beaufort Sea and the Proposed Action Area are unlikely to have much of a numerical effect on the Pacific walrus population. With increasing sea ice losses, more walrus terrestrial haulouts are likely to develop at points along the coastline of Alaska and Russia. The increased use of coastal haulouts introduces risks such as predation by polar bears, stampedes that crush individual walruses, and increased harassment from people. As the Pacific walrus population becomes increasingly dependent on coastal habitats, interactions with humans would likely increase as well.

Climate change may affect the Pacific walrus population by altering their distribution and possibly increasing their presence in the Beaufort Sea. By the late 21st century, areas with favorable ice conditions for breeding and calving would likely shift north, and then as projected losses of sea ice during summer becomes more pronounced walrus reliance on coastal haulouts would probably increase (Garlich-Miller et al., 2011). Such shifts in habitat use patterns could result in increased mortalities from disturbances and a reduced prey base near coastal haulouts. Ocean acidification could also act to reduce the prey base for walruses throughout the Arctic, depending on the severity of the changes. In addition, the spread of disease and parasites as a result of climate change through sea ice loss has also been suggested as a potential threat to Arctic marine mammals, including Pacific walruses, by emigration/immigration events, but the true potential for the spread of pathogens to Pacific walruses from various vectors is inconclusive, and while these factors are expected to eventually result in a population decline, the timeframe and magnitude remains speculative.

3.2.4.11 Polar Bear

In-depth descriptions of the status, distribution, life history, and survival of the polar bear populations occurring in U.S. waters (in the Chukchi and Beaufort seas) are provided in the FWS Range-Wide Status Review of the Polar Bear (*Ursus maritimus*) (Schliebe et al., 2006), the Polar Bear (*Ursus maritimus*) 5-Year Review: Summary and Evaluation (USFWS 2017), and Biological Opinions (USFWS, 2011, pages 20-27; USFWS, 2012, pages 46-49 and 66-71; USFWS, 2013, pages 15-18 and 27-32; USFWS, 2015a, Sections 3.3.3 and 4.4.5). The following text summarizes pertinent information from the aforementioned documents, which are incorporated by reference, and includes new scientific information when available.

3.2.4.11.1 Sound

Polar bears communicate through their body language, vocalizations, and scent markings (Owen et al., 2015; Stirling and Derocher, 1990; USFWS, 2013; Wemmer, Von Ebers, and Scow, 1976). With regards to hearing, one way young cubs (approximately 4 to 5 months old) can communicate with female bears is by humming (Derocher, Van Parijs, and Wiig, 2010; Peters, Owen, and Rogers, 2007). The purpose of this vocalization is hypothesized to stimulate milk release from lactating female bears (Peters, Owens, and Rogers, 2007). Hearing is also vital for successful prey capture. Although polar bears primarily use their sense of smell while hunting, their hearing becomes essential during the latter stages of hunting because at close distances sound propagates more rapidly than scent (Cushing, Cushing, and Jonkel, 1988).

Presently, no hearing threshold criteria specific to polar bears exists. For management and impact analysis purposes the otariid in-air functional hearing range of 100 Hz to 35 kHz is often used for polar bears because of the anatomical similarities between the otariid ear and that of other carnivores (Finneran and Jenkins, 2012). The U.S. Navy has assigned polar bears to the 20 Hz to 60 kHz boxcar frequency range (a multi-species functional hearing range category used in their impact analyses) (Ciminello et al., 2012). Research focused on collecting data that could be used to develop threshold criteria is ongoing. Nachtigall et al. (2007) used electrophysiological methods to measure the in-air hearing abilities of three anesthetized polar bears and found that the best sensitivity occurred in the frequency range from 11.2 to 22.5 kHz.

Recently, Owen and Bowles (2011) used behavioral procedures to measure the in-air auditory thresholds and hearing sensitivity of five female polar bears at frequencies between 125 Hz and 31.5 kHz. Results showed that the greatest sensitivity occurred between 8 and 14 kHz. Sensitivity declined sharply between 14 and 20 kHz, suggesting an upper hearing range 10 kHz to 20 kHz lower than small terrestrial carnivores (Bowles et al., 2008; Fay, 1988 in Owen and Bowles, 2011).

3.2.4.11.2 Vision

In addition to hearing, and olfaction, polar bears have well-developed vision, akin to that of other bear species that aids in detection and capture of prey (Stirling, 1974 in Dehnhardt, 2002).

3.2.4.11.3 Olfaction

Polar bears have a highly developed olfactory system that allows them to locate subnivean seal lairs when foraging (Stirling, 1988) and detect scent markings left in the tracks of other bears (Owen et al., 2015).

3.2.4.11.4 Population and Status

Of 19 formally recognized subpopulations (stocks) of polar bears, individuals from two stocks occur in the U.S. Beaufort Sea. On May 15, 2008, the USFWS listed the polar bear as threatened throughout its range (73 FR 28212, May 15, 2008). Consequently, the species has been designated a depleted species under the MMPA (i.e., the species is below its optimum sustainable population level) [16 USC 1362(1)(c)]. The polar bear was listed as threatened largely due to the ongoing and projected loss of sea ice habitat caused by climate change (73 FR 28212, May 15, 2008) and the USGS has predicted that without changes in the rate of sea ice loss, polar bear habitat in Alaska will decline by 60 to 80 percent by the end of the 21st century (Durner et al., 2009). On December 7, 2010, FWS published the final rule designating Critical Habitat in the Federal Register (75 FR 76086). The final rule identifies geographic areas containing features considered essential for the conservation of the polar bear. The FWS identified three areas or units as critical habitat that requires special management or protection: barrier island habitat, sea ice habitat, and terrestrial denning habitat. Barrier island habitat includes coastal barrier islands and spits along Alaska's coast. It is used for denning, refuge from human disturbance, access to maternal dens and feeding habitat, and travel along the coast. Sea ice habitat is located over the continental shelf and includes water approximately 985 feet or less in depth. Terrestrial denning habitat includes lands within approximately 20 miles of the northern coast of Alaska between the Canadian border and the Kavik River and within approximately 5 miles and Utqiaqvik (formerly Barrow). Polar bears and their designated critical habitat are protected from significant impacts caused by industrial activities through the BOEM leasing stipulations and required operating procedures, as well as subsequent MMPA incidental and directed take authorizations, and ESA consultations.

The most recent minimum estimate for the Southern Beaufort Sea (SBS) Stock of Polar Bears is 1,397 (90 percent Confidence Interval = 606 to 1,212; Coefficient of Variation = 0.106) (Bromaghin et al., 2015). The SBS stock likely was overharvested prior to the passage of the MMPA in 1972 (Amstrup, Stirling, and Lentfer, 1986), but the population generally increased from 1972 through the late 1990s (Amstrup, McDonald, and Stirling, 2001). Estimates by Regehr, Amstrup and Stirling (2006) suggest that by the mid-2000s the SBS population had stabilized and possibly declined. Recent analysis of data from 2001 through 2010 indicated that the SBS stock experienced a 25 to 50 percent decline in abundance from 2004 through 2006, likely due to poor foraging conditions and/or lack of prey (Bromaghin et al., 2015; Stirling et al., 2008). The overall survival rate of adults and young stabilized from 2008 to 2010, although survival rates of sub-adult bears continued to decline, likely a residual effect of the poor nutritional conditions in previous years (Bromaghin et al., 2015).

The most recent estimate of the Chukchi/Bering Seas (CBS) Stock of Polar Bears is 2,000 bears (Aars, Lunn, and Derocher, 2006; Lunn et al., 2002; Muto et al., 2017). This figure is based on extrapolations from older den survey data from Wrangel Island, Russia. Observations of low cub production and maternal denning on Wrangel Island in 2004 through 2013 suggest concern for reductions in natural population growth of the CBS stock (Ovsyanikov, 2012 in IUCN, 2014a). Concurrently, U.S. capture-recapture research conducted in spring of 2008 through 2011 indicated that CBS animals have good body condition and reproduction, suggesting capacity for positive population growth despite sea ice loss (Rode et al., 2014). Furthermore, human-caused removals, particularly illegal harvest in Russia, are thought to be significantly lower than in the late 1990s (IUCN, 2014a).

3.2.4.11.5 Distribution

Although they are classified as marine mammals and are strong swimmers, polar bears rely principally on sea ice to provide a substrate on which to roam, hunt, breed, den, and rest. They also use terrestrial islands and coastal mainland habitats. Preferred habitats include both the active seasonal ice zone that overlies the continental shelf and associated islands, and areas of heavy offshore pack ice (Derocher et al., 2013; Durner et al., 2004, 2009; Schliebe et al., 2006). Bears often travel great distances in search of prey and require large home ranges in order to meet foraging requirements (Auger-Méthé, Lewis, and Derocher, 2015; Derocher et al., 2013). Some bears may be observed swimming between offshore ice and the shoreline or barrier islands (Derocher et al., 2013; Durner et al., 2011; Pagano et al., 2012).

The SBS stock is predominantly distributed throughout the Beaufort Sea off of the northern coast of Alaska. The CBS is distributed throughout the Chukchi and Bering seas off of northwestern Alaska, although bears from the CBS stock could be encountered in the Beaufort Sea because the distribution of the two stocks overlap at their boundaries in the western Beaufort Sea and eastern Chukchi Sea (USFWS, 2010a, 2010b).

The original eastern boundary of the SBS stock, shared by the U.S. and Canada, occurred south of Banks Island and just east of the Baillie Islands, Canada (Amstrup et al., 2000). However, a new eastern boundary, moved westward near the community of Tuktoyaktuk, Northwest Territories, Canada (WMAC, 2011), is currently being implemented by the agencies that manage the stock (USFWS, 2016). The western boundary for the SBS stock is near Icy Cape, Alaska (Amstrup et al., 2004, Obbard et al., 2010).

The CBS stock is managed by the U.S. and the Russian Federation and this stock's boundaries are currently described differently by management and scientific organizations. The Agreement between the United States of America and the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population describes the western boundary as the mouth of the Kolyma River, Russia and its eastern boundary as a line extending north from Point Barrow, Alaska (Obbard et al., 2010 in USFWS, 2016). The Polar Bear Specialist Group describes the northwestern boundary as Chauniskaya Bay, in the East Siberian Sea, while the northeastern boundary is near Icy Cape, Alaska (Obbard et al., 2010; USFWS, 2016).

The southern distribution of the CBS stock is determined by the southern edge of the pack ice (Garner, Knick, and Douglas, 1990). The polar bear stocks are further classified as occurring in one of four ecoregions (Amstrup et al., 2008). Both the CBS and SBS stocks belong to the Divergent Ice Ecoregion which is characterized by the formation of annual sea ice that is transported towards the polar basin.

During the open-water season the SBS population occurs more commonly along the coast and barrier islands of the Beaufort Sea while the CBS population occurs mainly on Wrangel and Herald islands and along the Chukotka (and to a lesser extent the U.S. Chukchi) coast (Derocher et al., 2013; Kalxdorff et al., 2002; Kochnev, 2006; Kochnev et al., 2003; Ovsyanikov, 1998, 2003; Rode et al., 2015; Stishov, 1991).

During the winter and spring, polar bears tend to concentrate in areas of ice with pressure ridges, at floe edges, and on drifting seasonal ice at least 8 inches thick (Schliebe et al., 2006). In the winter, the use of shallow water areas is greatest in areas of active ice with shear zones and leads (Durner et al., 2004; Wilson et al., 2014). The use of landfast ice increases in the spring during the pupping season of ringed seals, and multi-year ice is used in late summer and early autumn as the pack ice retreats to its minimal extent (Derocher et al., 2013; Durner et al., 2004). Ringed seal pupping habitat is especially important to females with cubs of the year because they preferentially select this habitat to replenish their fat reserves immediately after they emerge from maternal dens (Derocher et al., 2013;

Stirling and Lunn, 1997; Stirling et al., 1993). Adult males usually remain with multi-year ice during late summer and early fall and rarely come ashore (Schliebe et al., 2006). SBS polar bears begin to appear on the mainland and barrier islands in increasing numbers during the open-water period in August when the pack ice can be very far from shore (Miller, Schliebe, and Proffitt, 2006; Schliebe et al., 2008). Recent surveys (2010 through 2013) along the Alaska Beaufort Sea coast during August through October have documented an average of 9, ±2bears/62 miles (Atwood et al., 2015).

Prior to freeze-up in fall, large aggregations of polar bears may form at subsistence-harvested bowhead whale carcass sites called bone piles, at Point Barrow, Barter Island, and Cross Island (Atwood et al., 2015; Miller, Schliebe, and Proffitt, 2006; Miller, Wilder, and Wilson, 2015). Atwood at al. (2015) calculated that after carcasses were added to the bone piles, 78 percent of all polar bears observed during their aerial surveys were within 10 miles of the pile. The greatest percentage of bears was documented near Barter Island (40 percent), followed by Cross Island (33 percent). With the return of sea ice in the fall, polar bears become more widely dispersed across the sea ice. This dispersal is not even; SBS bears concentrate on ice in shallow waters less than 185 feet deep over the continental shelf and in areas with more than 50 percent ice cover (Durner et al., 2004, 2006, 2009; Stirling, Lunn, and Iacozza, 1999). Meanwhile, CBS individuals range south through the Bering Strait (Schliebe et al., 2006; USFWS, 2010a; Voorhees and Sparks, 2012; Wilson et al., 2014).

Maternal dens are commonly located on pack ice in snow banks near pressure ridges or on land in compacted snow drifts adjacent to coastal banks (barrier islands and mainland bluffs), river, or stream banks. Dens are often also located at the edge of stable sea ice on the inshore side of barrier islands, although an increasing number of SBS bears are denning on land (Fischbach, Amstrup, and Douglas, 2007). The main terrestrial denning areas for the Southern Beaufort Sea population in Alaska occur on the barrier islands from Point Barrow to Kaktovik and along coastal areas up to 25 miles inland including the Arctic National Wildlife Refuge to Peard Bay, west of Point Barrow (Amstrup and Gardner, 1994; Amstrup, 2000; Durner, Amstrup, and Ambrosius, 2001, 2006). Approximately 63 percent of pregnant SBS bears rely on terrestrial habitat for maternal denning (Amstrup and Gardner, 1994; Fischbach, Amstrup, and Douglas, 2007). Denning of bears from the CBS stock occurs primarily on Wrangel and Herald islands, and on the Chukotka coast in the Russian Federation. Though maternal denning habitat is found on the western coast of Alaska, denning on land for the U.S. portion of the CBS stock is not common (78 FR 35364, June 12, 2013). Female polar bears do not show fidelity to specific den locations, but they tend to den on the same type of substrate, either pack ice or land, from year to year and may return to the same general area to den (Amstrup and Gardner, 1994; Schliebe et al., 2006; Fischbach, Amstrup, and Douglas, 2007). The USGS Alaska Science Center maintains a catalogue of polar bear den locations including records from USGS and FWS surveys, other research activities, and anecdotal reports from other government agencies, coastal residents, and industry personnel (Durner et al., 2010).

The FWS designated critical habitat for the polar bear (75 FR 76086) on December 7, 2010. The U.S. District Court for the District of Alaska issued a decision to the Service on January 11, 2013, which vacated and remanded the final rule on polar bear critical habitat in Alaska Oil and Gas Association et al. v. Salazar et al. (D. Alaska) (3:11-cv-00025-RRB). On February 29, 2016, the Ninth Circuit Court of Appeals upheld the final polar bear critical habitat rule on all points. The critical habitat includes barrier island habitat and sea ice habitat (both described in geographic terms), and terrestrial denning habitat (a functional determination). Barrier island habitat consists of coastal barrier islands and spits along Alaska's coast, and is used for denning, refuge from human disturbance, and travel to mainland maternal denning habitat and offshore maternal denning and foraging habitats. Sea ice habitat is located over the continental shelf, and includes water approximately 984 feet or less in depth. Terrestrial denning habitat includes lands within approximately 20 miles of the northern coast of Alaska between the Canadian border and the Kavik River, and within approximately 5 miles between the Kavik River and Point Barrow (75 FR 76086).

Polar bears are expected to use the Proposed Action Area. In the ice-covered season pregnant females could use the surrounding coastal areas for maternal denning. Non-denning bears (males and females) could use the area to hunt and as a travel corridor. In the open-water season most bears in the Proposed Action Area will be found on the barrier islands or the coastline. During long-term ecological monitoring by BPXA between 2000 and 2013, the mean number of bear sightings reported annually (excluding repeat reports) for the Endicott Satellite Drilling Island and Liberty Unit was 42, but varied from 8 to 158 reports per year (Streever and Bishop, 2014). The number of sightings reported annually was influenced by the number of personnel present, and type and duration of activity conducted in a given year. As such, direct comparison among years is not possible; however, across all of its oil fields BPXA has identified a general upward trend in the number of annual sightings of polar bears on land (Streever and Bishop, 2014). The highest concentration of polar bears near the Proposed Action Area occurs on land during the open-water period, when some polar bears enter the coastal environment as they abandon melting sea ice to search for food on/near land (e.g., whale carcasses), or search for suitable den sites (pregnant females). Aerts et al. (2008) recorded 9 sightings of a total of 10 polar bears in Foggy Island Bay during open-water seismic surveys (July 15 to August 25, 2008). More polar bears were observed on ice or land (60 percent) than swimming in the water (40 percent) (Aerts et al., 2008). During spring 2013 geotechnical investigations in Foggy Island Bay conducted for the Proposed Action, the tracks of one adult bear and one sow/cub pair were reported; however, no polar bears were sighted in the Proposed Action Area during the 2013 winter geotechnical investigations, nor were any seen during 2013 annual monitoring of the Proposed Action Area conducted by BPXA (BPXA, 2013a, 2013b). No polar bears were observed during the 2014 Liberty open-water season geohazard and seafloor mapping surveys (Smultea et al., 2014).

3.2.4.11.6 Life History

Survival. Polar bears are long-lived mammals and in large part are not known to be susceptible to disease, parasites, or injury. The oldest documented female polar bear in the wild was 32 years old and the oldest documented male was 28, though few polar bears in the wild live to be older than 20 (Stirling, 1990). Survival rates vary by age class and increase with age up to approximately 20 years of age (Schliebe et al., 2006). Polar bears are well adapted for thermoregulation in the Arctic, using a fat layer, insulative fur, and specialized hide to maintain a core temperature that is comparable to mammals found in temperate climates (Stirling, 1988).

Reproduction. Polar bears are characterized by a late age of sexual maturity, small litter sizes, and extended parental investment in raising young – factors that combine to contribute to a very low reproductive rate (Schliebe et al., 2006). Reproduction in the female polar bear is similar to that in other ursids. They enter a prolonged estrus between March and June, when breeding occurs (Schliebe et al., 2006; Stirling, Spencer, and Andriashek, 2016). The peak of breeding season appears to be from early April through mid-May. Observations and bloodwork analyses indicate that during the breeding period mating pairs as well as reproductively-mature but unpaired males spend very little time hunting, although in mating pairs the female spends a significantly greater proportion of time hunting than do males (Stirling, Spencer, and Andriashek, 2016). Implantation of the embryo is delayed; the timing is linked to day length in autumn (Lønø, 1970 in Stirling, Spencer, and Andriashek, 2016). Total gestation is 195 to 265 days (Uspenski, 1977 in Schliebe et al., 2006), although during most of this time, active development of the fetus is suspended. The timing of implantation, and therefore the timing of birth, is likely dependent on body condition of the female, which depends on a variety of environmental factors including availability of seal prey (Schliebe et al., 2006). Bears in the Beaufort Sea usually reach reproductive maturity at 5 years old (Lentfer and Hensel, 1980; Stirling, Pearson, and Bunnell, 1976).

Polar bears typically enter dens in the fall, give birth, and remain in or near their dens until they leave with their cubs in March or April. Only pregnant females den for an extended period during the winter; other polar bears may excavate temporary dens to escape harsh winter conditions, but otherwise remain active year-round (Amstrup, 2003). Some pregnant females construct and enter natal dens in October, but most do so in mid- to late November (Amstrup and Gardner, 1994). Birth occurs typically in late December or early January, and mothers and cubs emerge from natal dens in late March or April (Amstrup and Gardner, 1994; Amstrup, 2000; Smith et al., 2007). Researchers monitored den emergence and abandonment along the Beaufort Sea coast in or near the Prudhoe Bay area from 2000 to 2013 (Streever and Bishop, 2014). On average, over the 13 years of this study, female bears emerged from their dens on March 16 (SD = ±8.8 days) and stayed at den sites until March 23 (SD = ±9 days). After this initial emergence, bear families remained at the den site for periods ranging from 1 to 18 days, with an average stay of 6.5 days (Streever and Bishop, 2014).

Litter size and litter production rate vary by geographic area and are expected to change with population size relative to carrying capacity (Schliebe et al., 2006). Furthermore, litter size may change in response to hunting pressure, environmental factors, and other population perturbations. Litters of two cubs are most common (Schliebe et al., 2006). Litters of three cubs are seen sporadically across the Arctic (Ramsay and Stirling, 1988; Derocher and Stirling, 1992). The average litter size encountered during multiple studies throughout the range of polar bears varies from 1.4 to 1.8 cubs (Schliebe et al., 2006). Newborn polar bears weigh approximately 1.3 lbs (Blix and Lentfer, 1979) and are completely dependent on their mother for survival. Cubs grow rapidly, and may weigh 22 to 26.4 lbs by the time they emerge from the den in the spring. Survival of cubs is dependent on their weight when they exit dens (Derocher and Stirling, 1992). Most cub mortality occurred early in the period after emergence from the den (Amstrup and Durner, 1995; Derocher and Stirling, 1996). Young bears will stay with their mothers until weaning, which occurs most commonly in early spring when the cubs are 2.3 years of age (Schliebe et al., 2006). Female polar bears are available to breed again after their cubs are weaned. Therefore, in most areas, the minimum successful reproductive interval for polar bears is 3 years.

3.2.4.11.7 Diet

Polar bears are upper level predators in the Arctic marine ecosystem, preying primarily on ringed seals, and to a lesser extent on bearded and spotted seals (Pilford, 2014; Rogers et al., 2015; Schliebe et al., 2008; Smith, 1980; Allen and Angliss, 2013). They will also capture and consume larger prey such as walruses, belugas, caribou, and narwhals (Derocher, Andriashek, and Stirling, 1993; Gaston and Elliott, 2013; Rode et al., 2015; Stempniewicz, 1993) and will opportunistically forage on birds, eggs, and coastal plants (Derocher, Andriashek, and Stirling, 1993; Gaston and Elliott, 2013; Rode et al., 2015; Stempniewicz, 1993). Carrion, most notably the remains of subsistence-harvested bowhead whales at bone piles at Barter Island, Cross Island, and Point Barrow, are an increasingly important food source, particularly for SBS polar bears. The use of whale carcasses as a food source likely varies among individuals and years. Stable isotope analysis of polar bears in 2003 and 2004 suggested that bowhead whale carcasses comprised 11 to 26 percent (95 percent CI) of the diets of sampled polar bears in 2003, and 0 to 14 percent (95 percent CI) in 2004 (Bentzen et al., 2007). More recently, stable isotope analysis and telemetry data suggest an emerging alternate foraging strategy among SBS adult female polar bears: a subset of bears remained in close proximity to the coast and relied heavily on bowhead whale carcasses while the other portion continued to follow a more traditional strategy, foraging widely on the sea ice for ringed and bearded seals (Rogers et al., 2015). With anticipated continued declines in summer sea ice habitat and potential adverse consequences to ringed seal populations, polar bear reliance on bowhead whale bone piles may increase (Miller, Wilder, and Wilson, 2015; Overland and Wang, 2013).

3.2.4.11.8 Mortality

The primary threat to polar bears is loss of its sea ice habitat, driven by global climate change. Other sources of mortality are discussed below.

Predation. In general, polar bears have no natural non-human predators; however, cannibalism by adult males on cubs and occasionally on adult bears is known to occur (Amstrup et al., 2006; Derocher and Wiig, 1999; Stirling and Ross, 2011; Taylor, Larsen, and Schweinsburg, 1985). While grizzly bears are increasingly common at bone piles in the Beaufort Sea and recent observations at these bone piles indicate that grizzlies are socially dominant, this dominance is asserted without aggression and intraspecies predation at these aggregations have not been recorded in the U.S. Beaufort Sea (Miller, Wilder, and Wilson, 2015).

Harvest. Historically, polar bears have been harvested for subsistence, handicrafts, and recreational hunting. Since the enactment of the MMPA in 1972, polar bear harvest is only allowed for Alaska Native hunters living in coastal communities. This exception allows for the taking of polar bears for subsistence and making of handicrafts provided that the harvest is not conducted in a wasteful manner. The annual harvest from the SBS population was 39 per year in the 1980s, 33 per year in the 1990s, and 32 per year in the 2000s (USFWS, 2010b). More recently for the 10-year period of 2006 through 2015, an average of 19 bears per year were removed from the U.S. portion of the SBS stock (USFWS 2017). The annual harvest from the CBS stock was 92 per year in the 1980s, 49 per year in the 1990s, and 43 per year in the 2000s (USFWS, 2010a). From 2006 to 2015, an average of 30 bears per year were removed from the U.S. portion of the CBS stock which was estimated relative to the boundary near Icy Cape, Alaska, as recognized by the Polar Bear Specialist Group (Obbard et al., 2010). From 2010 to 2011, the annual illegal harvest was estimated at 32 bears per year in Russia, although harvest in Russia is hard to record and quantify (Kochnev and Zdor, 2015). Current removal levels for the CBS are thought to be significantly lower than in the late 1990s (IUCN, 2014a). The FWS has determined that human-caused removals, including subsistence harvest and lethal take for the protection of human life and property, are not a threat to the persistence or recovery of SBS and CBS polar bears as long as removal occurs at a sustainable rate that has only a small or negligible effect on the persistence of the populations (Atwood et al., 2015a; Regehr et al., 2015; USFWS, 2016).

3.2.4.11.9 Climate Change

As described in Section 3.1.6, climate change is expected to result in longer open-water periods, decreased sea ice formation, and increased sea ice losses, which is the primary threat to polar bears. The FWS found polar bear sea ice habitat is declining throughout the species' range, and the sea ice losses are expected to continue for the foreseeable future (Federal Register, 2008). The FWS (Federal Register, 2008) determined the SBS and CBS polar bear stocks, as part of the "threatened" polar bear population, are not currently in danger of extinction, but they are likely to become so in the foreseeable future.

Presently, the SBS stock is currently experiencing the effects of changes in sea ice conditions (Rode et al., 2007; Regehr et al., 2007; Hunter et al., 2007; Rode et al., 2014; Bromaghin et al., 2015). The population is vulnerable to large-scale dramatic seasonal fluctuations in ice movements, decreased abundance and access to prey, and increased energetic costs of hunting. Polar bears of the CBS stock do not seem to be responding to sea ice loss the same way as other populations are responding, such as the SBS stock, as CBS bears appear to be in good body condition and exhibit stable cub production (Rode et al., 2014).

New data continues to support that the global threat of habitat loss identified in the 2008 listing decision remains (USFWS, 2017). The FWS (2017) reported that sea ice continues to rapidly thin and retreat throughout the Arctic and currently there is no regulatory mechanism in place on the national or international level to address this threat. Wiig et al. (2015) reported that Arctic sea ice loss has progressed faster than most climate models have predicted (Stroeve et al., 2007). For example, NCEI (2015) reported that the year 2015 was the warmest year since records have been kept (1880 to 2015). The FWS (2017) concluded that climate change effects on sea ice and polar bears and their prey would very likely continue for several decades or longer unless greenhouse gases in the atmosphere can be held at suitable levels, primarily by reducing greenhouse gas emissions. The FWS continues to support the status of “threatened” under the ESA as bears continue to rely heavily on sea ice for essential life functions and Arctic warming is contributing to the continued loss of sea ice (USFWS, 2017).

3.2.5 Terrestrial Mammals

While several species of rodents and other small mammals, particularly furbearers, occur along Alaska’s North Slope, none of them have been identified as species of particular social or economic concern. For this reason they shall not be discussed further in in this document.

3.2.5.1 Caribou

3.2.5.1.1 Population and Status

Caribou herds on the North Slope and in the area of effect of the Proposed Action include the Western Arctic Caribou Herd (WAH), the Central Arctic Caribou Herd (CAH), the Porcupine Caribou Herd (PCH), and the more sedentary Teshekpuk Lake Caribou Herd (TCH) (Figure 3-29). The WAH has declined by 4 to 6 percent annually between 2003 and 2013. An area-wide survey of caribou herds conducted by ADF&G in 2013 counted 235,000 caribou in the WAH (Dau, 2015), a decline of around 27 percent since the time of the last estimate (325,000) conducted in 2011 (ADF&G, 2014b; Parrett, Dau, and Nedwick, 2014; Dau, 2011). Likewise, the TCH and CAH populations changed from 2011 estimates of 55,000 and 67,000, respectively (Parrett, 2011; Parrett 2015; Lenart, 2013a), to 32,000 (42 percent decline) and 22,630 (66 percent decrease) (ADF&G 2017; Parrett, Dau, and Nedwick, 2014).

Caribou occur in the Canadian Arctic with two herds, the Cape Bathurst and Tuktoyaktuk Caribou and reindeer herds occupying habitat that could be affected by the Proposed Action but only in the event of a very large spill. Of the two Canadian herds, the Cape Bathurst Caribou Herd (CBH) is larger numbering between 16,000 to 22,000 individuals (Davison et al., 2014; Northwest Territories 2015a). Caribou and reindeer have formed a small herd on the Tuktoyaktuk Peninsula (TPH) numbering 1,700 to 2,556 animals (Davison et al., 2014; Northwest Territories 2015b).

3.2.5.1.2 Distribution

Calving Areas

Spring migration of female caribou who are about to give birth from the overwintering areas to the calving grounds begins in late March and is correlated with the disappearance of snow cover (Hemming 1971; Bergerud, 1974). Often the most direct routes are used; however, certain drainages and routes probably are used during calving migrations, because they tend to be corridors free of snow or with shallow snow (Lent, 1980). Severe weather and deep snow can delay spring migration, with some calving occurring en route (Bergerud, 1974; Carroll et al., 2005). Cows calving en route usually proceed to their traditional calving grounds (Hemming, 1971).

The evolutionary significance of the establishment of the calving grounds may relate directly to the avoidance of predation on the caribou calves, particularly predation by wolves (Bergerud, 1974, 1987). Caribou calves are very vulnerable to wolf predation, as indicated by the documented account of surplus predation by wolves on newborn calves (Miller, Gunn, and Broughton, 1985). By migrating north of the tree line, caribou leave the territories of most wolf packs, which mostly overlap with caribou winter ranges or in the mountain foothills or along the tree line during the wolf-pupping season (Heard and Williams, 1991; Bergerud, 1987). By calving on the open tundra, the female caribou also avoid ambush by other predators such as bears and wolverines. Furthermore, the selection of snow-free patches of tundra on calving grounds helps to camouflage newborn caribou calves from other predators that hunt by sight, such as golden eagles (Bergerud, 1974, 1987).

The sequence of the spring migration, first by parturient females, then by males, non-parturient females, and yearlings, is believed to be a strategy for optimizing the quality of forage as it becomes available with snowmelt on the Arctic tundra, and possibly to alleviate competition between parturient females and other caribou for forage resources during the calving season (Whitten and Cameron, 1980; Griffith et al., 2002). Within days of calving, female caribou collect their offspring and form into herds to shift to summer ranges for grazing (Bergerud, 1974).

Summer Range. Non-parturient caribou migrate to or near calving areas in spring, and remain on the move throughout the summer months seeking nutritious forage so that they can fatten-up in preparation for the next winter. Shortly after calving, females with calves form up herds with each other and with other individuals, and begin moving across the landscape, most likely as a defense against predation and insect harassment (Bergerud, 1974; Helle and Aspi, 1983), and possibly to reduce levels of parasitic infestations (Folstad et al., 1991).

Insect Relief Areas. During the post-calving period in July through August, caribou generally attain their highest degree of aggregation into large herds of animals, sometimes in excess of tens of thousands (Lawhead, 1997). During the summer months, caribou use various upland, windy, and coastal habitats, sandbars, spits, river deltas, and some barrier islands, for relief from insect pests, which reduce foraging efficiency and increase physiological stress (Reimers, 1980). Helle and Aspi (1983) postulated herd formation by caribou is used as a defense against insect harassment by reducing the seriousness of the effects on individual animals, in spite of the obvious increase in intraspecific competition for forage among the caribou.

Winter Range. Bergerud (1974) noted the role of photoperiod (period of time each day during which an organism receives illumination) on hormone production in caribou which in turn make individual animals restless with a tendency towards larger aggregations. Heavy snowfall is the final stimulus needed to encourage caribou herds to migrate to wintering areas (Bergerud, 1974). The movement and distribution of caribou over the winter ranges reflects their need to avoid predators and their response to weather conditions (snow depth and density), which greatly influence the availability of winter forage (Roby, 1980; Ferguson and Messier, 2000; Henshaw, 1968; Bergerud, 1974; Bergerud and Elliot, 1986). Consequently, the numbers of caribou using a particular portion of the winter range are highly variable from year to year (Davis, Valkenburg, and Boertje, 1982; Fancy et al., 1990, as cited in Whitten, 1990).

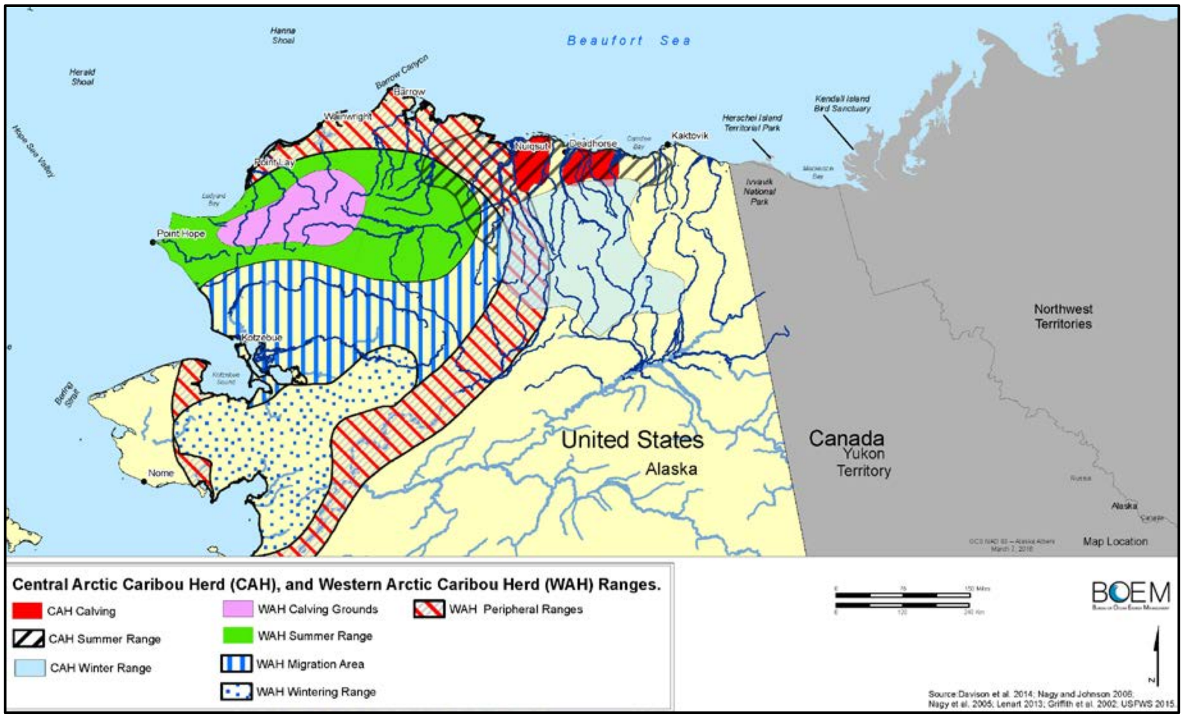

Figure 3-29 Western Arctic and Central Arctic Caribou Herd Habitats

Western Arctic Caribou Herd (WAH)

The WAH ranges over approximately 157,000 square miles of northwestern Alaska (Dau, 2013). During spring, most parturient cows travel north toward the calving grounds in the Utukok Hills, while bulls and nonmaternal cows move to the Wulik Peaks and Lisburne Hills (Figure 3-29). During the post-calving period, maternal cows and calves travel southwest toward the Lisburne Hills where they mingle with bulls and nonmaternal cows. During summer, WAH caribou move east through the Brooks Range. In late summer, most bulls become relatively sedentary in the upper Noatak–Nigu river area while most cows disperse back onto the coastal plain. Most caribou from this herd are more dispersed during fall than at any other time of year as they migrate to winter ranges lying on the Seward Peninsula and the Kobuk and Koyukuk river drainages. In some years, a relatively small proportion of this herd also winters near Point Lay.

Central Arctic Caribou Herd (CAH)

The CAH migrates between summering and calving areas on the Arctic coastal plain and wintering areas south of and in the Brooks Range. Figure 3-29 shows the two calving areas for this herd mostly occur between the Colville and Kuparuk rivers, and between the Sagavanirktok and Canning rivers. The actual areas used would vary between years due to access to forage and weather, etc.

Caribou from the CAH live in an area that generally lacks topographical features providing any significant insect relief. Instead these caribou move to coastal areas that are cooler and windier to escape the biting insects. On many occasions these caribou wade and sometimes swim out into coastal lagoons to escape the insect pests, and small groups of caribou are sometimes encountered on barrier islands in the Beaufort Sea. The CAH caribou use areas nearest the Proposed Action, including their eastern calving area that lies adjacent to and south of Stefansson Sound, Alaska. Consequently, caribou from the CAH are much more likely to be encountered or disturbed by the Proposed Action than caribou from any other caribou herd in Alaska or western Canada.

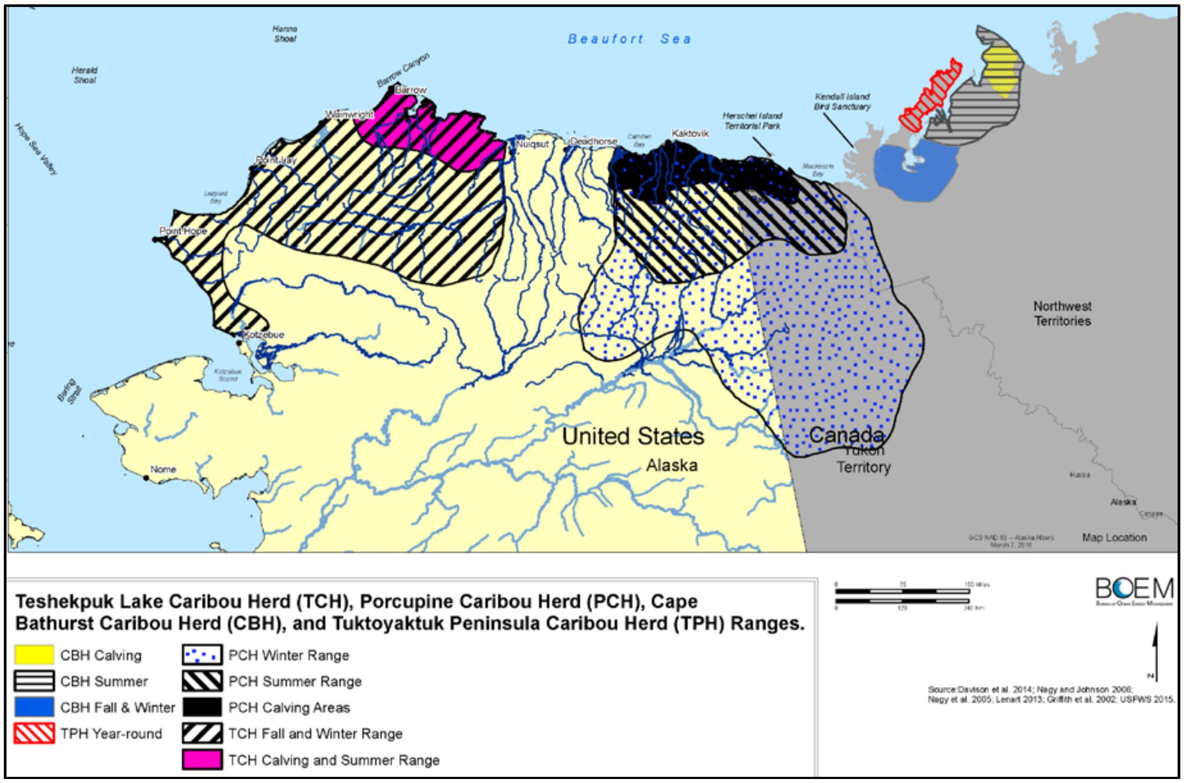

Figure 3-30 Teshekpuk, Porcupine, Tuktoyaktuk, and Cape Bathurst Caribou Herd Ranges

Teshekpuk Lake Caribou Herd (TCH)

Archeological and traditional knowledge suggest that caribou have been abundant near Teshekpuk Lake for at least the last 400 years (Silva et al., 1985). Based on a calving distribution that was geographically distinct from the adjacent WAH and CAH, the TCH was first identified as a distinct herd in 1978 (Davis and Valkenburg, 1978). The TCH primarily inhabits the central coastal plain north of the Brooks Range during spring and summer, but has a large historical range, encompassing wintering areas across northwestern Alaska (Figure 3-30).

Members of the TCH generally aggregate close to the coast for insect relief. Some small groups, however, gather in other cool, windy areas such as the Pik Dunes located about 19 miles south of Teshekpuk Lake (Hemming, 1971; Philo, Carroll, and Yokel, 1993).

Porcupine Caribou Herd (PCH)

In spring the PCH migrates from winter ranges to the northern slope of the Brooks Range to calve in an area that extends from the foothills to the coastline, and from around the Canning River in Alaska into the Yukon Territory (Figure 3-30). After calving, the PCH rapidly assembles into herds sometimes numbering into the thousands to wander across their summer range, feeding, and rearing their calves.

Caribou from the PCH are subject to mosquito harassment from mid-June into August, and oestrid fly harassment from mid-July to late August. To escape biting insects, caribou usually move from inland feeding areas to windswept, vegetation-free upland and coastal areas, such as sandbars, spits, river deltas, and barrier islands (USDOI, MMS, 1987). Caribou encountered on barrier islands occur in small groups numbering 20 animals or less. The primary coastal insect relief areas for WAH caribou occur between Kivalina Lagoon and Point Lay, while the TCH uses coastal insect relief areas between Point Barrow and the Colville River, and the CAH periodically uses coastal insect relief areas between the Colville River and western Camden Bay (NOAA, 2003, 2005).

Tuktoyaktuk Peninsula Caribou Herd (TPH)

The TPH is found on the northern half of the Tuktoyaktuk Peninsula in Canada's Northwest Territories. It has been suggested this herd reoccupied the range after domestic reindeer were removed from the peninsula, and crossbreeding between these caribou and reindeer may have occurred (Northwest Territories, 2015b) as has occurred elsewhere. The TPH lives an existence that is mostly sedentary when compared to the PCH or WAH, mostly remaining on the Tuktoyaktuk Peninsula year-round (Figure 3-30).

Cape Bathurst Caribou Herd (CBH)

The CBH migrates from their wintering grounds to their calving areas in the northern regions of Cape Bathurst. After calving, they generally move to the tip of Cape Bathurst before shifting to summering ranges directly to the south. Eventually, as fall and winter approach, these caribou move to their winter ranges in the lower Tuktoyaktuk Peninsula and the areas east and south of the southern Tuktoyaktuk Peninsula (Figure 3-30).

3.2.5.1.3 Life History

Caribou begin breeding at about 28 months of age, though females in very good physical condition have bred as early as 16 months (ADF&G, 2015). Calving takes place in the spring, generally from late May to late June en route to or at the calving grounds (Bergerud, 1974; Hemming, 1971). Typically, most pregnant cows reach the calving grounds by late May, where they give birth from the time of arrival into early June. Calving is synchronized with the timing of plant growth such that parturient females have access to fresh, nutritious vegetation when it is most needed (Post et al., 2003); however, an added advantage to synchronized calving is that predators hunting caribou calves are inundated or “swamped” by the sheer number of calves, limiting the window of opportunity for predators to kill and consume newborn caribou calves (ADF&G, 2015).

Within days of birth, caribou cows with their calves form into herds and by mid-June commence wandering across the Brooks Range foothills and the ACP. These sometimes large aggregations aid in escaping predators and insects (Bergerud, 1974; Dau, 2005; ADF&G, 2015) and possibly reduce the risk of parasitic infestations (Folstad et al., 1991). During summer, caribou continue moving over their summer rangelands feeding to put on fat and muscle mass for winter survival, and also encourage gestation as applicable (Bergerud, 1974; Adams, 2003; Gerhhart et al., 1996).

As the fall season sets in and day length decreases, the loss of daylight elicits hormonal changes in individual animals making them restless and more gregarious, and they shed the velvet from their antlers (Bergerud, 1974; ADF&G, 2015). With the first heavy snowfall, these caribou commence their fall migration from their summer ranges to winter ranges shown in Figure 3-29 and Figure 3-30.

The rut occurs sometime in October, after the fall migrations, and caribou bulls battle for the right to breed for the next 3 to 4 weeks (Maier and White 1998; ADF&G, 2015). Most fights between bulls are brief, though some can become violent, and caribou bulls are often injured or killed outright (ADF&G, 2015). After the rut ends bulls shed their antlers; however, females and small bulls typically retain their antlers until sometime in April, and pregnant females even into early June (ADF&G, 2015).

3.2.5.1.4 Diet

The caribou diet shifts from season to season and depends on the availability of forage. In summer (May through September), caribou eat the leaves of willows, sedges (grasslike plants), flowering tundra plants, and mushrooms. Caribou calves especially depend on cotton-grass (*Eriophorum spp*) for nutrition. Leafy shrubs (especially willows) are the predominant forage during the post-calving period (Lent, 1966; Thompson and McCourt, 1981; Eastland, Bowyer, and Fancy, 1989). The availability of sedges during spring, which depends on temperature and snow cover, likely affects specific calving locations and calving success rates. After insect numbers drop in August, caribou disperse to feed on willows and mushrooms to regain weight.

In fall and winter most caribou herds switch to lichens (*Cladina* and *Claytonia spp.* mostly), sedges (grasslike plants), and small shrubs (Arctic willow, blueberry, etc.) (ADF&G, 2015). Less migratory herds, such as the TCH which winters where relatively few lichens are present, may consume more sedges and vascular plants and less lichen and willow than migratory herds like the WAH or PCH. Similarly, the CBH at Cape Bathurst relies more on lichens and less on graminoids and willows (Parrett, 2007). After winter, caribou shift their diet back to vascular plants such as cotton-grasses (*Eriophorum spp.*), other sedges, grasses, willows, forbs, etc. (Lent, 1966; Thompson and McCourt, 1981).

3.2.5.1.5 Mortality

The primary predators of caribou are wolves; grizzly bears, and golden eagles, and wolverines vary in prominence as conditions dictate (Bergerud, 1983; ADF&G, 2015; Crête and Manseau, 1996; Young et al., 2002; Johnson et al., 1996). Caribou in Alaska are also affected by brucellosis (Neiland et al., 1968), and other microbial pathogens (Zarnke, 1983), as well as parasites (Folstad et al., 1991). Approximately 15,791 caribou from the WAH (Dau, 2013), 1,850 from the PCH (Caikoski, 2013), 3,386 from the TCH (Parrett, 2013), and 1,129 from the CAH (Lenart, 2013a) were harvested for subsistence and recreational hunting in Alaska during 2011.

3.2.5.1.6 Climate Change

In recent years, shrubs and trees have been observed growing in places where they previously did not exist; the potential for shrub and tree encroachment into the Arctic has become a cause for concern (McNew et al., 2013). The successful development of new plant communities, and the northward advance of trees and shrubs would depend on the genetically regulated abilities of a species to adapt to new environmental conditions (Nicotra et al.; 2010; Shaw and Etterson, 2012; Franks and Hoffmann, 2012). Consequently, there may be genetic limitations to how far north a plant species can grow, an environmental limitation other than temperature and precipitation; meaning trees and shrubs in northern Alaska may lack the genetic flexibility necessary to germinate and grow along the Chukchi and Beaufort Sea coastlines or on the ACP.

Kaarlejärvi (2014) determined herbivores such as reindeer (caribou), and microtines can prevent lowland forbs from invading areas of open tundra through herbivory, and that herbivores counteract the effects of climate warming by slowing or preventing the invasion of new plant species into tundra systems. Cahoon et al. (2012) determined large herbivores can mediate the responses of Arctic ecosystems to climate change through herbivory. Thus, maintaining healthy populations of caribou and other large herbivores in the Arctic may offset many of the ecological effects of climate change such as shifts in diversity, invasion by novel new species, and transitions to novel new ecological communities.

Beest et al. (2016) found when reindeer reduce shrub height and abundance, summer albedo increases in shrub-dominated vegetation and willow-dominated depressions. Results revealed lower net radiation, and latent and sensible heat fluxes in heavily-grazed sites in all shrub-dominated vegetation types, suggesting a structural shift from graminoid to shrub tundra drives the difference in summer albedo, rather than shifts from dwarf-shrub to tall-shrub tundra. Consequently caribou/reindeer had a potential cooling effect on climate by increasing summer albedo and decreasing net radiation.

An effect of longer, warmer growing seasons with a deeper layer of thawed permafrost is increased root production by vascular plants. A shift to earlier emergence of plants could potentially lead to a trophic-mismatch between plant development, nutritional quality of plants, and caribou calving and grazing (Kerby and Post, 2013). Increases in growing season length, temperatures, permafrost thawing, and increased precipitation could be advantageous to the production of vascular forage plants on summer ranges. The increase in vascular range plants would result in a corresponding loss to non-vascular winter range plants such as lichens, however, which could be detrimental to caribou. Caribou can be affected by the loss of sea ice in the Arctic. Without ice to moderate the effects of wind on the ocean's surface, larger storm events which could destroy extensive areas of coastal habitat over time could occur throughout the Beaufort Sea.

Increasing fire frequency is another characteristic of climate change in the Arctic and could lead to the long-term destruction of caribou winter ranges; some areas may take 50 years or more to recover from fires (Joly, Duffy, and Rupp, 2012; Gustine et al., 2014).

Recently, the topic of winter rain-on-snow event degradation of caribou winter ranges has been discussed. Tyler (2010) found little empirical evidence supporting such a view exists, and concluded the effects of climate variability on caribou are "dwarfed" by the effects of density-independent factors of politics, social issues, and economics. Since 2010, other studies have been conducted which support the assumption of adverse effects from rain-on-snow events (Descamps et al., 2017; Langolis et al 2017; Hansen et al., 2011; Hansen et al., 2014).

For these reasons climate change across the North Slope would have mixed effects on caribou along the North Slope and those near the Beaufort Sea.

3.2.5.2 Musk Ox

3.2.5.2.1 Population and Status

Indigenous populations of muskoxen were extirpated in the 1800s in northern Alaska (Smith, 1989). Muskoxen were reintroduced on the Arctic National Wildlife Range [which became the Arctic National Wildlife Refuge (ANWR) in 1980, and now referred to as the Arctic Refuge] in 1969 and in the Kavik River area (between Prudhoe Bay and the ANWR) in 1970; they were reintroduced west of the National Petroleum Reserve-Alaska (NPR-A) near Cape Thompson in 1970 and 1977 (Smith, 1989).

There are approximately 4,200 (Gunn et al., 2013) muskoxen in Alaska occurring in the northcentral, northeastern, and northwestern portions of the state, on Nunivak and Nelson islands, the Seward Peninsula, and the YKD. In recent years, the herds in northeastern Alaska, especially those in the ANWR and adjoining areas, have declined – presumably due to grizzly bear predation (ADF&G, 2015; Reynolds, Reynolds, and Shideler, 2002).

In 1998, a total of about 800 muskoxen were observed in the 310-mile area between the Itkillik River west of Prudhoe Bay and the Babbage River in northwestern Canada (Reynolds, 1998). By 2013, ADF&G estimated that there were more than 200 muskoxen on the Central and Eastern Arctic Slope, down from 302, most likely because of grizzly bear predation (Lenart, 2013b; Arthur and Del Vecchio, 2013).

3.2.5.2.2 Distribution

Muskox herd sizes are often small, consisting of a few calves mixed in among adults and yearlings. As a rule they are sedentary, usually remaining within a limited geographical area, though young males and sometimes females wander great distances. Recent radio-tracking of 121 adult female muskoxen in northwestern Alaska showed females moving across large geographic areas, contrary to prior assumptions regarding muskox site fidelity (Adams, 2013).

The most important habitats for muskoxen appear to be riparian, upland shrub, and moist sedge-shrub meadows (Johnson et al., 1996). Muskoxen generally do not migrate but will move in response to seasonal changes in snow cover and vegetation. They use riparian habitats along the major river drainages on the Arctic.

The reintroductions to the east established the ANWR population, which grew rapidly and expanded both east and west of the Refuge (Garner and Reynolds, 1986). North Slope muskoxen are found as far east as the Babbage River in northwestern Canada and as far west as the Kogru River. Common drainages where muskoxen have been observed include the Colville, Itkillik, Kuparuk, Sagavanirktok, Canning, Sadlerochit, Hulahula, Okpilik, Jago, and Aichilik rivers (Lenart, 2013b). Muskoxen occur from Cape Lisburne to Canada and from the Brooks Range to the Arctic coast, with fewer found in ANWR and more towards the western Brooks Range (Lenart 2013b; Westing 2013). A release of muskoxen at Cape Thompson on the Chukchi coastline and on the Seward Peninsula resulted in range expansion northward into the western Brooks Range and west to Cape Lisburne (Westing 2013), and they have been spreading into the Gates of the Arctic National Park and Preserve since at least 1989 (Lawler 2003). Generally sedentary, muskoxen occasionally make impressive journeys. One tagged muskox cow traveled from the Igichuk Hills to Corwin Bluff in 2009 to 2010 (Westing, 2013).

3.2.5.2.3 Life History

Calving takes place from about April to early June (Garner and Reynolds, 1987). Distribution of muskoxen during the calving season, summer, and winter are similar with little movement during winter (Reynolds, 1992). The breeding season begins during late summer, followed by mating which occurs between August and October (ADF&G, 2015). Smaller harem groups that form in the mating season may contain 5 to 15 females and sub-adults, with one dominant bull. The dominant bull muskox prevents other adult bulls from entering the group, and bulls excluded from such breeding herds wander widely in search of a harem during summer. Winter herds may include up to 75 animals and generally, lone bull muskoxen that were excluded during the mating season will join herds during winter. During winter, muskoxen mostly stay in place and rely heavily on the energy reserves they've accumulated over the spring, summer, and fall to survive (Adamczewski, Hudson, and Gates, 1993).

3.2.5.2.4 Diet

Muskoxen eat a wide variety of plants, including grasses, sedges, forbs, and woody plants particularly willows. They are poorly adapted for digging through heavy snow for food, so winter habitat is generally restricted to areas with shallow snow accumulations or areas blown free of snow (ADF&G, 2015).

3.2.5.2.5 Mortality

Grizzly bears are the primary predators for muskoxen and have been implicated in muskox population declines in some areas of Alaska (Westing, 3013; Lenart, 2013b). To a much lesser extent muskoxen are hunted; however, with declining herd numbers opportunities to hunt muskox will also decline. Since caribou in Alaska have been exposed to Brucella, it is likely muskoxen have been exposed too considering their shared habitat preferences; however, brucellosis has not been shown to be a causal agent in any population declines of muskoxen or directly associated with any muskoxen mortalities.

3.2.5.2.6 Climate Change

As sea ice losses continue to increase, larger storm events may occur throughout the Arctic Ocean, and without sea ice to moderate the effects of winds on water, large waves and swells would develop which could impact coastal habitat over time. Increases in growing season length, temperatures, permafrost thawing, and increased precipitation could be advantageous to the production of vascular forage plants on summer ranges, which would be a positive effect for muskoxen. An effect of longer, warmer growing seasons with a deeper layer of thawed permafrost is increased root production by vascular plants, and a shift to earlier emergence of plants that could lead to a trophic-mismatch between plant development, nutritional quality of plants, and muskox calving and grazing as Kerby and Post (2013) observed for caribou. However, the non-migratory behavior of muskoxen may prevent trophic-mismatches between muskox and their forage species. Increasing fire frequency could lead to the long-term destruction of musk ox winter ranges; however, seral stages that follow Arctic wildfires would include graminoid, forb, and shrub communities that could favor muskoxen.

Changes in long-term flora on the North Slope could affect Arctic herbivores. In recent years, shrubs and trees have been observed growing in places where they previously did not exist. The potential for shrub and tree encroachment into the Arctic has been a cause for concern (McNew et al., 2013); however, the development of new plant communities, and the northward advancement of trees and shrubs would depend on genetically regulated abilities of each species to adapt to new environmental conditions (Nicotra et al.; 2010; Shaw and Etterson, 2012; Franks and Hoffmann, 2012).

Consequently, genetic limitations may limit how far north a plant species can grow; meaning trees and shrubs in northern Alaska may lack the genetic flexibility necessary to germinate and grow along the Chukchi and Beaufort Sea coastlines or on the ACP. With a mixture of habitat, muskoxen would ideally graze sedge meadows on the ACP in summer, and use shrublands during winter for cover and browse from time-to-time.

Beest et al. (2016) found when reindeer reduce shrub height and abundance, summer albedo increases in shrub-dominated vegetation and willow-dominated depressions. Results revealed lower net radiation, and latent and sensible heat fluxes in heavily-grazed sites in all shrub-dominated vegetation types, suggesting a structural shift from graminoid to shrub tundra drives the difference in summer albedo, rather than shifts from dwarf-shrub to tall-shrub tundra. Consequently caribou/reindeer had a potential cooling effect on climate by increasing summer albedo and decreasing net radiation. Muskox are browsers, and their affinity for browsing may act to increase the albedo which would subsequently decrease temperatures to a point, as was suggested by Beest et al. (2016) for reindeer.

Kaarlejärvi (2014) determined mammalian herbivores can prevent lowland forbs from invading areas of open tundra through herbivory, and that herbivores counteract the effects of climate warming by slowing or preventing the invasion of new plant species into tundra systems. Cahoon et al. (2012) determined large herbivores can mediate the responses of Arctic ecosystems to climate change through herbivory. Thus, maintaining healthy populations of muskoxen and other large herbivores in the Arctic may offset many of the ecological effects of climate change such as shifts in diversity, invasion by novel new species, and transitions to novel new ecological communities, etc. Under the current climate change projections, muskoxen numbers may actually increase along the North Slope. Recently, the topic of winter rain-on-snow event degradation of caribou winter ranges has been discussed; however, muskoxen rely on stored reserves during much of the winter and generally do not browse or graze extensively, though some foraging does occur. A 2003 rain-on-snow event on Banks Island is believed to have resulted in the deaths of around 20,000 muskoxen due to starvation, and muskoxen venturing onto loose sea ice searching for food (Grenfell and Putkonen, 2008; Putkonen and Roe, 2003; Rennert et al., 2009). Consequently, the effects of icing on musk ox winter habitat would likely be moderate since some deaths could occur; however, the musk ox preference for “shrubby” habitat that is increasing in some areas of Arctic Alaska could provide some positive effects to muskoxen through the creation of new habitat.

3.2.5.3 Grizzly Bears

3.2.5.3.1 Population and Status

The grizzly bear population on the western North Slope was considered stable or slowly increasing in 1991. Densities were highest in the foothills of the Brooks Range and lowest on the Arctic North Slope (Carroll, 1991). Lenart (2013c) estimated a population of 656 grizzly bears in Game Units 26B and 26C; however, the overall number of grizzlies in the U.S. Arctic is likely much higher since Carroll (2013) did not attempt population estimates for Game Management Unit 26A, while noting densities appeared to be at high levels relative to carrying capacity.

3.2.5.3.2 Distribution

Presently no concentration areas on the Beaufort Sea coastline have been documented other than the area near Kaktovik where they can feed on bowhead whale carcasses in the fall (Miller, Wilder, and Wilson, 2015). Some inland waterways, such as the Colville and Sagavanirktok rivers, support modest spawning runs of anadromous fish, and bears are assumed to exploit such resources. Consequently, streams supporting anadromous fish may become temporary concentration areas for grizzly bears.

An estimated 60 to 70 bears, or approximately 4 per 386 mi^2, currently inhabit the central North Slope Coastal Plain (Shideler and Hechtel, 2000). Since 1990, the ADF&G has captured and marked 121 bears between Teshekpuk Lake and the Canning River while studying the bears' use of the oil fields (Shideler, 2006b, pers. comm.). These bears have very large home ranges (78 to 5,359 mi^2) (Shideler, 2006b, pers. comm.) and travel up to 31 miles in a day (Shideler and Hechtel, 2000). In 1992, the estimated population for Game Management Unit 26A, the area west of the Itkillik River and which includes all of NPR-A, was 900 to 1,120 bears (Carroll, 2005).

On the North Slope, grizzly bear densities vary from about 0.3 to 5.9 bears per 100 mi^2, with a mean density of 1 bear per 100 mi^2.

During winter grizzlies den in pingos, banks of rivers and lakes, sand dunes, and steep gullies in uplands (Harding, 1976; Shideler and Hechtel 2000), primarily in the last 2 weeks of September through early November. In mid-April to early June they begin to emerge from their dens before most caribou begin calving, with adult males entering dens the latest and emerging the earliest (McLoughlin, Cluff, and Messier, 2002; Shideler and Hechtel, 2000).

3.2.5.3.3 Diet

Grizzly bears forage in riparian areas, river deltas, coasts, and uplands in response to food availability or other habitat needs. In the western Brooks Range they use a variety of food sources including caribou, beach-cast marine mammal carcasses and, to some degree, seasonal salmon and Dolly Varden runs that occur in larger streams. Grizzlies also enjoy excavating Arctic ground squirrel burrows to capture and consume Arctic ground squirrels, and often go out of their way to engage in such behavior (Mueller, 1995).

Grizzlies in the Arctic require very large home ranges compared to bears farther south due to the brief growing season and low productivity in the Arctic. Mowat and Heard (2006) noted grizzly bear diets eastward of Harrison Bay on the ACP show a larger fraction of meat from terrestrial sources (greater than 45 percent of their diet), suggesting a greater nutritional dependence on animal matter versus plant matter among Arctic grizzlies than is observed elsewhere. Grizzly diets in more productive areas contain around 80 to 90 percent plant matter and 10 to 20 percent animal matter.

3.2.5.3.4 Mortality

The only naturally occurring predators for grizzly bears in the U.S. Arctic are other grizzly bears, and the rare occasion when a wolf pack discovers a hibernating bear, or the rare instance when a polar bear finds and kills a grizzly cub. Sport hunting and subsistence hunting are the two primary sources of mortality among grizzly bears on the North Slope and those numbers are low. Lenart (2013c) counted 22 bears harvested in Game Management Unit 26B and 15 in Game Management Unit 26C in 2011, while Carroll (2013) concurrently observed a harvest of 22 bears in Game Management Unit 26A. Both authors acknowledged the likelihood that some bears harvested by local residents might go unreported.

3.2.5.3.5 Climate Change

As sea ice losses continue to increase, larger storm events may occur throughout the Arctic Ocean and without sea ice to moderate the effects of winds on water, large waves and swells would develop which could impact coastal habitat over time. Such storms are more likely to deposit marine mammal carcasses and other food resources onshore that would have a positive effect on grizzlies engaged in scavenging for food.

Increases in growing season length, temperatures, permafrost thawing, and increased precipitation could be advantageous to the production of vascular forage plants on summer ranges, which would be a positive effect for grizzlies. One effect of longer, warmer growing seasons with a deeper layer of thawed permafrost is increased root production which leads to shifts from non-vascular plants to vascular plants, and a shift to earlier plant emergence that could become an important source for grizzly bears emerging from hibernation. Increasing fire frequency could lead to the conversion of moss- and lichen-dominated ecological communities to graminoid and forb-dominated ecological communities that may be better habitat for Arctic ground squirrels and other species grizzlies prey on including muskox, moose, and caribou. Grizzlies respond to fluctuations in prey species numbers by switching to other food sources such as salmon, and this behavior would likely continue into the future. For this reason, they should be more resilient to the effects of climate change than species that have a more specialized diet. They may also shorten their denning period in response to climate change effects to the duration and severity of winter, and a deeper permafrost melt might increase the amount and quality of denning sites. Under the current climate change projections, grizzly numbers could increase throughout the North Slope providing they have access to sufficient numbers of prey animals and forage plants.

3.2.5.4 Arctic Fox

3.2.5.4.1 Population and Status

The Arctic fox population on the North Slope has increased since 1929, as the values and harvest rates of white fox pelts declined (Chesemore, 1967). ADF&G (Caikoski, 2010; Carroll, 2010) reported healthy numbers of Arctic foxes in the U.S. Arctic, meaning Arctic fox populations in the U.S. Arctic remain self-sustaining.

3.2.5.4.2 Distribution

Arctic foxes (*Vulpes lagopus*) are ubiquitous and numerous throughout the U.S. Arctic and sometimes "island-hop" through the barrier islands of the Beaufort Sea scavenging, raiding bird nests, and caching food for later use. Arctic foxes on the Prudhoe Bay oil field readily use development sites for feeding, resting, and denning; their densities are greater in the oil fields than in surrounding undeveloped areas (Eberhardt et al., 1982; Burgess et al., 1993). Development on the Prudhoe Bay oil fields probably has led to increases in fox abundance and productivity (Burgess, 2000).

3.2.5.4.3 Life History

Mating occurs in early March and early April, followed by a 52-day gestation period (ADF&G, 2015). Arctic foxes mostly breed on the coastal plain in coastal regions and most dens have southerly exposure, and extend 6 to 12 feet underground. Enlarged ground squirrel burrows with several entrances are often used as dens.

Pups are born in litters of up to 15 in dens excavated in sandy, well-drained soils on low mounds, hillocks, and river banks. Adults are monogamous in the wild, and split the duties of bringing food to the den and rearing the pups. Pups begin eating meat at about 1 month of age and wean at around 6 weeks (ADF&G, 2015).

Starting at an age of about 3 weeks they begin to hunt, and begin cutting their association with the den around 3 months. In September and October, the family units begin to disintegrate and by mid-winter Arctic foxes are mainly leading a solitary existence, reaching sexual maturity at 9 to 10 months (ADF&G, 2015).

3.2.5.4.4 Diet

Fox populations peak whenever lemmings (their main prey) are abundant. Other food sources include ringed seal pups and the carcasses of other marine mammals and caribou, which are important throughout the year (Chesemore, 1967; Hammill and Smith, 1991). Tundra nesting birds also are a large part of their diet during the summer (Chesemore, 1967; Fay and Follmann, 1982; Quinlan and Lehnhausen, 1982; Raveling, 1989). The availability of winter food sources directly affects the foxes' abundance and productivity (Angerbjorn et al., 1991).

Marine mammals, including carrion and ringed seal pups, are an important diet item for Arctic foxes occurring along the coasts (Anthony, Barten, and Seiser, 2011).

3.2.5.4.5 Mortality

Arctic foxes are particularly subject to outbreaks of rabies, and their populations tend to fluctuate with the occurrence of the disease and with changes in the availability of food. In recent years, red foxes have been expanding their species range into the Arctic such that they may be found anywhere on the ACP or in the Brooks Range foothills. Red foxes habitually attack, dominate, and kill Arctic foxes when they encounter one another and this behavior was documented by Pamperin, Follman, and Peterson (2006). Other than predation from large raptors, red foxes, wolves, and terminal mishaps, trapping is the largest source of anthropogenic mortality amongst Arctic foxes with at least 109 harvested in Game Management Unit 26B as reported by ADF&G (2013).

3.2.5.4.6 Climate Change

Furbearing mammals such as Arctic foxes can be affected by climate change in the Arctic. Larger storms coming off the ocean are more likely to deposit marine mammal carcasses and other food resources onshore, which would be a positive effect for foxes scavenging on carrion. Another positive benefit of climate change could be the increased biological productivity that a warming climate would have throughout the terrestrial plant communities. Such productivity would initially include increased plant vegetative production, which would provide increased forage for herbivores over a longer growing season. Healthier and more abundant prey species, or new prey species, would have a beneficial effect on Arctic foxes through a more diverse diet with increased caloric value. For example, a decrease in caribou numbers might be compensated by increases in rodent, musk ox, moose, or sheep numbers due to better range conditions and milder temperatures. For Arctic foxes, having a resident population of prey species to rely upon rather than migratory caribou, could mean consistent, high quality nutrition throughout the year rather than hunger interspersed with periodic episodes of feasting when caribou calve or migrate through an area or as carrion becomes available.

An adverse effect of climate change on Arctic foxes could occur by concurrent increases in red foxes along the North Slope. Red foxes prey on and displace Arctic foxes (Frafjord, Becker, and Angerbjörn, 1989; Pamperin, Follmann, and Petersen, 2006; Tannerfeldt, Elmhagen, and Angerbjörn, 2002), and increasing numbers of red foxes in the future could potentially displace or eliminate Arctic foxes from habitats important to their continued presence on the ACP.

3.2.6 Vegetation, Wetlands and Substrate

This section describes the nearshore and onshore/inland vegetative communities that could potentially be affected by the Proposed Action's onshore or offshore activities, or a large oil spill. Figure 3-31 presents a vegetation and wetland delineation map of the "Wetlands Delineation Study Area" and a summary of the distribution of wetland types is found in Table 3-9.

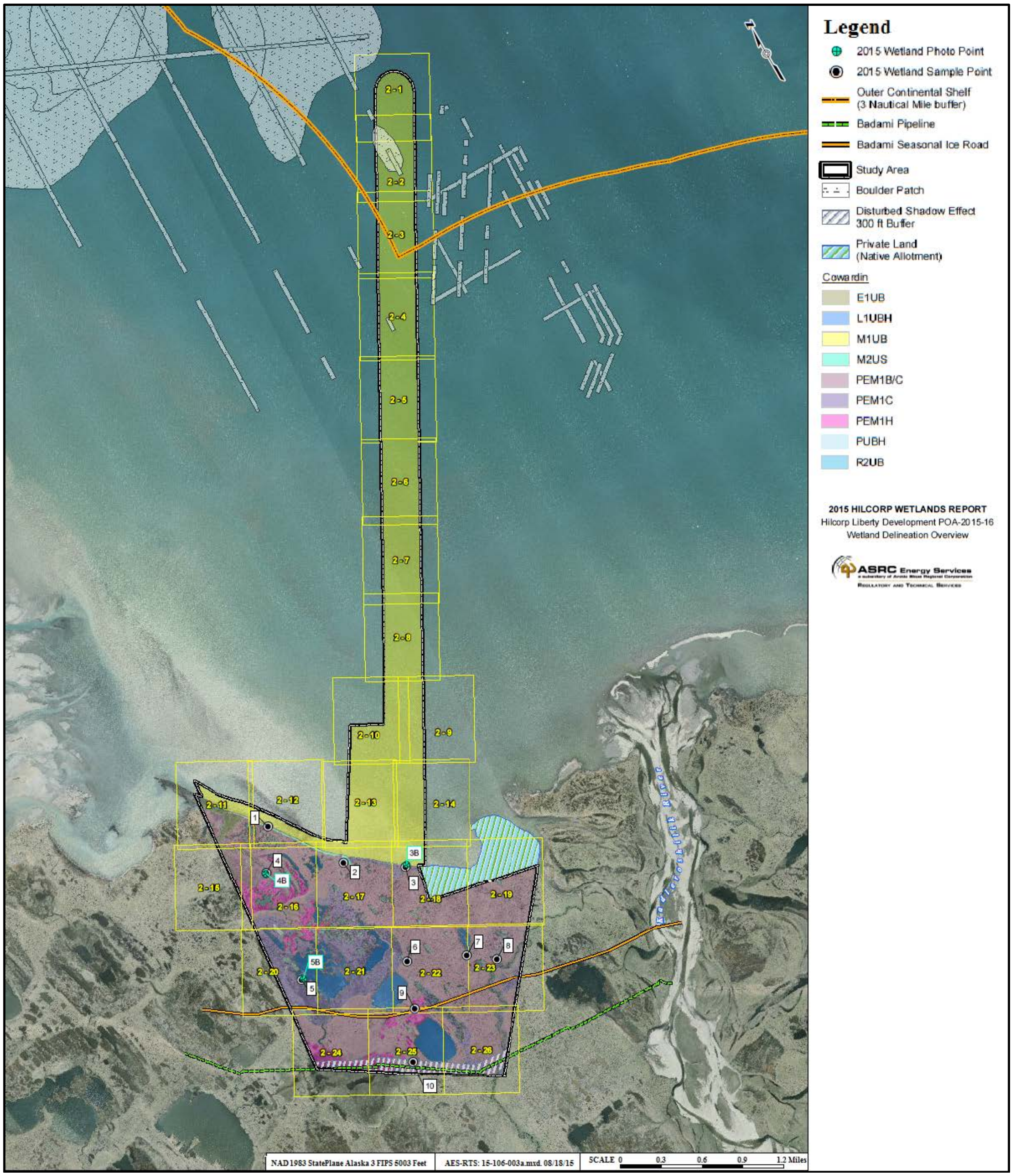

Figure 3-31 Vegetation and Wetlands Delineation of the Wetlands Study Delineation Area
Source: AES, 2015, Figure 1

AES prepared an aquatic site assessment (ASA) for the Proposed Action Area wetlands (see the Liberty Development Wetland Delineation Report, Foggy Island Bay, Alaska. August 2015). The ASA (Table 4.3-1, Appendix C of online Wetland Report at www.boem.gov/liberty) found that most of the wetlands were pristine and high functioning; but not rare, unique, being used for science, or under threat from upstream sediments or toxins. All other waters of the U.S. (marine, estuaries, lakes, and rivers) in Alaska are automatically rated as Category I. Wetlands in the project area are evaluated as Category I or II (Table 4.3-1 and Table 4.3-2). Areas of Marine Boulder Patches and *Arctophila* *fulva* rated as Category I+, were also mapped to illustrate their location (Wetland Report at www.boem.gov/liberty).

Soils in the study area consist of a thick organic layer overlying permafrost (histosols and histic epipedons). Thick sand and gravel deposits are layered with varying amounts of fines and silt/clay interbeds. Permafrost is found at a depth between 9 and 15 inches, and can range from 650 to 2,100 feet thick. Patterned ground with small rises and depressions is common throughout the area. Active layer depths can range from approximately 1 to 4 feet, with an average of about 1.5 feet.

The ACP is a physiographic province dominated by periglacial features (thaw lakes, marshes, and polygonal patterned ground) that provide little topographic relief. The area is characterized by poorly drained soils, lakes, and irregular coastline containing many small bays, lagoons, spits, beaches, and barrier islands. With the exception of thaw bulbs under larger lakes and streams, permafrost is continuous across the ACP (Jorgenson and Shur, 2007).

All of the nearshore and onshore areas that would be impacted by the Proposed Action's construction are classified by the FWS as wetlands. Construction associated with the Proposed Action would impact wetlands and deeper water habitat. A permit from the USACE, under Section 404 of the Clean Water Act, would be required for the discharge of fill in wetlands, or the discharge of fill into territorial seas below the mean high tide line. This section discusses vegetation, wetlands and soils within the Proposed Action Area (see Figure 3-31), and the substrate in the Beaufort Sea that could be impacted by the construction of the buried pipeline.

BOEM has incorporated by reference the Liberty Development Wetland Delineation Report, Foggy Island Bay, Alaska, performed by ASRC Energy Services (AES) (2015). This wetland and waters of the U.S. delineation study was performed in accordance with the USACE Wetlands Delineation Manual (Environmental Laboratory, 1987) and the Regional Supplement to the USACE Wetland Delineation Manual: Alaska Region (Version 2.0) (USACE, 2007). Additionally, AES (2015) performed an Aquatic Site Assessment based on the wetlands functions and values as described by Arctic Slope Regional Corporation's Wetland Mitigation Bank's "Arctic North Slope Rapid Assessment method" (ANSRAM).

3.2.6.1 Arctic Vegetation Types Potentially Affected

Table 3-9 Summary of Wetlands Distribution in the Wetlands Study Delineation Area

Cowardin Code	Description	Acres 10/404	Acres OCS
PEM1B/C	Palustrine Emergent Persistent Saturated/Seasonally Flooded	1,044	
PEM1C	Palustrine Emergent Persistent Seasonally Flooded	357	
PEM1H	Palustrine Emergent Persistent Permanently Flooded	172	
PUBH	Palustrine Unconsolidated Bottom Permanently Flooded	82	
R2UB	Riverine Lower Perennial Unconsolidated Bottom	8	
L1UBH	Lacustrine Limnetic Unconsolidated Bottom Permanently Flooded	180	
M1UB,M2US	Marine Subtidal Unconsolidated Bottom/Marine Intertidal Unconsolidated Shore	1,081	225
E1UB	Estuarine Subtidal Unconsolidated Bottom	24	

Source: AES, 2015.

3.2.6.1.1 Wetlands

Emergent wetlands are dominated by herbaceous angiosperms, and are the primary vegetated ecosystem in the project area. Emergent wetlands types differ with variances in hydrologic regime on the landscape and due to interaction with permafrost.

Wetlands with saturated hydrological regimes (PEM1B/C) are characterized by having soils periodically saturated with water during the growing season. These had the greatest variety in characteristics over the study area. Almost all of these had patterned ground formed from ice wedges being thrust to the surface, creating small rises and depressions throughout the area. These rises and depressions were examined for the possibility of wetland/upland mosaics, but found that the highest, driest rises still had wetland vegetation and soil characteristics. Saturation and/or high water tables were found in the depressions of the patterned ground. These areas had a variety of vegetation including very low shrubs such as Salix and Arctous, and herbs like Eriophorum and Carex. Soil profiles tended to have shallow permafrost, with organics observed. Hydrology is expected to perch on top of the shallow permafrost during spring snowmelt, flooding, and/or precipitation events to create anoxic conditions during the growing season.

Wetlands with seasonally flooded hydrological regimes (PEM1C) are characterized by having soils seasonally inundated with water during the growing season. These areas had greater high centered polygon topographic relief. These polygons were examined for the possibility of upland/wetland mosaics; but no evidence was found to support that type of problematic wetland. The depressions indicated evidence of seasonal flooding. PEM1C wetlands had a large number of very small shrubs present including small Salix and Dryas, along with large amounts of Carex. Soil profiles consisted of histic epipedons, with approximately 8 inches of saturated fibric organic and deeper layers of darker mineral soils. These are due to the colder Arctic temperatures and the anaerobic conditions due to the seasonal flooding.

Wetlands with permanently flooded hydrological regimes (PEM1H) are characterized by having soils frequently inundated with water during the growing season. These were low centered polygonal tundra, with large polygons and shallow water tables. These areas have relatively deep permafrost (15 inches) and thick layers of fibric organic material developed from the longer anaerobic conditions caused by permanent flooding. Few shrubs were present and vegetation consisted of *Carex* and *Eriophorum*.

Ponds

There are a great number of ponds (PUBH) in the project area. On the North Slope, ponds are often less than 20 acres large. They have a variety of wetland dependent plants supporting waterfowl and other types of wildlife.

Rivers

Riverine systems (R2UB) are present in the study area, with bed and bank features and ordinary high water lines. These river systems convey waters through the flat topography to the Beaufort Sea. These are low gradient systems, and water velocity is slow. Water may flow throughout the year, but given the harsh conditions of the Arctic some flow may be seasonal. The substrate was observed to be sand and mud. No signs of fish were observed, and ADF&G does not list Anadromous Fish Streams in the study area.

Lakes

Lakes (L1UBH) have complicated characteristics on the North Slope, often with very shallow banks, large littoral zones, and polygonal bathymetry due to the underlying permafrost. Some lakes freeze solid during the winter, while others are deep enough to have free water at depths greater than 5 feet. On the North Slope, lakes are often greater than 20 acres. The large littoral zones of lakes were found to often support dense habitats of aquatic vegetation.

Marine

The northern area of the project is the Beaufort Sea. The Beaufort Sea (a Traditional Navigable Water [TNW]) is the dominant habitat for the project. The marine (M1UB, M2US) shoreline in the project area consists of small (3- to 5-foot) bluffs where permafrost is eroding into the ocean. Cold Arctic winds circulate keeping vegetation small and stunted, and the majority of the year the ocean is covered in sea ice.

Estuary

On the far western edge of the project area is a small estuary (E1UB) system which appears to hold brackish water, and be the floodplain for some riverine systems. These areas are important transition zones between salt and freshwater environments, and provide a location for turbidity to fall out prior to entering the ocean. These locations can also provide overwintering habitat for some fish species. As freshwater areas freeze shut, estuaries can be refuges for typically salt water species.

Arctophila fulva

Arctophila fulva is an herbaceous plant which is of particular interest to conservation agencies due to its importance to waterfowl habitat. This plant has been identified to be important for many species including Endangered Species Act Steller's eiders, which seasonally inhabit the North Slope. Studies near Utqiaqvik have found that most (80 percent) Steller's eider broods are in *Arctophila fulva* habitat (Quakenbush et al., 2004).

In the study area *Arctophila fulva* is found at the edges between lacustrine, riverine or marine systems adjacent to wetland areas. These are where wetlands border bodies of water that have seasonal periods of surface water. In these locations, *Arctophila fulva* is dense and ubiquitous where it has not been heavily grazed. Many flocks of waterfowl and geese were observed in the *Arctophila fulva* areas.

Arctophila fulva was not found in the central region of the study area, where the Proposed Action is planned. These non-fulva areas are along the lacustrine/emergent wetland border areas (L1UBH-PEM1B/C or L1UBH-PEM1H). These habitats have better banks, without the gently increasing gradient in water depth that *Arctophila fulva* appears to prefer.

3.2.6.1.2 Climate Change

Wetlands are among the most abundant and productive aquatic ecosystems in the Arctic. They are ubiquitous and characteristic features throughout the Arctic and almost all are created by the retention of water above the permafrost (ACIA, 2005). Because the very nature of their habitats results from interactions between temperature, precipitation, and permafrost, these Arctic freshwater systems are particularly sensitive to climate change. Aside from habitat provision, river-flow attenuation, and a number of other ecological functions, wetlands also store and potentially release a notable amount of carbon, with potential positive feedbacks to climate change (e.g., radiative forcing by CH_4 and CO_2) (ACIA, 2005). The role of Arctic and subarctic wetlands as net sinks of sources of carbon is highly dependent on the seasonal water budget and levels, the brief and intense period of summer primary productivity (during which photosynthetic assimilation and respiration of CO_2 and bacterial metabolism and CH_4 generation may be most active), soil type, active-layer depth, and extent of permafrost (ACIA, 2005). The future status of wetlands as carbon sinks or sources will depend on changes in vegetation, temperature, and soil conditions all of which are sensitive to direct and indirect effects of climate change (ACIA, 2005).

3.2.6.2 Threatened/Endangered and Sensitive Plant Species

3.2.6.2.1 U.S. Status

No federally-listed threatened or endangered plants are known to occur on the ACP (USFWS, 2014d). The Alaska Natural Heritage Program (AKNHP) maintains a database of rare vascular plant species, which includes global and state species status ranks. Plants ranked as critically imperiled or imperiled in Alaska could occur in the area potentially affected by the Proposed Action. These include eight Bureau of Land Management sensitive species of plants which are known to occur (Cortés-Burns et al., 2009) within the area potentially affected by the Proposed Action for this FEIS:

- Alpine Whitlow-grass (*Draba micropetala*)

- Adam’s Whitlow-grass (*Draba pauciflora*)
- Oriental Junegrass (*Koeleria asiatica*)
- Drummond’s bluebell (*Mertensia drummondii*)
- Arctic poppy (Papaver gorodkovii)
- Sabine grass (Pleuropogon sabinei)
- Alaskan bluegrass (Poa hartzii ssp. Alaskana)
- Circumpolar cinquefoil (*Potentilla stipularis*)

3.2.6.2.2 Canada Status

The Yukon Territory has one species of Plant that is considered to be at risk under Canadian federal legislation, the Baikal Sedge (*Carex sabulosa*). This threatened sedge grows in active, shifting dune environments of southwest Yukon (Baikal Sedge Recovery Team, 2012). In the Northwest Territories the following plant species are of Global Conservation Concern and could be affected by a very large oil spill (VLOS); they are considered globally rare species that have not yet gone through the process to assess and list under the Canadian Northwest Territories “Species at Risk (NWT) Act” or the Canadian federal “Species at Risk Act.”

- Hairy Rockcress (*Braya pilosa*)
- Nahanni Aster (Symphyotrichum nahanniense)
- Banks Island Alkali Grass (*Puccinellia banksiensis*)
- Raup's Willow (*Salix raupii*)
- Drummond's Bluebell (*Mertensia drummondii*)

Only the Banks Island Alkali Grass occurs near the shores of inland freshwater lakes. Hairy rockcress is endangered; it grows on bluffs and dry uplands on patches of bare, calcium-rich sandy or silty soils. It is endangered by the loss of habitat through very rapid coastal erosion and saline wash resulting from storm surges, and by permafrost melting (COSEWIC, 2013).

3.3 Sociocultural Systems

3.3.1 Sociocultural Systems

3.3.1.1 A Subsistence Focus

Sociocultural systems and rural subsistence practices are inseparable in northern Alaska. Iñupiat peoples comprise the majority of the population in northern Alaska (Hunsinger and Sandberg, 2013). Subsistence substantially contributes to cultural continuity, well-being, identity, and life satisfaction in northern Alaska (Martin, 2012).

Subsistence is a dominant component of Iñupiaq socioeconomics and holds at least equal importance to that of the cash and wage earning sectors; the subsistence and monetary components of these systems have become irrevocably intertwined (Galginaitis, 2014b; Huskey, 2004). Both subsistence and commercial wage activities contribute to community survival, well-being, and the way of life so highly valued in rural communities (Huskey, 2004; 2009; Martin, 2012; Wolfe and Walker, 1987). Braund and Moorehead (2004, p. 105) defined “way of life” as the economic, social, and cultural relationships of a group of people and the meanings they attribute to these relationships, including their relationships to natural resources. During the late twentieth century to present, the production of wild foods and distribution of wild resources for local consumption and small-scale exchange have been the focus of subsistence activities in rural Alaska (Wolfe, 2009).

Researchers have documented a positive relationship in North Slope communities between cash income and subsistence harvest and sharing patterns; cash and employment play an integral role within the subsistence way of life (BurnSilver et al., 2016; Kofinas et al., 2016). Households with a source of cash income tend to invest more in subsistence activities and equipment, harvest more wild foods, and provide subsistence food to more households than those without cash incomes. North Slope Borough (NSB) residents have tended to allocate less time for subsistence activities as they increase employment time; yet greater income allows for fuel and equipment purchases that promote more efficient use of time spent engaged in subsistence activities, such as electronics used for navigation, radios used for communication, snowmachines, four-wheelers, and motor boats (Galginaitis, 2014c; USDOI, BOEM, 2015).

Residents of the NSB have exhibited substantial amounts of local control and self-determination since oil and gas development at Prudhoe Bay (NSB, 1993). The NSB has been able to pioneer many innovative political and legal arrangements related to governance of natural resources. These include co-management partnerships that direct the use of important natural resources such as bowhead whales and conflict avoidance agreements that reduce or eliminate some impacts of energy development on subsistence harvest patterns and sociocultural systems (Galginaitis, 2014c; Lefevre, 2013; Shadian, 2013).

For residents of Kaktovik and Nuiqsut, a subsistence way of life and a diverse set of subsistence-related activities, including harvest and sharing of wild resources, comprise the major sociocultural focus of households, families, and hunters (Galginaitis, 2014b; Kofinas et al., 2016; Pedersen et al., 2000; SRB&A, 2010, 2013). Iñupiat peoples living in coastal communities outside the Proposed Action Area also focus on subsistence activities as a dominant part of their cultures and economies. Examples include Utqiaġvik (Barrow) and Wainwright to the west and Inuit coastal communities to the east in Canada. It is important to consider coastal communities outside the immediate Proposed Action Area due to the possibility of a VLOS. Oil spills are illegal, unplanned, and accidental events. Although not part of the Proposed Action, a VLOS has the potential to affect Sociocultural Systems (Section 3.3.1), Economy (Section 3.3.2), Subsistence Activities (Section 3.3.3), Community Health (Section 3.3.4), and Environmental Justice communities (Section 3.3.5) outside the immediate Proposed Action Area.

Using a subsistence lens, this section summarizes important components of the sociocultural system in northern Alaska that could be affected by the Proposed Action.

3.3.1.2 Components of the Sociocultural System

Sociocultural systems generally encompass several principal components (Elwell, 2013; Wolfe, 1983). In the context of rural Alaska, a social, cultural, or economic system is a set of interacting, interrelated, or interdependent parts that form a collective whole (Wolfe, 1983). A breakdown in any part of the system can cause social disruptions, community dysfunctions, and economic hardships (Wolfe, 1983).

There have been substantial social, economic, and technological changes in the Iñupiaq way of life during the past century related to energy development and other contacts and interactions with people arriving from outside the North Slope (BurnSilver et al., 2016; Carothers, Cotton, and Moerlein, 2013; Kruse, 1982; Langdon, 1996; Martin, 2012). However, subsistence continues to be the visible central organizing element of Iñupiaq sociocultural systems (Kofinas et al., 2016; USDOI, MMS, 2001, 2002), and it is primarily through damage to subsistence resources and disruptions to subsistence activities that impacts to the sociocultural system of the North Slope can be assessed.

The next paragraphs briefly describe three key organizing and interrelated parts of the sociocultural system for Nuiqsut and Kaktovik. Using the umbrella of subsistence, the discussion focuses on social organization, cultural values, and formation of formal institutions (USDOI, BOEM, 2015). The description of these elements generally applies to Nuiqsut, Kaktovik, Utqiaġvik, and other northern coastal communities in Alaska and Canada. These components of the system are closely tied to the mixed subsistence-cash economy of northern Alaska and could be affected by the Proposed Action.

Social organization means how people are divided into social groups and networks. This component of the system corresponds most closely to existing structure at the household and community levels. Structure refers to how key individuals, families, and extended kinships interact to manage vital resources, which includes subsistence harvests but also encompasses many economic resources and involves the broader market economy (Huskey, 2004). The analytic focus is on households, families, and wider networks of kinship and friends that are embedded in groups responsible for harvesting/ collecting, distributing, and consuming available local resources. Social organization describes the non-governmental characteristics of a community that enable it to function and continue through time. For most Alaska Native peoples living on the North Slope, subsistence is the expression of cultural and spiritual identity (ICAS, 1979), and production, distribution, and sharing of subsistence foods are the activities around which most social organization and transmission of cultural traditions occur across generations.

Cultural values reflect the norms and most desirable behaviors of people in a society and are widely shared by members of a social group. Cultural values correspond to the Iñupiat traditional emphasis on maintaining a close relationship with natural resources (ICAS, 1979). They place particular emphasis on kinship, maintenance of the community, spirituality, humility, respecting elders, hunting traditions, cooperation, and sharing (ICAS, 1979; NSB, 2015). Differences in sociocultural systems and cultural values between outsiders and local residents can lead to substantial communication barriers (Bartely, Brooks, and Boraas, 2014; EDAW AECOM, 2009; Jacobs and Brooks, 2011). Residents of the Proposed Action Area place high value on social cohesion and group cooperation as expressed through subsistence activities (ICAS, 1979). Subsistence is a central activity that embodies and actualizes all Iñupiaq values, with bowhead whale hunting being the paramount offshore subsistence activity for Nuiqsut, Kaktovik, and Utqiaġvik. Iñupiaq cultural and spiritual values are played out in everyday life when these residents practice subsistence activities on the land (Galginaitis, 2014a; ICAS, 1979).

Institutional formation corresponds to the structure and function of the borough, city, and tribal governments that provide services to communities. This part of the system includes formal organizations such the North Slope Borough, Alaska Native regional and various village for-profit and not-for-profit corporations, and non-governmental organizations. Many Iñupiat are enrolled as shareholders in the for-profit Native corporations, and they are citizens of the North Slope Borough, which derives revenue from property taxes on petroleum facilities at Prudhoe Bay (ICAS, 1979). Non-governmental entities may work in conjunction with governmental organizations. For example, the AEWC and other local or regional organizations play important roles in the management of natural resources vital to the subsistence and cultural needs of the communities. These formal institutions are largely formed by Alaska Native peoples who are aware of and respect traditional knowledge of their elders and have a present-day awareness of their own beliefs and cultural foundations (Kendall et al., 2017). Many of the leaders of these institutions currently live or have lived a rural subsistence way of life and have a clear understanding of why and how to protect subsistence resources.

3.3.2 Economy

This section describes the existing conditions of the economy of the SOA, NSB, and Prudhoe Bay with respect to employment, personal income associated with employment, various types of revenue streams, and population. Additional information about the economy of the NSB and its communities is available in the 2015 Liberty EIA (Hilcorp, 2015, Appendix A). All of the numbers that BOEM presents in this section are approximate.

3.3.2.1 Employment and Labor Income (Wages)

Table 3-10 provides information on total employment and labor income (wages) for Alaska, the NSB, and Prudhoe Bay in 2015, as well as information on the percentage of employment that represents government jobs.

Table 3-10 Employment and Wages for Alaska, NSB and Prudhoe Bay (2015)

Geographic Area	Total Employment (Jobs)	% Government Jobs	Labor Income (Wages)
State of Alaska [1]	310,000	14.3	$13.6 billion
NSB[1]	3,360	60	$151 million
Kaktovik[2]	130	74	
Utqiaġvik[2]	2,120	55	
Nuiqsut[2]	190	59	
Prudhoe Bay[3]	12,550	0.0	$1.39 billion

Source: [1]ADLWD, 2015d; [2]ADLWD, 2015b; [3]ADLWD, 2015a.

3.3.2.1.1 Alaska Employment and Wages

Oil is a critical resource for the U.S. economy, and North Slope oilfields produced an average of 20 percent of the nation's domestic production between 1980 and 2000. Oil production from the North Slope started in the late 1970s, peaked in the late 1980s, and has continued to decline since. With the Trans-Alaska Pipeline System (TAPS) now running at three-quarters empty, Alaska's share of domestic oil production has fallen to 7 percent, and the state has fallen from second to fourth in U.S. oil production (RDC, 2017).

Although the oil and gas industry employs less than 5 percent of all Alaska workers, it has driven much of the growth in Alaska's economy for the past 40 years. Oil production (not including support activities) has directly accounted for a quarter of total gross state product, and approximately one-third of all jobs and personal income in Alaska can be traced to work in oil production-related activities, spending of the state's oil revenues, or the Permanent Fund Dividend (Goldsmith, 2007). Moreover, oil and gas industry wages are roughly 2.5 times higher than average annual wages for all industries in the state combined (ADLWD, 2013). Since 2007, however, the relative contribution of the oil and gas industry to the State's economy has declined due to lower oil and gas prices and reduced throughput of oil in the TAPS.

3.3.2.1.2 NSB Employment and Wages

As shown in Table 3-10, there were approximately 3,360 persons employed in the NSB in 2015 including 2,120 in Utqiaġvik (formerly Barrow), 130 in Kaktovik, and 190 in Nuiqsut. Local government, which includes schools, is the top employer of North Slope permanent residents. Nearly 60 percent of persons employed in the NSB were Borough government employees: 55 percent in Utqiaġvik; 74 percent in Kaktovik; and 59 percent in Nuiqsut (ADLWD, 2015b). The high percent of local government employees in the NSB is in contrast to the SOA (14.3 percent) and the U.S. (3.8 percent). Property tax payments by North Slope oil and gas producers are the main source of revenue for the NSB and directly support this high percentage of local government jobs (AOGA, 2014). The total wages for workers in the NSB in 2015 was approximately $151 million (ADLWD, 2015b). High unemployment and underemployment are characteristic of communities of the NSB (Hilcorp, 2015, Appendix A).

Only 5 residents of the NSB worked in "primary oil and gas companies" and 70 worked in oil and gas support services in Alaska in 2013 (AOGA, 2014). The relatively low share of employment of Borough residents could, in part, be due to the fact that the job requirements at Prudhoe Bay require certain work schedules that may limit the ability of NSB residents to practice seasonal subsistence. In addition, NSB residents have the option of relatively high paying NSB government jobs with schedules that more easily allow for seasonal subsistence. Training programs and workforce development will continue to be important in the future to increase oil and gas industry employment of local residents. Industry can best address this issue by partnering with the NSB, Arctic Slope Regional Corporation, SOA, community colleges, University of Alaska, vocational technical schools, and job training facilities (Shell, 2011).

3.3.2.1.3 Prudhoe Bay Employment and Wages

Prudhoe Bay and the surrounding fields form a worker's enclave within the boundaries of the NSB; the workers are not permanent residents of the NSB. Therefore, the SOA, Department of Labor and Workforce Development records Prudhoe Bay employment and wage data separately from that for the NSB. In 2015, the oil and gas industry at Prudhoe Bay provided approximately 12,550 jobs and accounted for $1.39 billion in annual wages (ADLWD, 2015a). These 12,550 jobs were in the following categories: 74 percent in oil and gas extraction activities (of which 16 percent were in crude petroleum and natural gas extraction and 58 percent in support activities for oil and gas operations including drilling wells); 14 percent in professional and business services; and 11 percent in four other smaller categories (ADLWD, 2015a).

Another aspect of the Prudhoe Bay oil and gas enclave is that workers have almost no integration into the local economy. Infrastructure, work sites, and housing are largely self-contained enclaves, separate from the closest communities of Nuiqsut and Kaktovik (Shell, 2011; AOGA, 2014). The exception is the Kuukpik Hotel in Nuiqsut, which caters to workers at the Alpine field, 8 miles to the south of Alpine. Nuiqsut is 86 miles and Kaktovik 92 miles from the Proposed Action Area.

3.3.2.2 Revenues

3.3.2.2.1 Federal Revenues

The Federal government collects revenues from the production of oil and natural gas on the OCS through bonus bids, royalties, and rents from lessees. Federal revenues reported for all OCS production totaled $2.79 billion in FY 2016. The U.S. Department of the Treasury distributes about half of the revenues generated from all mineral development in various proportions to the states, the Historic Preservation Fund, the Land and Water Conservation Fund, the Reclamation Fund, and Native American Tribes and Allottees. The other half remains at the U.S. Treasury, helping to fund U.S. programs (ONNR, 2016b).

3.3.2.2.2 State Revenues

The SOA receives revenues from oil and gas activities in the form of royalties, property taxes, State corporate income tax, and revenues associated with the TAPS. By FY 2013, it had received $197 billion in oil revenues since Statehood in 1959 (AOGA, 2014). For over two decades, about 80 percent of Alaska's unrestricted general fund revenue has come from oil taxation and royalties (Hilcorp, 2015, Appendix A).

The total SOA oil and gas revenues were $2.6 billion in FY 2015 (ADR, 2015), $1.6 billion in FY 2016 (ADR, 2016), and $1.7 billion in FY 2017 (ADR, 2017).

The general fund pays for almost every state service, including education, transportation infrastructure, public health and safety services, and a host of other programs throughout Alaska. Since late 2014, the price of oil has dropped dramatically and the TAPS throughput has dropped further, reducing revenues to the State. The State discontinued personal income and sales taxes in 1978 when Prudhoe Bay production started generating very high royalties for the State. The State is now considering some form of tax because of budget deficits.

In addition, the Federal government transferred $1.42 million in FY 2016 in royalties, rents, bonuses, and other revenues from OCS leases as provided by Section 8(g) of Outer Continental Shelf Lands Act (ONRR, 2016a). It transferred a total of $94.8 million to the State from FY 2003 through FY 2016 under the same provision. These revenues are from production at Northstar in the Beaufort Sea

State waters adjacent to the 3-mile line separating U.S. and State waters. The proposed facility directionally drills from State waters into the OCS resulting in OCS production revenues shared between the U.S. government and the State under Section 8(g) provisions. The $1.42 million of Section 8(g) revenue represents a relatively small share compared to the $7.4 billion the State collects from oil and gas royalties within the State.

3.3.2.2.3 NSB Revenues

The NSB receives revenues primarily from property taxes on high value onshore oil and gas infrastructure at Prudhoe Bay. NSB property taxes increased from $307 million in 2011 to $339 million in 2015 (ADLWD, 2015c). As the depreciable value of oil and gas infrastructure decreases, the revenues accruing to the NSB from oil and gas activities will also decline unless new onshore infrastructure is constructed.

The NSB FY 2015 Operating Budget was $379 million and the property taxes collected on the oil and gas infrastructure was $340 million, which represents 90 percent of the operating budget (NSB, 2017).

3.3.2.3 Population

Table 3-11 provides 2015 population data for the SOA, NSB, local jurisdictions, and Prudhoe Bay (Prudhoe Bay is not a jurisdiction). Oil and gas workers who regularly rotate in and out of Prudhoe Bay are not permanent residents of the Borough.

Table 3-11 Population of Permanent Residents (2015)

Jurisdictions	Population
State of Alaska	737,200
NSB	9,890
Utqiaġvik (formerly Barrow)	4,550
Kaktovik	240
Nuiqsut	450
Prudhoe Bay (not a jurisdiction)	0

Source: ADLWD, 2015e.

While the overall population of permanent residents of the State and the NSB increased between 2000 and 2012, most of the small communities of the NSB lost population over that time period (Hilcorp, 2015, Appendix A).

3.3.3 Subsistence Activities and Harvest Patterns

3.3.3.1 Overview

A primary source of information for this section is Galginaitis (2014b), adopted from the September 8, 2015 Hilcorp EIA (Hilcorp, 2015, Appendix A). The discussion focuses on subsistence harvest patterns for Nuiqsut and Kaktovik. The information included in Hilcorp's 2015 EIA was reviewed and verified by BOEM, and BOEM has updated and expanded the information. BOEM has added information about Utqiaġvik due to the importance of marine mammal hunting and coastal fishing for the residents of Utqiaġvik. The discussion provides greater detail about the bowhead whale hunt launched from Cross Island than whaling in other communities because it is the subsistence whaling activity closest to the Liberty site (Galginaitis, 2014b). BOEM also relied on information in the OCS Study MMS 2009-003 (SRB&A, 2010) and the OCS Study BOEM 2013-218 (Galginaitis, 2014a).

For centuries, physical and cultural survival in the Arctic has centered on gathering of subsistence foods and materials and the knowledge needed to harvest these resources. The majority of permanent residents of the NSB are of Iñupiat descent (Hunsinger and Sanberg, 2013; NSB, 2010). Iñupiaq culture, similar to any culture, changes and evolves through time. The Iñupiat pass knowledge and beliefs about subsistence resources and practices from one generation to the next, including observations of animal behavior (NSB, 2010). They do this to successfully locate and harvest fish and game in the present and ensure successful harvests in the future (Spencer, 1976).

The Iñupiat of northern Alaska remain socially, economically, and ideologically loyal to their subsistence heritage and way of life (BurnSilver et al., 2016; Fall, 2016; Galginaitis, 2014a, 2014b; Kishigami, 2013a, 2013b; Martin, 2012; NSB, 2010; USDOI MMS, 2001). In 2010, 66.7 percent of Iñupiat households reported depending on subsistence resources for one-half or more of their total diet (NSB, 2010). In Alaska, a subsistence way of life includes substantial amounts of resource sharing and other types of exchanges within and between related kinship groups, families, and households (BurnSilver et al., 2016; Carothers, Cotton, and Moerlein, 2013; Heinrich, 1963; Kishigami, 2013a, 2013b; NSB, 2010; Wolfe and Magdanz, 1993; Wolfe et al., 2009).

For residents of Nuiqsut, Kaktovik, and Utqiaġvik, many subsistence activities are practiced and serve a central focus of personal and cultural identity. Subsistence harvests are usually group activities that further the cultural values of community, kinship, respect for elders, and cooperation. Subsistence activities provide social organization and integration and a rich diet that contributes to good health (Kishigami, 2013a, b); subsistence foods, especially the fats therein, are healthier than store-bought foods and reduce the risk of cardiovascular disease (Nobmann et al., 2005). Subsistence harvests provide special foods for religious and social occasions, preserving traditional practices such as the Apugauti (Beaching of the Boats) festival and the Nalukataq (Spring Whaling) festival held to pay respect and honor to the harvested whales and ensure the success of future hunting seasons (Kishigami, 2013a, b). These festivals often include large feasts in which many residents, especially elders, widows, and other persons in need can partake of highly esteemed foods and reaffirm their identities as Iñupiat (Kishagami, 2013a, b). People living in Nuiqsut, Kaktovik, and Utqiaġvik give and receive maktak, whale meat, and other subsistence foods and local resources to connect families and communities and maintain ties with family members living far outside these communities (BurnSilver et al., 2016; Carothers, Cotton, and Moerlein, 2013; Kishigami, 2013a, b).

The most visible and easily documented component of subsistence activities on the North Slope is the actual harvest of subsistence resources (Galginaitis, 2014b). Communities tend to harvest local resources most available to them, concentrating efforts along rivers and coastlines and at sites close to town that have proven particularly productive. Two broad subsistence harvest niches (i.e., groupings, mixes) occur on the North Slope and demonstrate how subsistence resources generally co-occur in time and/or space (Galginaitis, 2014b): coastal and marine harvesting of whales, seals, waterfowl, fish, and other marine species; and terrestrial and aquatic harvesting of caribou, fish, moose, bears, furbearers, small game, and edible roots and berries. Kaktovik, Nuiqsut, and Utqiaġvik depend on resources from each of these groupings with marine mammals, especially bowhead whales, caribou, and fish being the primary resources harvested. Various types of ice seals and migratory waterfowl play important roles at certain times of the year. The communities differ in their overall subsistence harvest patterns.

Global climate change is already having immediate impacts on Alaska Native peoples and other indigenous communities in the Arctic (Becker, 2011; Parson et al., 2001). For the North Slope, BOEM anticipates increases in temperature, sea level, rain, and ocean acidification and decreases in snow extent, permafrost, and sea ice coverage and thickness (Section 3.1.6). Climate change in the NSB has adversely impacted the timing of wildlife migrations, access to subsistence resources, failure of village infrastructure, erosion of village lands, and loss of food storage capacity related to permafrost thawing and failing ice cellars (ANTHC, 2014; NSB, 2014, 2015).

Hunters from Utqiaġvik and Kaktovik have noted more bowhead whales during recent decades; however, less multi-year sea ice and thinner shorefast ice has made it difficult for whalers to find ice on which to haul whales out for butchering in spring (Huntington, Quakenbush, and Nelson, 2016,

p. 2). In this study, hunters reported travelling on sea ice for hunting is more dangerous and limited now, because shorefast ice is thinner, less extensive, and no longer anchored by multi-year ice.

Some effects of global climate change during the next 25 years may be beneficial for subsistence hunters. For example, rising water levels in rivers are projected, which most likely would improve and extend upriver and downriver access to important subsistence harvest areas and resources such as caribou, moose, and freshwater fishes (Huntington, Quakenbush, and Nelson, 2016). Whalers living in Nuiqsut rely on boat travel down the Colville River to access Cross Island and their traditional whaling area.

As described in Section 3.1.6, global climate change is projected to have many and varying effects in Arctic Alaska in the foreseeable future, and some changes in baseline environmental and social conditions could become more evident during the life of the Proposed Action. The current conditions in the Proposed Action Area would most likely change during the 25-year life of the Proposed Action; subsistence hunters have emphasized that effects on marine mammals and people are the result of interactions among multiple factors, not of changing sea ice alone (Huntington, Quakenbush, and Nelson, 2016, p. 3). Hunters have been able to adapt to some of these changes by improved equipment and changes in the timing of hunting, and marine mammals appear to be adjusting to a longer open-water period (Huntington, Quakenbush, and Nelson, 2016).

3.3.3.2 Subsistence Communities

The Proposed Action Area encompasses lands and waters traditionally and presently used for subsistence harvests by residents of Nuiqsut and Kaktovik (Figure 3-32; Galginaitis, 2014b; Pedersen, 1979; SRB&A, 2010). Nuiqsut is approximately 80 miles west of the proposed LDPI, and Kaktovik is approximately 94 miles east of the proposed LDPI (Galginaitis, 2014b). In the following subsections, BOEM describes details of relevant subsistence resources relative to each community.

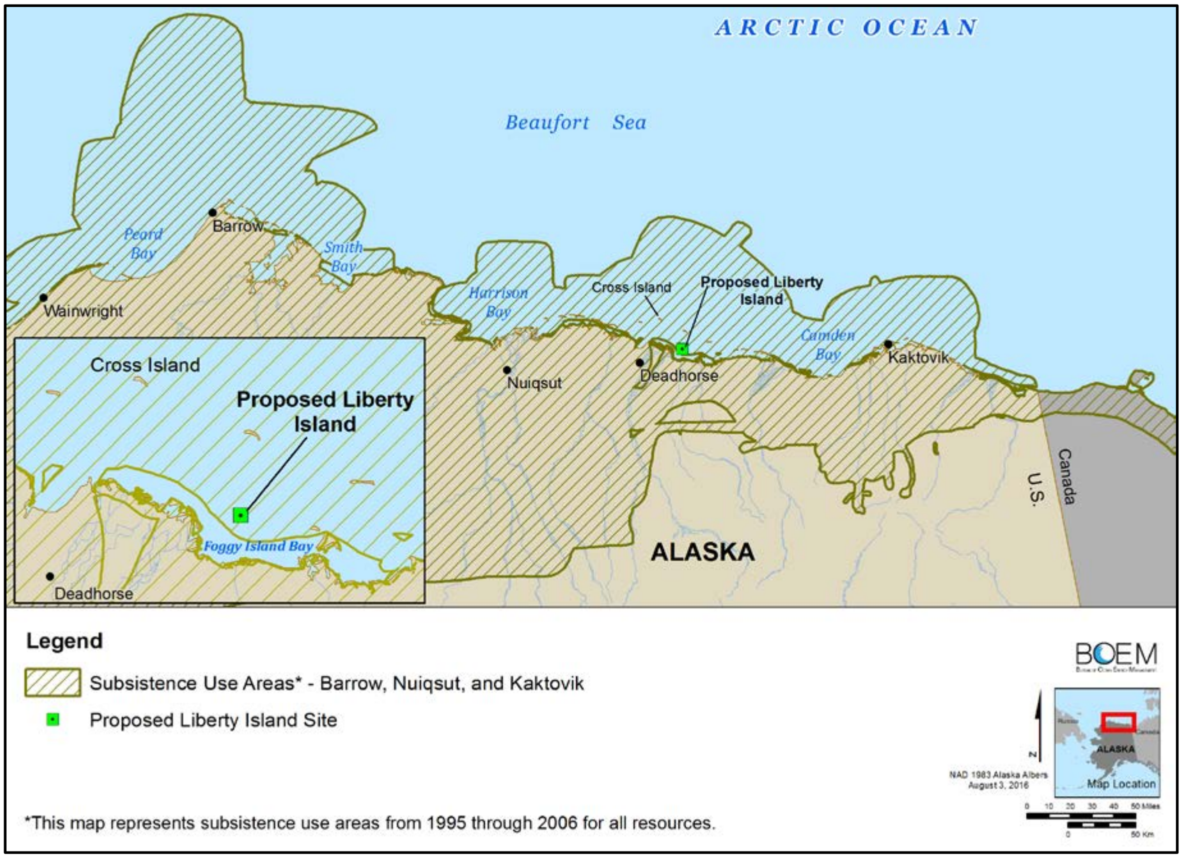

Figure 3-32 Subsistence Use Areas for Utqiaġvik, Nuiqsut, and Kaktovik
Subsistence use areas were derived from interviews with active and knowledgeable subsistence harvesters in the following communities: 75 harvesters in Utqiaġvik, February, March, April, and December 2006; 33 harvesters in Nuiqsut, November 2004, November 2005, and November, December 2006; 38 harvesters in Kaktovik in June 2005, November 2005, and November 2006.

Source: Stephen R. Braund & Associates (2010) in coordination with the North Slope Borough Department of Wildlife Management, local tribal governments, and local subsistence harvesters.

The areas for Nuiqsut's bowhead whaling, Kaktovik's caribou hunting, and the Arctic cisco subsistence fishery in the Colville River are discussed in greater detail than other subsistence resources. These three subsistence resources are critical to maintaining the sociocultural system and are considered most proximate to the Proposed Action Area and may overlap with it to the greatest extent at various times of year due to normal movement patterns exhibited by these species. Many of the marine mammals, birds, fish, and caribou harvested by Nuiqsut and Kaktovik in areas and places outside the Proposed Action Area migrate through and/or use the Proposed Action Area for habitat (Galginaitis, 2014b; NOAA, 2014). Changes or disruptions to these migratory resources could potentially affect subsistence harvesters in Nuiqsut and Kaktovik and in places farther from the Proposed Action Area such as Utqiaġvik to the west and Inuvialuit communities near the Mackenzie River delta to the east.

3.3.3.2.1 Nuiqsut

The city of Nuiqsut is located about 12 miles inland on the Colville River, which is navigable for a substantial distance. It is located in the midst of numerous oil company facilities and industrial developments. In 1973, 27 Iñupiat families moved back to Nuiqsut from Utqiaġvik; in 1974, the Arctic Slope Regional Corporation funded construction of the community. The population of Nuiqsut in 2010 was about 415, and about 92 percent were Alaska Native peoples (NSB, 2015a). Nuiqsut generally has more of a terrestrial orientation than Kaktovik (Galginaitis, 2014b). The Colville River provides access to the ocean, however, and residents of Nuiqsut do rely on the harvest of marine mammals. Nuiqsut hunters go looking for bowhead whales offshore from camps on Cross Island starting in late August and ending in October (Galginaitis, 2014a, 2014b). Belugas are not a prevailing subsistence resource for Nuiqsut (NOAA, 2014). Caribou are hunted throughout the year by residents of Nuiqsut, but June through September are the predominant months for caribou hunting using boats along the coast and the Colville River (Table 3-12; SRB&A, 2010). Nuiqsut hunters use coastal areas around the Colville River delta to harvest geese and sea ducks (SRB&A, 2010). Residents of Nuiqsut primarily go fishing inland in the Colville River for Arctic cisco and other species. Moose are important for subsistence to residents of Nuiqsut, but are primarily hunted inland along the Colville River south of town (SRB&A, 2010). Galginaitis (2014b) and Pedersen (1996) reported Nuiqsut's overall total subsistence harvest is almost equally divided among marine mammals (32 percent), terrestrial mammals (33 percent), and fish (34 percent).

3.3.3.2.2 Kaktovik

The city of Kaktovik is located on Barter Island and has no nearby rivers that are navigable for any great distances. The community is on the northern edge of the 20 million acre Arctic National Wildlife Refuge. In 2010, there were about 308 residents, and over 88 percent were of Alaska Native descent (NSB, 2015b). Kaktovik is generally considered to be oriented toward harvests of coastal and marine resources (Galginaitis, 2014b). Inland terrestrial resources also play important roles in the annual round of subsistence activities of Kaktovik (Table 3-12; Jacobson and Wentworth, 1982; SRB&A, 2010). Kaktovik hunters go for bowhead whales offshore in September and hunt for caribou throughout the year, but primarily in July and August on the coastline and barrier islands (Huntington, 2013; Koski et al., 2005; SRB&A, 2010; Wolfe, 2013). Seals are important to residents of Kaktovik and are hunted offshore and in coastal areas April through September (SRB&A, 2010). Researchers documented that beluga whales did not play a major role in the annual subsistence round for Kaktovik but were occasionally harvested during the bowhead season in September (Jacobson and Wentworth, 1982; Frost and Suydam, 2010; NOAA, 2014). However, Kofinas et al. (2016, p. 71, 126) found beluga to be a core subsistence species harvested and shared in Kaktovik; the communal hunt takes place near the village outside the Proposed Action Area and thus is not analyzed in Chapter 4. The residents of Kaktovik use coastal areas and rivers to fish for Arctic char and Arctic cisco in July and August and hunt geese and sea ducks May through September (Pedersen, 1990a; SRB&A, 2010). For Kaktovik, 59 to 68 percent of the total subsistence harvest has historically consisted of marine mammals, 17 to 30 percent terrestrial mammals, and 8 to 13 percent fish (Galginaitis, 2014b; Pedersen, 1996).

3.3.3.2.3 Utqiaġvik

The town of Utqiaġvik (previously Barrow) is the largest permanent community on the North Slope and serves as the administrative and commercial hub of the region. It is a traditional Iñupiaq settlement and the largest employer in the NSB, with numerous residents and businesses providing support services to oil field operations (NSB, 2010, 2015c). In 2010, the population of Utqiaġvik ranged from 4,212 to 4,974 and 61 to 68 percent were Alaska Native peoples (Norris, Vines, and Hoeffel, 2012; NSB, 2015c). Subsistence whaling, caribou hunting, and fishing are important to the economy (Table 3-12; Schneider, Pedersen, and Libbey, 1980; SRB&A, 2010), and many residents with full- or part-time jobs continue to hunt and fish for food and sociocultural identity (NSB, 2015c). Whaling crews from Utqiaġvik go for bowheads April through May and September through October in offshore areas using boats and various other types of equipment (Kishigami, 2013a, 2013b; SRB&A, 2010). Utqiaġvik residents primarily hunt caribou in coastal areas by boat from July through September and fish for Arctic char, Arctic cisco, and broad whitefish at coastal sites and inland waters from June through December (SRB&A, 2010). Residents of Utqiaġvik use coastal areas for hunting eiders April through October and geese in May (SRB&A, 2010). Other marine mammals are important for subsistence in Utqiaġvik including ringed seals throughout the year (pursued by boat or on ice with snowmachines); and bearded seals and walrus, pursued June through August offshore by boats (SRB&A, 2010). Beluga whales play a minor role in the subsistence economy of Utqiaġvik and are generally harvested incidental to whaling or fishing (Frost and Suydam, 2010; SRB&A, 2012). For calendar year 1992, Fuller and George (1997) reported Utqiaġvik's overall total subsistence harvest approximately divided among marine mammals (72 percent), terrestrial mammals (19 percent), fish (7 percent), and birds (2 percent).

Table 3-12 Utqiaġvik, Nuiqsut, and Kaktovik Subsistence Resources and Peak Harvest[1]

Resource Group	Subsistence Resource	Utqiaġvik	Nuiqsut	Kaktovik
Marine Mammals	Bowhead Whale	April – May & September – October	September	September
Marine Mammals	Bearded Seal	June – August	June – September	July – September
Marine Mammals	Ringed Seal	June – August	June – August	June – September
Land Mammals	Caribou	July – September	June – September October – February	April July – August
Fish	Broad whitefish	July – November	June – August October	July – September
Fish	Arctic cisco	July – November	October – November	July – August
Fish	Arctic char	July – September	August – September	April July – August
Migratory Waterfowl	Geese	May – June	April – May	May – June August – September
Migratory Waterfowl	Eider ducks	April – October	June – August	May – June

Note: [1] Peak Harvest Season = months of harvest effort for the last 10 years (1996-2006) measured as highest number of subsistence use areas reported by month (SRB&A, 2010).
Source: SRB&A, 2012; Galginaitis, 2014b; Jacobson and Wentworth, 1982.

3.3.3.3 Subsistence Resources

3.3.3.3.1 Bowhead Whales

The whaling tradition of the Iñupiat people is essential for their continued cultural and social identity. Bowhead whales (*Aġviq*) and the relationship between whales and people are afforded special significance.

> "A bowhead whale is a special entity to the coastal Iñupiat people. The Iñupiat people believe that a whale has the capability to see and hear what is happening in human society from far away… a whale gives itself to a whaling captain and his wife who are generous and kind both to other people and to the whale. A whaling captain's wife is thought to attract whales… for her husband's whaling crew. Thus whaling captains and their wives try to behave or speak properly so as not to threaten or bother whales… they share their game with others and help those in trouble or need" (Kishigami, 2013:114-115).

The bowhead whale harvest is highly important in Nuiqsut, Kaktovik, and Utqiaġvik (Galginaitis, 2014a, 2014b; Long, 1996; SRB&A, 2010). Hunting bowhead whales provides a cultural and spiritual foundation for sharing and community cooperation (Ahmaogak, 1989; Kishigami, 2013). The bowhead hunt serves an important function as an organizational framework for community events throughout the year and a significant portion of the total community subsistence harvest in typical years. Bowhead whaling strengthens family and community ties, and provides a sense of common heritage in Iñupiaq society (Galginaitis, 2014a; Kishigami, 2013a, 2013b; USDOI, MMS, 1998).

For Nuiqsut residents, bowhead whales are a major subsistence resource (Galginaitis, 2014a, b). Bowhead whales are the most critical subsistence resource in terms of importance for maintaining an intact sociocultural system. The Nuiqsut subsistence bowhead hunt is launched from a base camp about 100 miles away from the village on Cross Island, which lies approximately 18 statute miles north to northwest of the proposed LDPI (Figure 3-33; Galginaitis, 2014b). Cross Island is close to the migration path for bowhead whales and is a traditional and historic whaling site.

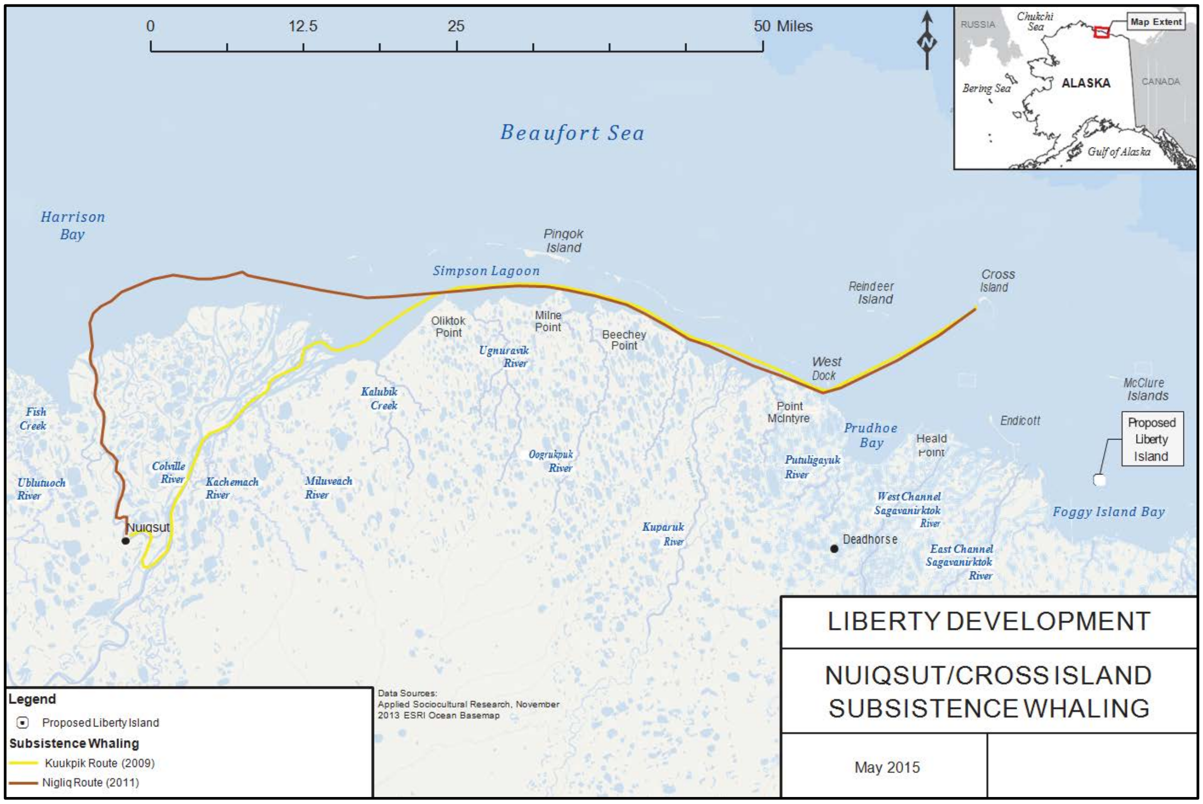

Figure 3-33 Nuiqsut/Cross Island Location and Travel Routes with Landmarks
Source: Applied Sociocultural Research, 2013

Figure 3-34 depicts whale sightings in the Cross Island area for 2001 through 2012. Historically, the hunt occurred around the start of September through mid-October. Recently documented seasons in 2001 through 2013 have lasted two to three weeks from late August through mid-September with relatively little ice but frequent adverse weather conditions and large storms. There is a winch on Cross Island that is used to pull whales up on shore for butchering. Nuiqsut crews at Cross Island use trailers and other structures as cabins.

Nuiqsut hunters' current quota is four strikes whether the animals are landed or not. Not all days are equally good for whaling, and there are periods when crews do not go out because of wind and waves (Galginaitis, 2014b). Whales are not reliably found in the same locations from one year to the next near Cross Island. The hunt is largely cooperative in nature. When whales are spotted, the boats are coordinated to intercept them in such a way that at least one crew should have a good shot at striking a whale. Until a whale is spotted, however, crews may independently scout for whales. There is some competition to be the first to strike a whale (Langdon, 1996), as this increases the prestige of that captain and his crew. Once a whale is struck, all crews in the area go to help procure the whale, haul it back to Cross Island, and process the animal into food and other useable products.

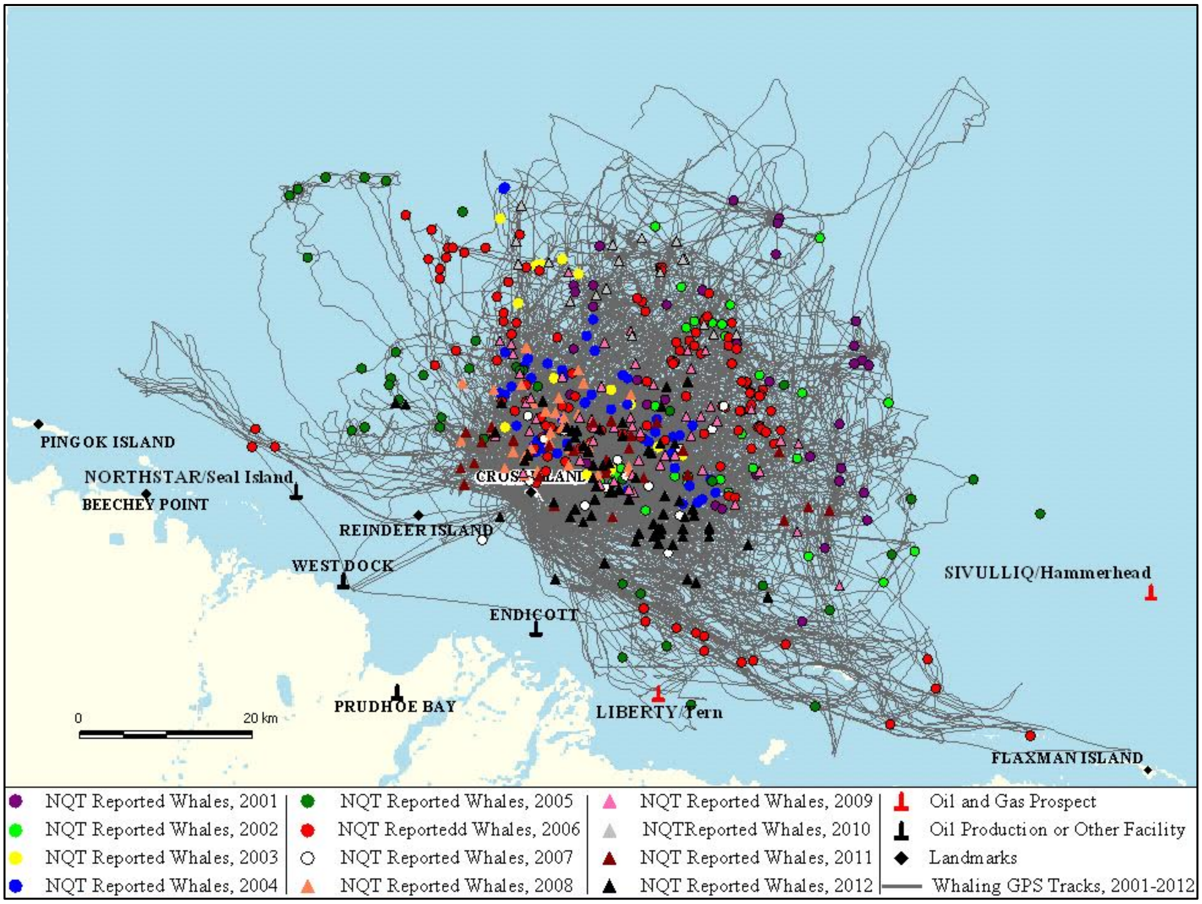

Figure 3-34 Bowhead Whale Sightings in the Vicinity of Cross Island

Source: Reported by Nuiqsut Whalers (NQT), 2001-2012. Bowhead whale sightings made during scouting and hunting trips by whaling crews from Nuiqsut with GPS tracks of whaling boats (Galginaitis, 2014a, p. 85-86).

Nuiqsut crews do their whale hunting immediately north of the Proposed Action Area, and in some years have scouted for whales directly in the Proposed Action Area (Galginaitis, 2014a, b). The general Nuiqsut harvest area for bowhead whales is located off the coast between the Kuparuk and Canning rivers. The whalers think of this area as bounded by the farthest distance from which they would be willing to tow a whale back to Cross Island. During 2001 through 2012, the majority of bowhead whales harvested by Nuiqsut hunters were located north to northeast of Cross Island (Galginaitis, 2009, 2014a; USDOI, BOEMRE, 2011b; SRB&A, 2010). All of their documented whale strikes have been within an area extending from about the Northstar unit in the west to Bullen Point in the east. Nuiqsut crews have landed most of their whales in a smaller area from 5 miles west of Cross Island to about 30 miles east of Cross Island (Figure 3-35; Galginaitis, 2009, 2014a, b; SRB&A, 2010).

This smaller area is most likely the core Nuiqsut whaling area (Galginaitis, 2014a, b). Some Nuiqsut whaling captains will set the eastern boundary as the Canning River/Flaxman Island area or even mid-Camden Bay. For logistical reasons however, it would be unusual for a captain under current operating procedures to strike a whale outside of the smaller core area. Once a whaling captain reaches about 20 miles from Cross Island, he starts to consider the length of the tow back should he strike a whale. Only when whalers cannot find whales closer to Cross Island than 20 miles do they look and strike at farther distances (Galginaitis, 2014a, b; Huntington, 2013). Maps indicate that the Nuiqsut whaling area extends east to Kaktovik (Pedersen 1986; SRB&A 2010, 2011). This reflects one year in the 1980s when conditions were too poor to whale from Cross Island and Nuiqsut whalers continued on to Kaktovik and whaled from there with Kaktovik crews.

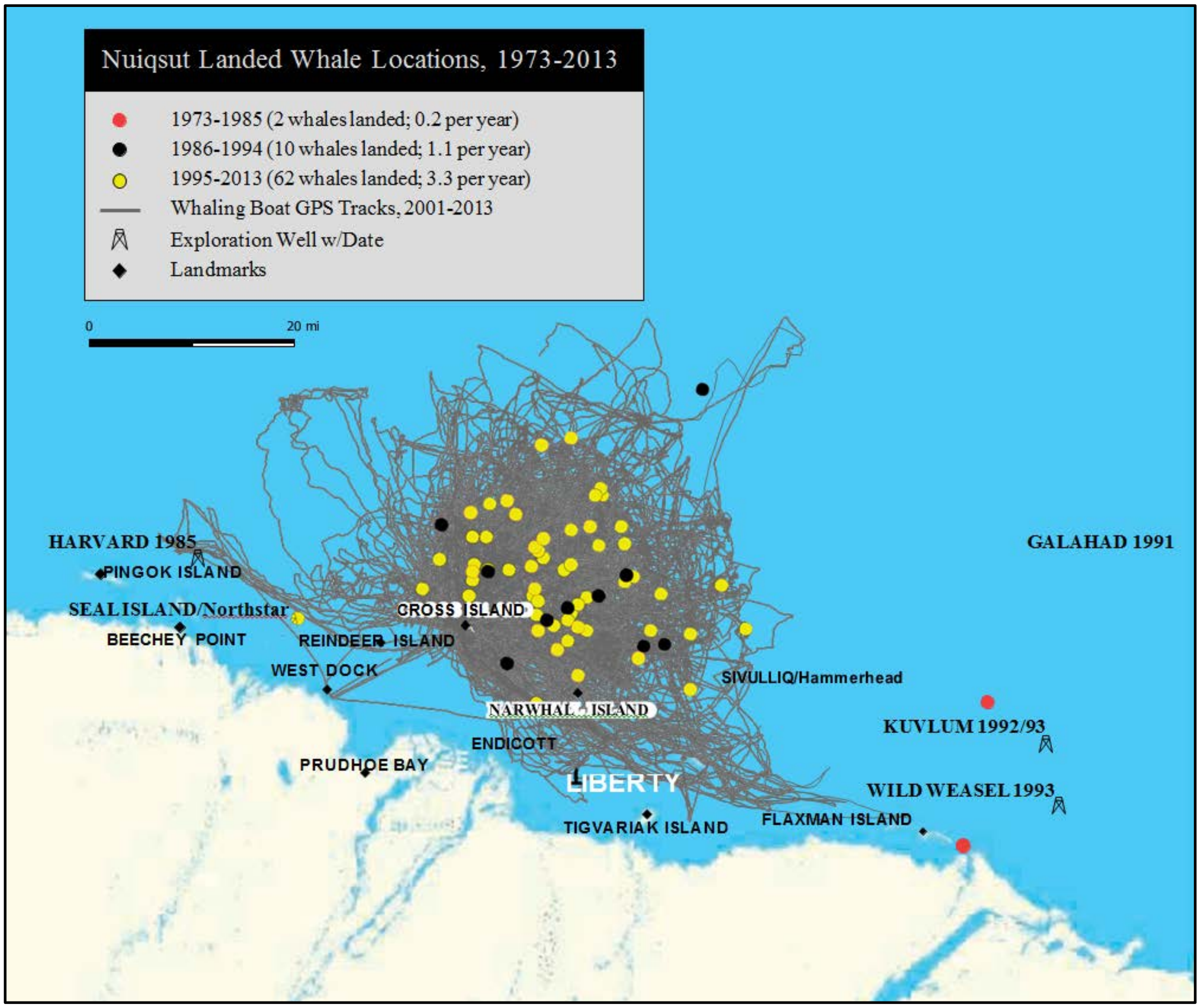

Figure 3-35 Nuiqsut Landed Whale Locations 1973-2013
Data displayed using aggregated global positioning system whaling tracks 2001-2012 (Galginaitis, 2014b).

Residents of Kaktovik participate in whaling for bowhead in September, sometimes travelling up to 50 miles offshore to harvest whales (SRB&A, 2010). Whaling crews from Kaktovik generally reported travelling between Camden Bay to the west and Nuvagapak Lagoon to the east in search of bowhead whales (SRB&A, 2010). The extreme limits of the Kaktovik whaling area are the middle of Camden Bay in the west and just north of the Kogotpak River in the east. This is as far as Kaktovik whalers can conceive of trying to tow a whale back to Kaktovik (Galginaitis, 2014b). The western edge of this area is about 65 miles east of the Proposed Action Area. The core whaling area for Kaktovik is from the Okpilak and Hulahula rivers in the west to what is labeled Tapkaurak Point on the USGS base map in the east, farther from the Proposed Action Area. The core area extends out as far as 20 miles from the coast, although most of the time crews will stay within approximately 12 miles of shore. Nearly all whales harvested since 1964 have been struck within this core area (Kaleak 1996; Koski et al., 2005). The farther away from Kaktovik a whale is killed the longer the tow will be, and there is a greater chance that at least part of the meat will spoil.

There are over 50 whaling captains in the community of Utqiaġvik (SRB&A, 2010). The spring hunt (April through May) is conducted using skin-covered boats called umiaqs; spring whaling is ice-based and snowmachines are also used in these bowhead hunts (Kishigami, 2013). The spring bowhead hunt generally occurs west of Point Barrow and closer to shore, while fall hunting occurs September through October both west and east of Point Barrow and sometimes greater than 20 miles offshore (SRB&A, 2010, 2012). The fall hunt is shore-based using metal boats equipped with outboard motors (Kishigami, 2013). Residents of Utqiaġvik reported hunting bowhead whales almost as far as Smith Bay to the east and as far as Skull Cliff to the west during the fall season (SRB&A, 2010). The core area for bowhead whaling used by crews from Utqiaġvik is located up to 20 miles offshore between the Walakpa River to the west and Cooper Island to the east (SRB&A, 2010).

3.3.3.3.2 Ringed Seals and Bearded Seals

In the past 13 whaling seasons, two or three bearded seals have been taken; a few smaller seals were taken for consumption by the whalers during the hunt, and the ugruk were butchered and sent back to Nuiqsut (Galginaitis, 2014a; Huntington, 2013). Nuiqsut residents use bearded seal meat and oil for its nutritional value, and hunters harvest ringed (*Natchiq*) and bearded (*Ugruk*) seals in the Beaufort Sea during the open water season. Seal hunting activity peaks in July and continues through September for Nuiqsut hunters.

Subsistence use areas for ringed seal are located west from Cape Halkett, east to Camden Bay, and up to approximately 20 to 25 miles from shore, with some hunters traveling up to 40 miles offshore near Thetis Island (SRB&A, 2010). Hunting of ringed seals occurs in open-water near the ice pack as seals follow the ice. Less sea ice in the future may affect seal behavior and availability for subsistence harvest. The specific patterns of seal hunting may change during the 25-year life of the Proposed Action. For Nuiqsut hunters, bearded seal hunting occurs between Harrison Bay and Flaxman Island with a high number of hunts occurring between the mouth of Fish Creek and Thetis Island. Hunting occurs up to 20 miles offshore extending as far west as Cape Halkett eastward to Camden Bay, and sometimes up to 40 miles offshore (SRB&A, 2010).

Nuiqsut hunters currently harvest fewer seals than in the past (Galginaitis, 2014b). An exception is for bearded seals, which are larger than other seals. Seal oil is still an important condiment in almost all households, and bearded seals are preferred for making seal oil, and the meat is highly prized. A small number of families with a maritime orientation catch most of the seals. There is fairly good agreement among informants that the prime sealing area is just north of the Colville River delta and centered on Thetis Island, which is the most commonly used base camp for this area (Galginaitis, 2014b; SRB&A, 2010). This core area extends as far west as Fish Creek and as far east as Pingok Island. Other sites used as base camps in this area are the Spy Islands and Pingok Island. In 1990, some people indicated that they sealed as far west as Atigaru Point, which they used as a base camp, and as far east as the Cottle/Long Island area. They would seal in these areas before break-up by snow machine. Now, most seal hunting is in June through September by boat and concentrates on ugruk. Seal hunters and families reported camping for up to two weeks on the more eastern islands in 1990; these would be multi-purpose trips and caribou and other subsistence resources would be taken if and when they were encountered (Galginaitis, 1990a). This pattern is no longer evident, and Nuiqsut hunters tend to take seals more locally near Thetis Island and the Colville River delta during open-water periods.

For Kaktovik, informants did not provide much specific information about where they hunt seals in 1990 (Galginaitis, 1990b). Jacobson and Wentworth (1982, p. 54) identified the most intensively used sealing area as Pokok Lagoon in the east to Collinson Point near the Canning River to the west, which is 62 miles east of Foggy Island Bay and the Proposed Action Area. Historically, Kaktovik residents reported hunting bearded seals along the coast as far west as Prudhoe Bay and as far east as the Canadian border (SRB&A, 2010).

Residents of Kaktovik have indicated that ringed seal hunting is less common than in the past because there are so few sled dogs, and people used to use ringed seal for dog food (SRB&A, 2010). Ringed seal are usually harvested in conjunction with looking for bearded seals. Ringed seals are usually harvested by boat or snowmachine during March through September. Most harvests occur after the ice breaks up in July and through August. Bearded seals remain an important source of food for many Kaktovik residents, and they are generally harvested in the same areas as ringed seals. Hunters have traveled as far offshore as 30 miles in search of bearded seal but prefer to hunt them closer to shore up to 5 miles off the coast (SRB&A, 2010). Kaktovik hunters can take seals in many places, and as efficient hunters they most commonly take them close to the village. If they encounter seals farther from the village, they will harvest them if logistics allow. All recently documented seal harvest for Kaktovik is east of the Proposed Action Area (SRB&A, 2010). For Kaktovik, hunting for bearded seals begins in March and ends in September.

Bearded seal is an important resource for residents of Utqiaġvik, providing meat and oil for food and skins for building umiaqs used during spring whaling (SRB&A, 2010). Informants indicated that bearded seals follow the ice pack north during their summer migrations, and their availability to subsistence hunters depends on the year's ice conditions. Utqiaġvik subsistence hunting of bearded seals primarily occurs by boat May through September between Skull Cliff and Point Barrow and over 20 miles offshore (SRB&A, 2010). SRB&A (2010) reported a relatively high number of use areas for bearded seal farther from shore, as far west as Peard Bay, and as far east as Ekalugruak Entrance.

During interviews in Utqiaġvik, respondents indicated that ringed seals are not harvested in great quantities and are not as important as bearded seals (SRB&A, 2010). A number of respondents did report that they continue to hunt ringed seals during all months as needed, using them for meat and oil, and some said that they hunt for ringed seals while looking for bearded seals. For Utqiaġvik, the majority of hunting for ringed seals takes place June through August by boat. Subsistence use areas for ringed seals extend offshore from Peard Bay in the west to beyond Smith Bay to the east. The core area for hunting ringed seals is from Nulavik to Point Barrow and along the coast to Skull Cliff and along the Tapkaluk Islands (SRB&A, 2010).

3.3.3.3.3 Walruses

Subsistence walrus (*Aiviq*) harvests on the North Slope can vary by tenfold between years, and in some years none are taken (Fuller and George, 1997). Walrus are rarely seen near Kaktovik and are not harvested on any purposive or regular basis (Galginaitis, 2014b; SRB&A, 2010; USDOI, MMS, 1982). Walruses are rare in the Eastern Beaufort Sea and only harvested by Kaktovik hunters when they present themselves during other hunts in the summer months. Kaktovik hunters reported occasionally hunting walrus offshore primarily north of Barter Island but also in areas west of the village toward Mikkelsen Bay and east near Herschel Island. Fuller and George (1997) indicated a harvest of five walrus for Kaktovik in 1992. Walrus were listed in only one of four previous years when surveys were conducted in Kaktovik (ADF&G, 1995).

Walruses have been rarely encountered by Nuiqsut hunters in the past (USDOI, MMS, 1982). In 2 of the last 13 years, Nuiqsut whalers at Cross Island have seen and taken a single walrus (Galginaitis, 2014b). These were considered to be rare encounters. Nuiqsut residents rarely see walrus close enough to the community to hunt them on a regular basis; there is not much on the central and eastern Beaufort seafloor for walruses to eat (Huntington, 2013). Walrus are not purposively hunted near Cross Island because the focus is on whaling, and the noise made by purposively firing weapons at walruses is believed to frighten whales further out to sea (SRB&A, 2010), and thus walrus hunting is not analyzed in Chapter 4.

3.3.3.3.4 Polar Bears (Nanuq)

For the Iñupiat and the Inuit, polar bears hold substantial cultural significance and symbolism and are worthy of great respect; people of the Arctic had many traditional uses of polar bears (Pokiak, 2013;

Russell, 2005). Historically, subsistence hunters have targeted polar bears, particularly in years when polar bears are unusually abundant near communities (Galginaitis, 1990b; Jacobson and Wentworth, 1982; Nageak, Brower, and Schliebe, 1991; USFWS, 2010a; Voorhees et al., 2014). Traditionally, the majority of polar bears were harvested in late fall and early winter, when bears are in good condition and there is adequate snow cover for tracking bears with dog teams or snowmachines (Russell, 2005; Voorhees et al., 2014).

The Proposed Action Area overlaps with the historical extent of traditional polar bear hunting areas for Nuiqsut and Kaktovik (ADF&G, no date; Pedersen, Coffing, and Thompson, 1985). For Kaktovik, however, the core area for polar bears was closer to the village, extending from the Hulahula-Okpilak River delta on the west to Pokok Lagoon on the east and as far as 10 miles offshore (Jacobson and Wentworth, 1982). The relatively few polar bears taken by Nuiqsut hunters are caught primarily at Cross Island during the whaling season. Most polar bears taken at Cross Island are considered nuisance bears, bothering the whaling crews or approaching butchered whales to feed (Galginaitis, 2009b, 2014a, b).

In Kaktovik, bears are occasionally harvested in town near peoples' homes to protect human life and property. This has occurred at times when village-run bear hazing patrols were not operating (USFWS, 2010b). In 2004, the FWS, Office of Marine Mammals began working closely with staff at the Arctic National Wildlife Refuge to expand outreach and education efforts with residents of Kaktovik to address human/bear interactions and to engage local residents in polar bear conservation. A new focus of this partnership has been addressing the increase in polar bear viewing tourism late July through October at Barter Island and establishing a permitted program for community-based polar bear viewing tourism (USFWS, 2010b, 2015; Wolfe, 2013). Polar bear viewing on Barter Island, when bears gather to feed on remains of the bowhead hunt, has been formally classified as a sensitive tribal area and activity for Kaktovik (Wolfe, 2013). The bear viewing operations provide employment for local guides and engage local youth in polar bear conservation. Tourism centered on polar bear viewing in Kaktovik is a growing industry, thereby both continuing and expanding the local resource values and cultural relationships associated with polar bears (Dvorak and Brooks, 2013).

There are fewer active polar bear hunters today in northern Alaska than in the past, and the average number of polar bears harvested per active subsistence hunter has decreased compared to previous generations (Voorhees et al., 2014, p. 532). In 1989 to 1990, North Slope hunters from four villages harvested 24 bears, including one killed in defense of life and property (Nageak, Brower, and Schliebe, 1991). In 2008 to 2009, subsistence polar bear harvest was recorded to be 19 bears for Utqiaġvik, 4 bears for Kaktovik, and 0 for Nuiqsut (USFWS, 2010b). Polar bears are primarily harvested opportunistically during other subsistence pursuits (such as seal hunting), while travelling between villages, or for public safety – not necessarily as a regular source of food, hides, or handicrafts (Jacobson and Wentworth 1982; Russell, 2005; MMS, 2002, Volume I, p. III-11; USFWS, 2010b; Voorhees et al., 2014), and thus subsistence polar bear hunting is not analyzed in Chapter 4. See Section 3.2.4.11, Marine Mammals and Acoustic Environment – Polar Bears for information about harvest and quotas.

3.3.3.3.5 Caribou

Caribou (*Tuttu*) are an important subsistence resource for the residents of Nuiqsut, Kaktovik, and Utqiaġvik, providing a substantial amount of subsistence foods and other materials for these communities on an annual basis (Braem et al., 2011; Fuller and George, 1997; Galginaitis, 2014b; Jacobson and Wentworth, 1982; SRB&A, 2010). For these three communities, caribou hunting peaks in July and August, tapering off in September (SRB&A, 2010). Summer caribou are generally hunted by boat, along the coastline or shores of barrier islands where groups of caribou congregate for relief from insects and heat.

Hunting for caribou for Nuiqsut occurs throughout the year, with June through September being primary harvest months (SRB&A, 2010). Nuiqsut has hunted caribou from the Beaufort Sea coast south to the foothills of the Brooks Range and from the Sagavanirktok River and Prudhoe Bay in the east to Utqiaġvik and Atqasuk in the west (SRB&A, 2010). Nuiqsut hunters conduct their caribou hunts primarily by boat after the river ice breaks up. The core caribou hunting area for Nuiqsut is primarily along the Colville, Itkillik, Chandler, Anaktuvuk, and Kikiakrorak rivers; along the coast between Atigaru Point and Oliktok Point; in an overland area surrounding Fish and Judy creeks, and Colville River to the west and Itkillik River to the east (SRB&A, 2010). The Proposed Action Area is spatially near the far eastern extent of the caribou hunting area for Nuiqsut, and operations are proposed for the open water season when Nuiqsut hunters go for caribou along the coast and barrier islands. Specific harvest locations collected by the NSB and ADF&G indicate the primary harvest areas for caribou include the immediate Nuiqsut locality, Colville River delta, Nigliq Channel, and Fish and Judy creeks (Braem et al., 2011; Brower and Hepa, 1998).

Caribou are the staple and most preferred terrestrial mammal in Kaktovik's subsistence diet (Jacobson and Wentworth, 1982; Wolfe, 2013). Kaktovik residents harvest caribou from the Porcupine and Central Arctic caribou herds. The Central Arctic herd to the west of Kaktovik is the focus of the summer hunt because these animals are fatter (Wolfe, 2013). Kaktovik hunters go for caribou year-round, using boats or snowmachines; July and August are the peak months for caribou hunting with boats (SRB&A, 2010). Caribou are generally harvested where they are found, and people prefer to take them close to the community but will travel farther when caribou are not found nearby the community (Galginaitis, 2014b). Kaktovik residents reported hunting caribou along the coast as far east as the Mackenzie River delta in Canada and as far west as the Ikpikpuk River and around the shores of Teshekpuk Lake (SRB&A, 2010). The Proposed Action overlaps temporally and spatially with the far western extent of Kaktovik's subsistence caribou hunting area along the coast and barrier islands.

The primary caribou hunting area for Kaktovik is a smaller core area along the coast between Bullen Point and Demarcation Bay (Galginaitis, 2014b; SRB&A, 2010). Bullen Point is approximately 2 miles east of the Proposed Action Area. Caribou hunters from Kaktovik sometimes hunt in coastal areas west of the Arctic National Wildlife Refuge to Flaxman Island and occasionally farther west to the Shaviovik River and Foggy Island (LGL Alaska et al., 1998; SRB&A, 2010). In most years, hunters from Kaktovik seldom use, or expect to use, this entire area, but it is important to have this larger coastal area available during times when caribou and other important resources are not present near the community or in the core hunting area. The information available indicates that over half the caribou harvested by Kaktovik residents are taken during June through September on the coast (Pedersen and Coffing, 1984; Coffing and Pedersen, 1985; Pedersen, 1990b; Wentworth, 1979; LGL Alaska et al., 1998). Kaktovik hunters also harvest substantial numbers of caribou in April but not as many as in July and August (Pedersen, 1990b; SRB&A, 2010). Kaktovik hunters use coastal sites at both these times of year. Fifty-eight percent of the total caribou harvest came from coastal sites in 1987 and 1988 (Pedersen, 1990b).

Historically, researchers have documented Kaktovik's summer subsistence area extending from the Canadian border to Tigvariak Island west of Mikkelsen Bay, which overlaps with the Proposed Action Area (Pedersen, 1986; Galginaitis, 1990b, 2014b; SRB&A, 2010). Available information on specific locations of caribou harvest is limited and dated for Kaktovik, but indicates that current coastal harvest usually takes place no farther west than the Canning River and no farther east than Griffin Point (Pedersen and Coffing, 1984; Coffing and Pedersen, 1985; Pedersen, 1990b). For the years 1981 through 1988, Kaktovik hunters caught less than 10 percent of their total caribou at the mouth of the Canning River (Galginaitis, 2014b). For the regulatory year 1982 and 1983 when caribou were not as available in other areas, Kaktovik hunters took 37 percent of their caribou harvest from the Canning River delta (Pedersen and Coffing, 1984; Coffing and Pedersen, 1985; Pedersen, 1990b). Thus, while the coastal areas west of Camden Bay may not be used as often as some other areas for caribou hunting, the ADF&G continues to map the Canning River delta as part of Kaktovik's intensive caribou use area (Galginaitis, 2014b). The Canning River delta area is important for hunting when areas closer to Kaktovik are unproductive; it is approximately 40 miles east of the Proposed Action Area.

For hunters living in Utqiaġvik, coastal caribou hunting has occurred as far east as Prudhoe Bay and as far west as Icy Cape on the Chukchi Sea coast (SRB&A, 2010). Caribou are commonly harvested year-round by Utqiaġvik hunters. Caribou hunting occurs along the coast, along local rivers, and/or overland as far as the Inaru River. Peak hunting for caribou is July through September and occurs by boat along the coast and inland along various rivers. In the winter, caribou are taken as needed using snowmachines. Utqiaġvik hunters are least likely to take caribou in April and May (SRB&A, 2010).

3.3.3.3.6 Fish

Fishing is a major component of the annual subsistence rounds of Nuiqsut, Kaktovik, and Utqiaġvik. Carothers et al. (2013) documented that the primary motivations for subsistence fishing on the North Slope reflect the core Iñupiaq values of food gathering, sharing, and connection to the land. The primary species of importance for these communities include Arctic cisco (*qaaktaq*), Arctic char (*iqalukpik*), and broad whitefish (*aanaakłiq*) (SRB&A, 2010).

Pink and chum salmon have been documented in subsistence fisheries in the central North Slope region, and local harvest of salmon species has begun to increase within the last 10 to 20 years for Nuiqsut and Utqiaġvik (Brewster et al., 2008; Carothers, Cotton, and Moerlein, 2013; Woods and Carothers, 2011). Salmon comprise a very minor portion of the subsistence fishery for Nuiqsut (Woods and Carothers, 2011). Residents of Kaktovik do not harvest salmon as a regular part of their seasonal round (Fuller and George, 1997; Pedersen, 1990a), but they have caught some on occasion in nets during July and August (Jacobson and Wentworth, 1982) and using rod and reel near the airport (Woods and Carothers, 2011). Salmon are a minor subsistence resource in the region compared to whitefishes and Arctic char, and thus subsistence salmon fishing is not analyzed in Chapter 4.

Arctic cisco are important to the culture of Iñupiat people living on the North Slope, and the subsistence Arctic cisco fishery on the Colville River delta provides a major source of food for residents of Nuiqsut (ABR et al., 2007; Fuller and George, 1997; SRB&A, 2010). Each spring a large number of Arctic cisco leave the Mackenzie River and travel to the central Beaufort Sea where they feed in summer in nearshore waters; a substantial number of these fish overwinter in the Colville River for approximately 7 years, feeding in the sea near shore each summer before returning to the Mackenzie River to spawn when mature (ABR et al., 2007; SRB&A, 2010).

Nuiqsut is uniquely located for harvesting Arctic cisco as the Colville River plays an important role in the lifecycle of the fish. Nuiqsut residents primarily go fishing for Arctic cisco September through December, using snowmachines and nets (SRB&A, 2010). Fishing occurs in the Colville River delta, including Nigliq, Kupigruak, and Elaktaveach channels and the easternmost channels of the delta. Residents of Nuiqsut fish at their camps and near the community, depending on time of season and their family situation. Subsistence catches of Arctic cisco in the Colville River vary yearly from an estimated low of 3,935 fishes in 2001 to a high of 46,944 fishes in 1993 (ABR et al., 2007). In 1992, researchers estimated that 45,402 Arctic cisco were harvested from the Colville River (Fuller and George, 1997).

Subsistence fishing for Arctic char is a common activity for residents of Nuiqsut, but these fish contribute less to the total subsistence harvest than Arctic cisco and broad whitefish (SRB&A, 2010). Using boats, nets, and rod and reel, residents of Nuiqsut primarily go fishing for Arctic char in August and September; yet some char are harvested in the peripheral months of May, June, July, October, and November (SRB&A, 2010). Subsistence fishers from Nuiqsut harvest Arctic char at several locations north of the village on Nigliq Channel and south of town along the Colville River to Sentinel Hill and at the mouth of the Chandler River.

Broad whitefish are an important resource that contributes highly to Nuiqsut's annual subsistence harvests (SRB&A, 2010). Residents most often go for broad whitefish before freeze-up, using boats and nets and while fishing for other species; summer harvests of broad whitefish are used to make dried fish used as food during long winters and for sharing. Those who catch large amounts of broad whitefish are given status in the community because people prefer to eat and give away broad whitefish during the spring whaling festival and for Thanksgiving and Christmas (Carothers, Cotton, and Moerlein, 2013). Nuiqsut residents reported accessing broad whitefish areas between May and November; the peak season for broad whitefish occurs June through August with July being the most popular month (SRB&A, 2010). Nuiqsut residents fish for broad whitefish in the Colville River between its mouth and Sentinel Hill; they use Fish Creek, Itkillik River, Chipp River, and some area lakes for harvesting broad whitefish. Residents reported setting nets in the Nigliq Channel south of the community and in the easternmost channel of the Colville River delta. Subsistence fishers have noticed some broad whitefish from the Colville River and Nigliq Channel near Nuiqsut have patchy fungal-like lesions on the exterior surface; the lesions, while not common, are caused by a water mold (Saprolegnia) which is not exotic to the NSB and surrounding area (ADF&G, 2013).

The main fish harvested by Kaktovik residents for subsistence purposes include Arctic char, Arctic cisco, broad whitefish, and grayling (Jacobson and Wentworth, 1982; Pedersen, 1990a; SRB&A, 2010). Fishing by residents of Kaktovik has occurred as far west as the Sagavanirktok River and as far east as the Mackenzie River delta and in various inland rivers and lakes in between (Galginaitis, 2014b; SRB&A, 2010). Kaktovik residents harvest fish year-round with nets and rod and reel in coastal areas and around Barter Island, Arey Island, and Bernard Spit. Kaktovik fishers go for Arctic cisco July through August, Arctic char in all months but mainly July through August, and broad whitefish July through August (Jacobson and Wentworth, 1982; SRB&A, 2010).

Kaktovik residents often harvest Arctic char and Arctic cisco in the same places, but Arctic cisco fishing is primarily limited to coastal areas, while Arctic char can be harvested both inland in rivers and in coastal areas (SRB&A, 2010). Arctic char is the most extensively used fish species for Kaktovik (Jacoboson and Wentworth, 1982). Arctic char are the first to appear in nets after the ice goes out in early July. Kaktovik residents reported going for Arctic char along the coast between Mikkelsen Bay to the west and Shingle Point in Canada to the east, and inland in the Sagavanirktok, Canning, Hulahula, Kongakut, Mackenzie, and Big Fish rivers (SRB&A, 2010). Fishing for broad whitefish is less common than fishing for Arctic char and cisco for residents of Kaktovik. They primarily fish for broad whitefish along the coast or in the mouths of rivers between Mikkelsen Bay and Shingle Point and inland at Lake Schrader. Grayling has been reported to be a major subsistence resource for Kaktovik caught in many of the area's rivers and river deltas (Jacobson and Wentworth, 1982; Pedersen, 1990a).

Arctic cisco and char are important resources in the community of Utqiaġvik. Harvest of Arctic cisco is limited to certain locations in the Utqiaġvik area, and these fish occur in limited supply (SRB&A, 2010). Some residents travel to the Nuiqsut area to harvest them, or they receive these fish from family living in Nuiqsut. Near Utqiaġvik, residents primarily harvest Arctic cisco in Kuyanak Bay, and some are harvested incidentally by nets in Elson Lagoon and toward the mouth of the Inaru, Meade, and Chipp rivers. Utqiaġvik residents harvest Arctic cisco inland near the Usuktuk River and Teshekpuk Lake. Arctic ciscoes are best harvested right after freeze-up; harvests occur in all months except January and April with the greatest harvest effort in July through November (SRB&A, 2010). Arctic char are harvested near Point Barrow in Elson Lagoon and at various locations on the Inaru, Mead, and Chipp rivers of Dease Inlet. Arctic char have been harvested by Utqiaġvik residents near

Peard Bay and the Kugrua River. Most harvest occurs in July and August by boat, using nets or rod and reel. Some Arctic char are taken as early as May and as late as December.

Utqiaġvik residents commonly harvest broad whitefish, which provides a substantial amount of their annual harvests in comparison to other fish (SRB&A, 2010). These fish are harvested as far east as the Colville River and as far west as Peard Bay. Utqiaġvik fishers most commonly reported harvesting broad whitefish on the Chipp, Inaru, Meade, Alaktak, and Miguakiak rivers and near Pittalukruak Lake (SRB&A, 2010). Some harvest locations were reported closer to Point Barrow such as Elson Lagoon, Lake Tusikvoak, and Lake Sungovoak and south of town at Walakpa and Peard bays on the Chukchi Sea. Most Utqiaġvik fishers go for broad whitefish July through October. Unlike Arctic cisco, broad whitefish are best harvested right before freeze-up (SRB&A, 2010). Some broad whitefish are taken as early as May and as late as December. Boats and snowmachines are used most often to access harvest areas for broad whitefish. Broad whitefish are a preferred food of whaling crews because eating them with seal oil helps keep hunters warm; broad whitefish are a favorite food and considered prestigious to be served and shared at spring whaling festivals (Brewster et al., 2008; Carothers, Cotton, and Moerlein, 2013; SRB&A, 2010).

3.3.3.3.7 Migratory Waterfowl

Geese are an important food resource on the North Slope because they provide fresh meat after a long winter and goose soup is a favorite of hungry whaling crews. Most Nuiqsut residents use waterfowl for subsistence purposes, and the primary species hunted are white fronted geese (*niġliq*), Canada geese (*israqġutilik*), and snow geese (*kaŋu*q) (Fuller and George, 1997; SRB&A, 2010). Fuller and George (1997) also reported harvest of brants (*niġliñġaq*) by Nuiqsut hunters. Using snowmachines, residents of Nuiqsut harvest geese April through June with most harvests occurring in May. Nuiqsut hunters go for geese in coastal areas just west of the mouth of the Colville River, including its tributaries and parts of the delta (SRB&A, 2010). Fish and Judy creeks are visited by geese hunters from Nuiqsut. Geese hunters prefer to stay close to town if the birds are nearby. The core goose hunting areas for Nuiqsut are located on Fish Creek, along the Colville River at various places south of town, and north of the community along Nigliq Channel.

Nuiqsut residents hunt for king eiders (*qiŋalik*) and common eiders (*amauligruaq*) (Fuller and George, 1997; SRB&A, 2010). They tend to combine eider hunting with hunting seals offshore north of the Colville River delta (SRB&A, 2010). For Nuiqsut, eider season starts in May and ends in September with most effort occurring in June and July. Nuiqsut residents reported hunting eider ducks in the Beaufort Sea between Atigaru Point and the mouth of the Kuparuk River and farther east in an area overlapping Nuiqsut’s bowhead whaling territory north and east of Cross Island (SRB&A, 2010). Other popular hunting areas for eider ducks include Fish Creek, near Ocean Point in the Colville River, and along the Colville River delta. Residents reported travelling offshore over 30 miles when hunting eiders in the ocean; the core eider hunting area for Nuiqsut is a smaller area up to 10 miles offshore of the Colville River delta and east to Thetis Island (SRB&A, 2010).

Kaktovik residents also hunt geese and eiders (Fuller and George, 1997; SRB&A, 2010). The four goose species hunted by Kaktovik residents include brants, white fronted geese, Canada geese, and snow geese. Kaktovik residents hunt geese close to shore and along inland rivers during the months of April through October with most effort in May, June, and September (SRB&A, 2010). They reported hunting for geese as far west as Prudhoe Bay and as far east as the Mackenzie River delta. The smaller core hunting area for geese is located between Collinson Point to the west, Pokok Lagoon to the east, and inland along the Hulahula, Okpilak, and Jago rivers and across from Barter Island.

In Kaktovik, eider duck hunting is less common than goose hunting and often occurs as the opportunity presents itself when hunting for other resources (SRB&A, 2010). Residents of Kaktovik hunt both king and common eiders usually in the same area and at the same time as goose hunting is occurring (SRB&A, 2010). Residents of Kaktovik reported hunting eiders along the coast as far west as the Sagavanirktok River and as far east as the Mackenzie River delta and inland along the Okpilak and Jago rivers (SRB&A, 2010). The areas nearest the Proposed Action Area where Kaktovik residents have recently reported hunting for migratory waterfowl are in Camden Bay, and their reported use there is infrequent and usually occurs in combination with other subsistence activities (Galginaitis, 2014b).

SRB&A (2010) reported that Utqiaġvik residents travel inland to camps and cabins to hunt for geese after the spring bowhead whaling season with members of family and whaling crews. Those who do not participate in whaling go to camp earlier. Geese hunted by most Utqiaġvik residents include white fronted geese, Canada geese, brants, and snow geese. Geese, usually in the form of goose soup, are customarily shared by whaling crews at the Nalukataq festival. Most geese are taken in May and June. Utqiaġvik residents reported hunting geese as far east as Teshekpuk Lake, past Wainwright to the south, and substantial distances offshore north and west of Point Barrow (SRB&A, 2010). Snowmachines are the primary means of transportation used for hunting geese.

Residents of Utqiaġvik generally hunt for both king and common eiders with the highest harvest effort in May and August (SRB&A, 2010). This subsistence activity can be combined with bowhead whale hunting. Utqiaġvik residents took more eiders than geese in the 1992 season (Fuller and George, 1997). Eider hunting occurs offshore north of Point Barrow at a location called Piġniq and in the Chukchi Sea near Peard Bay to the Tapkaluk Islands, near Wainwright, and on the Inaru and Meade rivers (SRB&A, 2010). Utqiaġvik residents primarily use snowmachines and boats while hunting for eider ducks.

3.3.4 Community Health

3.3.4.1 Overview

Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity (Habitat Health Impact Consulting, 2015; WHO, 1986). Community health is a collaborative enterprise that uses science from the public health field, applied strategies based on evidence, and other approaches from multiple disciplines and sectors of society (Goodman, Bunnell, and Posner, 2014; NRC, 2011). A recurring theme in contemporary definitions and assessments of community health is the essentialness of community engagement, collaboration, and partnerships (Andreen, Gove, and Contributors, 2014; Bhatia and Wernham, 2008; IPIECA, 2007; McAninch, 2012; HHIC, 2015). The primary objective of undertaking community health projects and assessments is to engage and work with stakeholders, partners, and communities in ways that are culturally appropriate, to optimize health and quality of life of all persons who live, work, and/or otherwise participate in potentially affected communities (Goodman, Bunnell, and Posner, 2014; NRC, 2011).

Community health is holistic and consists of multiple and interrelated determinants (Curtis, Kvernmo, and Bjerregaard, 2005; HHIC, 2014; Loring and Gerlach, 2009). For example, community health can be determined by where people live; the condition of their surroundings; their genetics, diet, and nutrition; their food security; their incomes and education levels; access to healthcare; their relationships with friends, family, and the larger community; and the integrity of their cultures and cultural identities (Bouchard-Bastien, Gagné, and Brisson, 2014; Curtis, Kvernmo, and Bjerregaard, 2005; Loring and Gerlach, 2009; McAninch, 2012; HHIC, 2015). These social and environmental conditions contribute to medical health outcomes in people including diseases, illnesses, states of mental health, and accidental injuries or other traumas such as suicides (HHIC, 2015; see Baseline Human Health Summary at www.boem.gov/liberty).

3.3.4.2 Community Health under the NEPA

The NRC (2011, p. 204) and the North Slope Borough (2015, p. 17) provided guidance to governmental agencies and the private sector for analyzing health effects under the National Environmental Policy Act (NEPA). BOEM has summarized the guidance in this subsection.

To determine the level of potential health effects, agencies should consider:

- Scoping comments submitted on community health
- Levels of controversy surrounding perceived or documented health concerns
- Presence of other factors known to substantially affect community health (e.g., poor indoor and outdoor air quality)

There are some known effects of resource development that may adversely affect community health (NRC, 2011), including:

- Emissions of hazardous substances
- Changes in community demographics
- Involuntary displacement of residents or businesses
- Changes in industrial practices, employment, government revenues, or land-use patterns
- Reduced access to natural resources
- Changes in local food resources

In describing the community health environment, BOEM focuses on issues that are relevant to the community health concerns identified through scoping and collaboration with partners and stakeholders (NRC, 2011).

During public scoping for the Draft Liberty EIS, BOEM heard examples of community health concerns related to the Proposed Action and oil and gas projects in general, including:

- Effects of a large oil spill on biological resources, human health, and cultural well-being of communities that depend on subsistence resources, especially migratory marine mammals and ocean fishes.
- Concern over food security, food purity, environmental contaminants, and related community health outcomes.
- Social and environmental justice impacts in the community of Nuiqsut related to nearby industrial developments.
- Concern that conditions related to encroaching industrial developments pose unreasonable risks to community health; for example, cumulative effects of air pollution from gas well flares, small fuel/oil spills, and industrial accidents may result in contamination of wildlife and other food and water resources and health risks to people such as increased respiratory problems (Ahtuangaruak, 2015; SRB&A, 2009).

3.3.4.3 Community Health Determinants and Outcomes

3.3.4.3.1 Subsistence Foods, Food Security, and Nutrition

In the NSB, traditional subsistence foods anchor cultural identity and nutritional health, and security of all food resources is a key issue of public concern in Alaska (McAninch, 2012) that has been linked to resource development (HHIC, 2014, p. 25). Traditional foods are foods that originate in the populations' habitat such as seal, whale, caribou, birds, and fish, whereas foods found in the community store, for example, are imported (Vaktskjold et al, 2009). BOEM heard concerns over food security during scoping for the Draft EIS and provides a brief description of food security because it is related to subsistence harvest, diet, nutrition, and community health outcomes in the NSB (Loring and Gerlach, 2009).

Food security includes physical and economic access to sufficient, nutritious, and healthy foods (i.e., traditional and/or imported foods) to meet dietary needs and food preferences for an active and healthy life (Power, 2007). People who are food insecure report they cannot afford enough food, and commonly skip meals or eat less than they need (HHIC, 2014). Food security means that the food is safe, nutritionally adequate, culturally appropriate, and obtained in a way that upholds basic human dignity (FAO, 2006).

Iñupiat living in northern Alaska understand food security in a holistic manner. The Inuit Circumpolar Council-Alaska (ICCA) has developed and published a conceptual model of food security characterized by environmental health (ICCA, 2015). For the North Slope Iñupiat, environmental health and food security are achieved through the presence and strength of six factors (i.e., pillars of food security), including health and wellness, availability, accessibility, stability, Inuit culture, and decision making power and management. Three tools support the stability of these six factors: sources of knowledge, policy, and co-management (ICCA, 2015). The model is presented in the circular image of a traditional drum bound together by the spirit of all—Cilliam Cua, Eslam Yuga, Iñua, and Ellam Yua. The drum is held up by food sovereignty, which is a requirement to have food security (ICCA, 2015).

Food security depends on availability of sufficient quantities of food on a consistent basis; having sufficient resources or income to obtain appropriate foods for a nutritious diet; and appropriate uses of foods based on knowledge of basic nutrition and health (FAO, 2006). There are other factors that may substantially affect food security, including poverty and unemployment; educational attainment; changes in food sharing networks; vulnerability to global climate change; thawing of permafrost in which foods are stored; access to subsistence hunting lands; loss of traditional knowledge; and readily available imported foods (ANTHC, 2014; Bersamin et al., 2007; Power, 2007). Food security is not an individual or community health-related behavior; it is a social, political, and economic phenomenon (McAninch, 2012).

Residents of the NSB derive substantial health benefits from harvesting and eating traditional foods (McAninch, 2012; Smith et al., 2009). Many local traditional foods provide inexpensive and readily available nutrients, essential oils, antioxidants, calories, and protein; other benefits to health from traditional foods include protection from diabetes, improved maternal nutrition, and neonatal and infant brain development (Egeland, Feyk, and Middaugh, 1998; McAninch, 2012). Researchers have documented that traditional foods contribute more protein, monounsaturated fat, polyunsaturated fat, healthy fatty acids, vitamin B12, and iron than imported store-bought foods (Ballew et al., 2006; Bersamin et al, 2007). Seal oil and salmon were shown to be the main sources of omega-3 fatty acids for all individuals eating traditional foods; 69 percent of traditional food energy intake was from marine sources such as seal oil and fish (Bersamin et al., 2007). According to McAninch (2012), analyses of bowhead whale tissues used as subsistence foods have been found to be rich in protein, healthy omega-3 fatty acids, and important elements such as iron; the skin of the bowhead whale has been found to contain substantial amounts of dietary fiber, which has been found to be low in other Alaskan subsistence diets (Ballew et al., 2006).

Due to increased modernization of the rural Arctic, communities have increasing access to imported, store-bought and processed foods that lack nutritional value, and some households may be shifting away from a traditional subsistence diet to ensure food security or for other social or economic reasons (Loring and Gerlach, 2009; McAninch, 2012; Vaktskjold et al., 2009). Promotion of healthy imported foods high in vitamin C, calcium, and fiber also is essential to improving the diets of Alaska Native peoples (Bersamin et al., 2007). Store-bought imported foods do represent a degree of food security for rural Alaskans, but it remains questionable if imported foods in the NSB are sufficient to support an acceptable level of overall community health and cultural wellbeing (Loring and Gerlach, 2009, p. 470).

Traditional foods provide numerous other benefits in addition to good nutrition (AMAP, 2009, p. 22), including:

- Sharing traditional foods plays a role in the maintenance of social norms and is an important element of social wellbeing and local culture (Baseline Human Health Summary, www.boem.gov/liberty).
- Given the high cost of living in most Arctic communities, traditional foods can save families money.
- There are important spiritual aspects associated with traditional food use.
- There are many physical health benefits associated with harvesting and processing traditional foods.
- Sharing of food and material wealth is a cultural value ensuring that families or individuals are provided for in times of need.

3.3.4.3.2 Environmental Contaminants in Traditional Foods

The procurement and consumption of traditional foods is important for maintaining cultural values, cultural identity, and social well-being (Chan et al., 2006; McAninch, 2012; Vaktskjold et al., 2009). In many Alaskan communities, traditional foods are an economic necessity. However, foods from mammals, birds, and fish have been documented as the main source of human exposure to environmental contaminants (Vaktskjold et al., 2009). Native leaders and their communities are seriously concerned about reports of environmental contaminants from long-range and/or local origin that affect the quality of the land, water, and food species (Kuhnlein, 1995, p. 766). Some rural Alaskans may be dissuaded from harvesting and eating traditional foods because of perceived or documented contamination and related risks to human health (Loring and Gerlach, 2009). However, processing and cooking methods significantly affect nutrient and contaminant concentrations in traditional foods; direct testing of actual food items is highly recommended to determine risks and benefits of traditional diets (Moses et al., 2009). Researchers studied the tissues of spotted seals and sheefish in the Northwest Arctic region of Alaska and concluded traditional foods provide essential nutrients with relatively low risk posed by intake of environmental contaminants (Moses et al., 2009).

3.3.4.3.3 Cultural Well-being

Cultural well-being in communities plays an important role in the overall health and stability of communities and larger sociocultural systems (Vaktskjold et al., 2009). Rapid social, cultural, economic, and environmental changes in Inuit communities can adversely affect community health through changes in living conditions and ways of life (Curtis, Kvernmo, and Bjerregaard, 2005, p. 449). Maintaining cultural values and a positive cultural identity has been linked to positive physical and mental health outcomes for both individuals and communities in rural Alaska (McAninch, 2012). Preservation of and respect for the Iñupiaq language, respect for elders, participation in subsistence activities, sharing, and family stability are cultural values that remain strong. Iñupiaq language is spoken in the communities of Nuiqsut, Kaktovik, and Utqiaġvik, and use of this language can strengthen cultural identity and overall well-being for the Iñupiat people of the North Slope. Two-thirds of Iñupiat households have at least one member who speaks fluent Iñupiaq and two-thirds have at least one household member who reads Iñupiaq language (McAninch, 2012). Across the NSB, elders are identified as highly respected members of their communities (HHIC, 2014; McAninch, 2012).

3.3.4.3.4 Municipal Infrastructure

Law enforcement and other services such as water, solid waste disposal, emergency services, and heating are essential infrastructure for all NSB residents (HHIC, 2014). These services vary between communities of the North Slope. Reliable supplies of potable water are critical to having good community health. Most communities rely on a surface water source with a water treatment system, and all communities in this region use a combination of piped and trucked water. A majority of houses in most communities have municipal sewage facilities with 10 percent of homes in Nuiqsut using holding tanks to store water (HHIC, 2014). A substantial portion of residents rely on outhouses. In many rural Alaskan communities the cost of water is a health and economic issue that leads to rationing of household water consumption. There are currently new challenges with infrastructure in a North Slope environment that is warming and undergoing rapid changes such as sinking homes, erosion of municipal lands, damage to buried water lines, and failure of traditional underground ice cellars used to store wild foods (ANTHC, 2014). These changes and challenges are projected to continue and worsen during the 25-year life of the Proposed Action.

3.3.4.3.5 Community Health Care Services

Health care services in the communities of the NSB are comprised of health clinics staffed by health aides. The Samuel Simmonds Memorial Hospital was built in Utqiaġvik in 2010. Resource development projects such as the Proposed Action have potential to increase demand on local health care services, due to in-migration of workers or by increasing exposure of local residents to communicable diseases (HHIC, 2014). Resource development projects may improve availability of health care services by providing funding through tax revenues. In 2013, the total number of patient visits to health clinics and the Samuel Simmonds Memorial Hospital was 81,468 visits for Utqiaġvik, 7,862 for Nuiqsut, and 5,130 for Kaktovik (HHIC, 2014). Residents of the NSB have to travel or be transported to a hospital or other healthcare provider in Fairbanks, Anchorage, or Seattle if they need more extensive care than the local clinics or the hospital in Utqiaġvik can provide.

3.3.4.3.6 Income

Median household income levels can be used as a determinant of community health. In Alaska, income data normally includes wages, the Alaska Permanent Fund Dividend, corporation dividends, and public assistance. The oil and gas industry is a major economic driver in the NSB and jobs in this industry can affect income and health status of these communities in beneficial ways (HHIC, 2014; McDowell Group, 2012). See Sections 3.3.2, Economy, and 3.3.5, Environmental Justice, for additional background information on employment, income, and poverty levels in the NSB.

3.3.4.3.7 Climate Change and Community Health

Global climate change (Section 3.1.6) is affecting the lives of Alaska Native peoples living on the North Slope and other rural residents of Alaska (ANTHC, 2014; Loring and Gerlach, 2009), especially in the Arctic region. Entire food production systems in parts of the Arctic are vulnerable to global climate change to various degrees that are difficult to predict (Ericksen, 2008). It is difficult for rural residents to accommodate these unprecedented and unpredictable changes. During the 25-year life of the Proposed Action residents of the NSB will continue to experience challenges related to changes and effects of global climate change.

Dramatic changes in weather and environmental conditions make subsistence harvests of traditional foods generally more challenging than in the recent past or altogether impossible for some households; for example, changing sea and river ice conditions and altered wildlife migration patterns can limit access to important resources such as sea mammals caribou, and freshwater fish (Huntington et al., 2016; Loring and Gerlach, 2009, p. 469).While hunters have been able to adjust and adapt to some changes, continued environmental changes linked to global climate change may further challenge their ability to acquire wild foods in the future (Huntington et al., 2016).

Traditional adaptation and coping mechanisms employed by rural residents do not work as well as they did in the past due to the dramatic and unpredictable nature of change; contemporary management policies used by governmental agencies to manage fisheries and wildlife can exacerbate the situation because these often lack flexibility and are slow to change (Loring and Gerlach, 2009).

3.3.4.4 Community Health Status

Community health professionals use data on physical health of communities such as infant mortality, nutrition, leading causes of death, and disease rates to establish the baseline health status of a community (Baseline Human Health Summary, www.boem.gov/liberty). In conjunction with the 2010 NSB Census and the NSB Planning Department, the NSB Department of Health and Social Services recently conducted a baseline community health analysis (McAninch, 2012). BOEM has summarized some findings of the baseline health analysis in this subsection to provide a broad view of community health status and current health conditions and outcomes.

A large majority of NSB residents either self-reported or were reported to have good general health status; infant mortality rates have declined since the late 1970s; cases of vaccine-preventable illnesses and infectious diarrheal illnesses have decreased since the 1980s; since 2003, cigarette smoking has decreased in Utqiaġvik households; self-reported prenatal alcohol use has declined since the early 1990s; and Alaska Native peoples living in the NSB have one of the lowest rates of type II diabetes in Alaska and a substantially lower rate of type II diabetes than most Native Americans living in the lower 48 states (McAninch, 2012).

As reported by McAninch (2012), the five leading causes of death in the NSB have remained constant since the early 1990s with small changes in rank order over the years; the SOA reported the same leading causes of death for 1999 through 2013 in the NSB (DHSS, 2015); these have included:

- Cancer
- Heart disease
- Chronic lower respiratory disease
- Unintentional injury/trauma from accidents
- Suicide

Accidents and suicides are the leading causes of premature deaths in the NSB (McAninch, 2012). However, the NSB has demonstrated some positive community health achievements in these areas. Despite persistently high rates of suicide in the region, adults' self-reported mental health in the NSB is among the best in Alaska, and death rates from unintentional injuries have declined since the late 1970s.

In the 2010 NSB Census, the leading self-reported chronic health problems among adults were arthritis and/or chronic pain; high blood pressure; high cholesterol; and chronic respiratory problems. The leading admitting diagnoses to Samuel Simmonds Memorial Hospital in Utqiaġvik in 2008 and 2009 were pneumonia, chronic obstructive pulmonary disease, and congestive heart failure (McAninch, 2012).

McAninch (2012) reported several factors that most likely have a positive influence on community health in the NSB, including:

- Participation in the subsistence way of life, which includes harvesting (i.e., hunting, fishing, gathering); processing and sharing traditional foods; and consumption of traditional foods. Participation in subsistence activities is the foundation of community life in the NSB.
- Commitment of local leadership to supporting strong cultural values and subsistence practices in schools, homes, at work, and in communities through policies such as subsistence leave and community festivals and feasts, which contribute to mental and physical health.

- Increase in overall education levels.
- Substantial improvements in water and sanitation infrastructure.
- Below-average unemployment and poverty rates and above-average median household income.
- Availability of basic health care, social services, and medical insurance.
- The NSB provides a means to a strong local voice and personal empowerment in decisions and legislation affecting communities; self-determination may benefit overall mental and physical health.
- A majority of youth are connected and engaged with their schools and communities, and many youths show promise as future community leaders.

McAninch (2012) also reported several factors that probably have a negative influence on community health in the NSB, including:

- Food insecurity; more than one in three household heads in the NSB reported difficulty in getting the food needed to eat healthy meals, and more than one in four Inupiat household heads reported that, at times during 2010, household members did not have enough to eat (McAninch, 2012, p. 6).
- Inadequate amounts of physical activity and high consumption of sugary drinks; associated with increasing rates of obesity.
- Low levels of helmet and seatbelt use; only 18 percent of heads of household in the NSB reported wearing a helmet when riding snowmachines or four-wheelers.
- Rising school drop-out rates; despite overall gains in education levels over the last three decades, overall high school graduation rates in the NSB School District are below state and national averages for some villages. Educational attainment is positively associated with healthy outcomes throughout life.
- Difficulty in accessing health services; residents must often travel long distances at high expense, inconvenience, and risk to access necessary health services.
- Increasing rates of sexually-transmitted infections impact reproductive health.
- High rates of smoking and alcohol abuse.
- High child maltreatment rates and domestic and sexual violence.
- Economic stresses such as high cost of living and dramatic fluctuations in poverty and unemployment rates over the past one to two decades.

To follow up the baseline health analysis report, the NSB held a number of health forums in communities. Residents who participated in the forums engaged one another in discussing three questions designed to capture their general perspectives on community health. The questions included: What does a healthy North Slope mean to you? What assets does the North Slope have that encourages it to be a healthy community? What do you think are the most important health issues facing North Slope residents? After each group's discussions, common themes were highlighted in summary reports for each community.

Nuiqsut residents' discussions focused on the importance of eating healthy foods and having access to heathy foods, both subsistence and store-bought foods such as fresh affordable produce; the benefits of community gatherings, working together, and unity such as whaling festivals and holiday feasts; the importance of community organizations and programs such as churches and emergency response departments; the need to address social problems such as substance abuse, smoking, and suicide; and specific health concerns such as prevalence of cancers, respiratory health, mental illnesses, air pollution, and residential and industrial pollution (NSB, 2013a).

Discussions in the Kaktovik forum were similar to those in Nuiqsut and included the importance of healthy activities and physical fitness; eating healthy subsistence and store-bought foods; resolving social problems; and specific health concerns such as respiratory illnesses (NSB, 2013b).

Discussions in the Utqiaġvik forum focused on the importance of better communication and collaboration among individuals, organizations, and communities; the importance that faith and spirituality have in becoming a healthy person, a belief that churches are a health asset to North Slope communities; the need to resolve social problems, including domestic violence and sexual assault; the health benefits of cultural identity, preservation of cultural values and the Iñupiaq language, and learning from elders; education programs and providing more opportunities for youth in communities; and food security, healthy foods, eating less processed food from the grocery store, and continuation of a subsistence way of life (NSB, 2013c).

The results of the community health forums corroborate many of the findings of the baseline community health analysis reported by McAninch (2012). The main themes that emerged from these forums closely reflect three dimensions of sociocultural systems, including social organization, cultural values, and formal and informal institutions. This demonstrates the holistic nature of community health and its inseparableness from a subsistence way of life and an intact and functional sociocultural system in the NSB (Curtis, Kvernmo, and Bjerregaard, 2005; Loring and Gerlach, 2009).

3.3.4.5 Community Health and Subsistence

The 2010 NSB Census showed that participation in subsistence activities is high for North Slope households across all age groups (McAninch, 2012; HHIC, 2014). In the NSB, this is particularly the case for hunting land and sea mammals; fishing; and processing, sharing, and cooking wild foods. Fifty-five percent of male heads of Iñupiaq households hunted sea mammals, and 70 percent of male household heads participated in subsistence fishing; for female heads of households, 49 percent participated in subsistence fishing, and 82 percent shared, cooked, and processed wild foods (McAninch, 2012).

Participation in traditional subsistence activities provides nutritious foods, physical activity, and social interactions across generations and is a vital part of maintaining cultural integrity and individual and community health in rural Alaska (McAninch, 2012, p. 90; Smith et al., 2009). Availability of and access to traditional foods and other local subsistence resources are critical determinants of physical and social health and cultural well-being for Nuiqsut, Kaktovik, and Utqiaġvik.

3.3.5 Environmental Justice

3.3.5.1 Overview

Bass (1998) defined environmental justice (EJ) as the fair and socially equitable treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws. Fair treatment means that low-income and minority groups should not shoulder a disproportionate share of the potentially negative environmental effects of government actions. EJ analyses should examine the equity of potential impacts across segments of the human population living in the affected environment (CGG, 2006). The purpose of doing an EJ analysis is to determine whether a Proposed Action would impact low-income and minority populations to a greater extent than it would impact the general population of an area or community (Bass, 1998; ICPG, 2003).

On February 11, 1994, the President of the United States outlined a policy on EJ in Executive Order (EO) 12898 entitled Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (59 FR 7629, February 16, 1994). The President wrote an accompanying

Presidential memorandum to the heads of all Federal departments and agencies to underscore provisions of existing laws that help ensure all communities and persons across the United States live in a safe and healthful environment (Clinton, 1994). The intent of EO 12898 is to promote fair treatment of people of all races and income levels, so no person or group of people bears a disproportionate share of negative effects from government programs.

EO 12898 is especially pertinent to Federal actions that propose to develop natural resources, and for which environmental assessments (EA) or EIS' are required under NEPA (USDOI, 1995, 2016).

3.3.5.2 Environmental Justice under the NEPA

Assessment of EJ is a highly focused type of social impact assessment often conducted within the NEPA process (Bass, 1998; CEQ, 1997; EPA, 1998; Ross, 1994; USDOI, 1995). EO 12898 and the Presidential memorandum require each Federal agency to consider EJ issues when undertaking Federal actions and implementing programs and policies having potential to cause social impacts. Social impacts are consequences of private or public actions or programs that result in substantial changes in people's ways of life, cultures, communities, economies, political systems, environments, health and well-being, personal and property rights, and/or aspirations for the future (CGG, 2006).

In the context of the NEPA process, each Federal agency has been directed to:

- Achieve EJ as part of its mission by identifying and addressing disproportionally high and adverse human health, economic, social, or environmental effects of its actions on minority and low-income populations in the United States (59 FR 7629, February 16, 1994).
- Evaluate in an EA/FONSI or EIS/Record of Decision (ROD) whether a Proposed Action or action would have disproportionately high and adverse effects on these populations (CEQ, 1997; Clinton, 1994).
- Provide early, meaningful, and effective opportunities for communities to identify alternatives, potential adverse effects, and mitigation measures while improving public access to meetings, documents, and notices used in the NEPA process; this may require agencies to use adaptive, innovative, and audience-appropriate approaches to overcome language, cultural, and economic barriers to effective participation in the decision-making process (CEQ, 1997; Clinton, 1994; EPA, 1998; 59 FR 7629, February 16, 1994).
- Develop mitigation measures in consultation with affected communities and groups for inclusion in NEPA decision documents and provide ongoing participation and coordination as mitigation measures are implemented (CEQ, 1997; EPA, 1998; GSA, 2000).
- Identify differential patterns of consumption of natural resources among these populations (i.e., differential rates of subsistence among minority populations, low-income populations, or tribes as compared to the general population) (CEQ, 1997; 59 FR 7629, February 16, 1994).

3.3.5.3 Description of Minority and Low Income Populations

The Iñupiat people of the NSB are a recognized minority (CEQ, 1997) and the predominant year-round residents of the NSB (Hunsinger and Sandberg, 2013). The USCB (2014) defined minority to be individual(s) who are members of population groups of American Indian or Alaska Native; Asian or Pacific Islander (or Native Hawaiian); or Black (or African American), not of Hispanic (or Latino) origin. These population groupings are reported each decade during the U.S. Census. Low income populations are defined as groups of people living below the poverty level as reported in the American Community Survey.

The CEQ (1997) identifies groups as minority or low income populations when either:

- The minority or low income population of the affected area exceeds 50 percent.

- The minority or low income population percentage in the affected area is meaningfully greater than the minority population percentage in the general population (e.g., Alaska).

Table 3-13 Ethnic Composition of Potentially Affected Communities[1]

Community	Caucasian[3]	Alaska Native and American Indian[4]	Asian[4]	Hispanic or Latino[5]	African American[4]	Native Hawaiian and other Pacific Islander[4]	Some other Group[4]	Minority[6]
Utqiaġvik	16.9	68.6	10.9	3.1	2.0	3.4	1.1	83.8
Kaktovik	10.0	90.0	0	0	0	0	0	90.0
Nuiqsut	10.0	89.6	0	0	0.7	0	0	90.0
Deadhorse-Prudhoe Bay	85.2	8.6	2.2	4.0	2.3	0.4	1.7	16.6
North Slope Borough	33.4	58.5	5.5	2.6	1.8	1.6	0.9	67.4
State of Alaska	66.7	19.5	7.1	5.5	4.7	1.6	2.1	35.4

Notes: [1] Compared to the North Slope Borough and Alaska, 2010 (Hilcorp, 2015; USCB, 2013).
[2] Percent of population based on population size for each area, not adjusted for differential population sizes.
[3] Alone
[4] Alone or in combination with one or more other groups
[5] Of any group
[6] Minority = Total - (Caucasian alone + some other group alone + two or more groups + Caucasian and some other group) + (Hispanic or Latino, Caucasian alone + Hispanic or Latino + some other group alone).
Source: Hilcorp, 2015; USCB, 2013

Table 3-14 Poverty Rates for Potentially Affected Communities[1]

Area	Percent of Residents Living below Poverty Line	Percent Margin of Error (+/-)
Utqiaġvik	12.3	5.2
Kaktovik	14.8	13.3
Nuiqsut	3.0	3.4
Deadhorse-Prudhoe Bay[2]	3.5	7.7
North Slope Borough	10.2	2.5
State of Alaska	10.1	0.3

Notes: [1] Rates are compared to the North Slope Borough and Alaska, 2010 through 2014.
[2] Figures for Deadhorse-Prudhoe Bay area are from the 2007-2011 5-year U.S. Census estimates as reported in Hilcorp (2015).
Source: American Community Survey, 5-Year Estimates (USCB, 2014).

Utqiaġvik, Kaktovik, and Nuiqsut qualify as minority or low income populations, and therefore BOEM considers these to be EJ communities.

The NSB and three potentially affected communities both had aggregate minority populations larger than that for Alaska as a whole in 2010 (Table 3-13; Hilcorp, 2015). This was not the case for the Deadhorse-Prudhoe Bay area. Table 3-13 shows the minority compositions of Nuiqsut, Kaktovik, and Utqiaġvik meet the 50 percent population threshold which classifies them as communities to be assessed in an EJ analysis on the basis of their proportional Alaska Native and total minority memberships (CEQ, 1997; Hilcorp, 2015; USCB, 2013). Utqiaġvik and Kaktovik have a meaningfully higher estimated poverty rate than that of the NSB and SOA, while Nuiqsut and the Deadhorse-Prudhoe Bay area have a lower estimated poverty rate than the NSB and Alaska (Table 3-14; USCB, 2014).

3.3.5.4 Environmental Justice and Scoping

Federal agencies are required to incorporate effective public participation and consultation in scoping for EJ analyses in the NEPA process (CEQ, 1997). Federal agencies that work with the public in rural Alaska are most effective when they improve cross-cultural communication methods and ensure full and meaningful participation by indigenous residents during scoping, including procedures to incorporate local and TEK in NEPA documents and other agency reports (Arctic Council, 2009; Bartley, Brooks, and Boraas, 2014; Jacobs and Brooks, 2011).

In Alaska, BOEM routinely hosts public scoping meetings and tribal consultations to inform its EJ analyses as part of the NEPA process. BOEM considers issues and concerns voiced at these meetings and consultations as it formulates issues, alternatives, and potential mitigation measures (USDOI, MMS, 2002:3; USDOI, BOEMRE, 2011a).

In early November 2015, BOEM hosted public scoping meetings in Fairbanks, Kaktovik, Nuiqsut, Utqiaġvik, and Anchorage and participated in government-to-government consultations with tribal leaders in Kaktovik, tribal leaders in Nuiqsut, and tribal leaders of the Iñupiat Community of the Arctic Slope in Utqiaġvik. BOEM has also received written comments from the AEWC and Kuukpik Corporation in Nuiqsut, among others. BOEM heard a number of specific concerns and recommendations related to EJ issues and subsistence resources and practices including:

- Increased offshore vessel transit and barge traffic and potential effects on bowhead whales and subsistence activities from related noise.
- Observations of too many offshore seismic studies; concern over lack of data sharing.
- Disruptions to migratory Arctic cisco, caribou, and bowhead whales.
- Critical need for a buffer zone to be established around the Cross Island whaling area.
- Lack of comprehensive scientific assessments of sensitive habitats such as Camden and Foggy Island bays and other areas important to subsistence hunters.
- Deflection of subsistence resources further away from hunters due to noise associated with the Proposed Action.
- Lack of clearly defined mitigation measures and monitoring strategies to protect bowhead whale migration and subsistence practices.
- Concern over food security, food purity, environmental contaminants, and related human health problems.
- Increased infighting over economic benefits of oil and gas development.
- Inadequate revenue sharing; recommended more royalties come back to local communities.
- Too few opportunities for local people to be employed in the oil and gas industry.
- Emergency use of the gravel island by locals as a safe haven during storm events or search and rescue operations.
- Lack of support of communities on the part of industry after decommission.
- Strong insistence that HAK sign conflict avoidance agreements with whaling captains and other local entities.
- Recommended use of subsistence advisors and communication centers throughout the life of the Proposed Action.
- Recommended use of good neighbor policies and endowments for communities.
- Cumulative impacts of oil and gas development and global climate change on local way of life.
- Fears of large oil spills destroying Iñupiaq culture and the future of Iñupiat children.

In scoping, BOEM also heard concerns and recommendations related to the public involvement process including:

- Inadequate sharing of results from environmental analyses and research.

- Inadequate involvement of top decision makers from agencies and industry at public meetings.
- Concern that local people cannot understand documents used in the public process.
- Too little time to review documents preventing meaningful public comments; recommended an extension of the comment period.
- Recommended that all public meeting transcripts be posted to BOEM's public website.
- Feelings that the process is being rushed.
- Inadequate involvement of elders and other local leaders in the process; lack of traditional knowledge studies.
- Strongly recommend formal consultation with Kuukpik Corporation in Nuiqsut.

Finally, BOEM heard specific concerns and recommendations related to planned actions described in the DPP, including:

- Concern about the siting of the gravel island due to strong ocean currents and storms; recommended locating the gravel island closer to shore.
- Concern that man-made islands cause shoals, currents, and silting that affects local transportation routes, animal behavior, and sea life.
- Concern that processing on the island would cause constant noise and adversely affect wildlife and hunters; recommended that the processing plant be located onshore.
- Concern that proposed undersea pipelines may fail due to ice movements and divert caribou movements when continued onshore.
- Concern that the proposed gravel mine site would cause displacement of residents from their native allotment.

3.3.5.5 Environmental Justice and Subsistence

There is an important nexus between a subsistence way of life and EJ communities. In the Alaska OCS Region, BOEM primarily focuses EJ analyses on Section 4-4 of EO 12898, entitled Subsistence Consumption of Fish and Wildlife (USDOI, BOEM, 2014). The EJ analysis in Chapter 4 will address human populations with differential patterns of subsistence consumption of fish and wildlife (59 FR 7629, February 16, 1994, p.7631).

3.3.6 Archaeological Resources

Section 106 of the National Historic Preservation Act (Title 54, U.S.C. 306108) requires that Federal Agencies take into consideration the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation an opportunity to comment. The statutory responsibilities involve archival and record searches documenting known archaeological resources and survey reports written in the past, consultation, and often field surveys to identify historic properties that may be affected by the proposed action (36 CFR 800). Historic properties are those that are on or eligible for the National Register of Historic Places, described in 36 CFR 60. Typical field surveys are conducted on land, and occasionally are conducted in the marine environment, depending on the scope and nature of the proposed action. A more detailed description of the affected environment, including the potential for discovering historic properties, archaeological surveys, and findings conducted in association with the Liberty DPP may be found in the Archaeology Report posted to www.boem.gov/liberty.

3.3.6.1 Liberty Project Archaeological Surveys

The area of potential effect for the Liberty DPP has been extensively surveyed and assessed archaeologically during the past 17 years due to the oil and gas industry's interest in the potential for extracting oil from the prospect. Because of the potential for the presence of archaeological resources in the marine portions of the area of potential effects, four separate geological and geotechnical surveys with coring were conducted and archaeological analyses were performed to evaluate the proposed island location and pipeline route to shore (Rogers, 2014, 2015). Additionally, seven terrestrial archaeological surveys were conducted in the vicinity of the Liberty project since the mid-1970s; four of which were specifically linked to the Liberty DPP (Campbell 1974; Higgs, 2013; Lobdell 1980, 1987, 1998a, 1998b; Reanier 2004, 2008, 2014; Rogers 2013). Although sites on land identified through previous archaeological surveys were relocated, no new archaeological sites either on- or offshore have been identified. The proposed activities will avoid all previously identified sites. As a result of these surveys, BOEM found that no historic properties would be affected and the State Historic Preservation Officer concurred.

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Chapter 4

Environmental Consequences

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CHAPTER 4. ENVIRONMENTAL CONSEQUENCES

4.1 Introduction and Background for Analysis

This chapter presents analyses of potential environmental, social, cultural, and economic impacts resulting from the oil and gas development, production, and decommissioning activities described in the 2015 Hilcorp Development Plan (referred to as "the Proposed Action,") and each alternative considered by the Bureau of Ocean Energy Management (BOEM). Technical information cited from the Proposed Action refers to the 2015 Liberty Development and Production Plan (DPP) (Hilcorp, 2015). Information from Hilcorp's Environmental Impact Assessment (Appendix A to the DPP) is cited as the 2015 Liberty Environmental Impact Analysis (EIA) (Hilcorp, 2015, Appendix A).

4.1.1 Accidental Oil Spills, Exercises and Drills, and Gas Release Estimation

This section summarizes technical information from the Liberty DPP (Hilcorp, 2015) and the Oil Spill Risk Analysis (OSRA) conducted for this Final Environmental Impact Statement (EIS) to create a set of assumptions for purposes of environmental effects analysis of the Proposed Action.

The OSRA and the analysis of a Very Large Oil Spill (VLOS) for the Liberty DPP have been combined into one document, Appendix A. The OSRA gives background information from which these assumptions are derived, and the VLOS analysis discloses impacts that could result from an unplanned oil spill. Due to the level of public interest in oil spill risk and potential impacts, BOEM has posted Appendix A on its website at www.boem.gov/liberty.

Accidental oil spills have a varying potential to occur. Accidental oil spills or gas releases may potentially affect resources during all phases of the Proposed Action, depending on the spill type, source, and size (volume). The assumptions in this section were developed using technical information and historic data (Appendix A at www.boem.gov/liberty), modeling results, statistical analysis, professional judgment, and Liberty DPP-specific information. The analyses are based on a set of assumptions about the number, volume, and types of spills or releases estimated to occur during the different phases.

4.1.1.1 Small Oil Spills (Less than 1,000 bbl)

**Note: This document refers to "bbl" or barrels of oil. One bbl of oil = 42 gallons.*

Small spills, although accidental, occur during oil and gas activities with generally routine frequency and are considered likely to occur from development, production, or decommissioning activities associated with the Proposed Action. The majority of small spills would be contained on the proposed Liberty Development and Production Island (LDPI) or landfast ice (during winter). Small refined spills that reach the open water would be contained by booms or absorbent pads; these would also evaporate and disperse within hours to a few days. A 3 barrel (bbl) refined oil spill during summer evaporates and disperses within 24 hours and a 200 bbl refined oil spill during summer evaporates and disperses within 3 days. The subsections below estimate the number and size of small spills that could occur during various phases of the Proposed Action.

4.1.1.1.1 Summary of Assumptions about Small Spills

BOEM bases the analysis of effects from small oil spills for the Proposed Action on the assumptions in Table 4-1 (below). In this document, BOEM assumes about 70 small spills—58 of these less than 10 bbls—would occur over the course of the 25.5 years of development (development begins approximately 2 years before production), production (approximately 22 years duration), and decommissioning (approximately 18 months duration). These estimated small spills are totaled and rounded to the nearest whole number. Details are described below and in Appendix A www.boem.gov/liberty.

Table 4-1 Small Spill Assumptions

Variable	Assumption for Purposes of Analysis
Assumed number of Spills	70 total – Rounded to the nearest whole number and inclusive of spills in which the spill volumes are greater than 1 bbl and less than 1,000 bbl.
Activities	Small refined oil spills occur during development, production, and decommissioning activities. Small crude oil spills occur during development and production activities.
Timing	Small refined and crude oil spills during development and production could occur any time of the year.
Spill Sizes	Development, production, and decommissioning: most spills would be 2-3 bbl. 58 spills would be >1 bbl and ≤10 bbl 11 spills would be >10 bbl and ≤200 bbl 1 spill would be >200 bbl and <1,000 bbl
Medium Potentially Affected	• Air • Proposed LDPI and if not contained then the water or ice • Open-water • Broken ice • On top of or under solid ice • Shoreline • Tundra or snow • Ice road • Freshwater systems
Weathering	A 3 bbl refined oil spill during summer evaporates and disperses within 24 hours. A 200 bbl refined oil spill during summer evaporates and disperses within 3 days (Appendix A, Tables A-2-6 and A-2-8).

Source: Robertson et al., 2013; BOEM, 2016

About 70 small crude and refined spills, 58 of which would be less than 10 bbls, could occur during the life of the project. Small crude oil spills would not occur before drilling operations begin. Small refined oil spills may occur during development, production, and decommissioning. The estimated total and annual number and volume of small refined oil spills is displayed in Table 4-2. The majority of small spills are likely to occur during the approximately 22-year production period, which is an average of about 3 spills per year.

Table 4-2 Total and Annual Potential Small Oil Spills in barrels (bbl) throughout Program

Estimated Total Spills	Estimated Total Volume	Average Annual Spills	Average Annual Volume
0–70	0–196 bbl	0–3	0–9 bbl

Note: Table represents the estimated number and volume of small crude or refined oil spills by total and annual average during development, production, and decommissioning.

4.1.1.2 Large Oil Spill (Greater than or equal to 1,000 bbl)

A large spill is a statistically unlikely event. Based on the OSRA data summarized in Appendix A (www.boem.gov/liberty), there is a 99.32 percent chance of no large spills occurring. There is a 0.68 percent chance of one or more large spills occurring over the life of the Proposed Action: the statistical distribution of large spills shows that it is much more likely that no large spills occur over the life of the Proposed Action. However, BOEM analyzes the impacts of a large spill occurring during the Proposed Action because large spills are an important concern, and no one can foresee the future. This “what if” or conservative analysis discloses any potential serious environmental harm and informs the decision maker of potential impacts should a large spill occur.

The decision to analyze one large spill of crude or refined oil is based on considerable historical data that indicates large Outer Continental Shelf (OCS) spills greater than or equal to 1,000 bbl may occur during the development and production phases (Anderson, Mayes, and Labelle, 2012). The mean number of large spills is calculated by multiplying the spill rate from Bercha (2016), by the estimated barrels produced (0.11779 billion barrels [Bbbl] or 117.79 million barrels [MMbbl]). By adding the mean number of large spills from the proposed LDPI and wells (approximately 0.0044) and from pipelines (approximately 0.0024), a mean total of 0.0068 large spills were calculated for the Proposed

Action. Based on the mean spill number, a Poisson distribution indicates there is a 99.32 percent chance that no large spill occurs over the development and production phases of the project, and a 0.68 percent (less than 1 percent) chance of one or more large spills occurring over the same period.

The assumptions BOEM uses to analyze the potential effects of a large crude or refined oil spill that could occur from development and production, are set forth in Table 4-3. The analysis of the potential effects from a large spill is contained in Section 4.1.2.2.

The spill sizes and types assumed in the analysis are based on median spill sizes for each type of spill in the historical record and on operator-provided spill volume estimates. For further description of the methodology BOEM used to estimate spill volume and type, see Appendix A (posted at www.boem.gov/liberty), Section A-1, Accidental Large Oil Spills.

Table 4-3 Large Spill Assumptions

Variable	Assumption for Purposes of Analysis
Percent Chance of One or More Occurring	99.32% chance no large spills occurring; 0.68% chance of one or more large spills occurring
Number of Spills/ Releases	1 large spill occurring during development and production from either the proposed LDPI or offshore pipeline or onshore pipeline.
Timing	A large spill could occur any time of the year. A large crude oil spill could occur during the development (drilling) or production phases. A large diesel spill could occur from the proposed LDPI during development or production.
Sizes and Oil Type	Offshore Pipeline (5,000 bbl crude oil rupture or 1,700 bbl crude oil leak), Onshore Pipeline (2,500 bbl crude oil spill), or proposed LDPI (5,100 bbl crude oil or diesel spill)
Medium Potentially Affected	• Air • proposed LDPI and if not contained then water or ice • Open-water • Broken ice • On top of or under solid ice • Shoreline • Tundra or snow
Weathering After 30 days	A 5,100-bbl diesel oil spill will evaporate and disperse much more rapidly than crude oil, generally within 1 to 30 days. After 30 days in open-water or broken ice, BOEM assumes the following weathering for a 5,100-bbl crude oil spill: 16.5-17.2% evaporates, 3.3-56.1% disperses, and 26.7-80.2% remains (Appendix A, Tables A-2-2 and A-2-3).
Chance of Large Spill Contacting and Timing	Assuming a large spill occurs, the time to contact and chance of contact from a large oil spill are calculated from an oil spill trajectory model (Conditional Probability; Appendix A, Tables A-4-1 through A-4-9).
Chance of One or More Large Spills Occurring and Contacting	The overall chance of one or more large oil spills occurring and contacting is calculated from an Oil Spill Risk Analysis (OSRA) model (Combined Probability; Appendix A, Tables A-4-10 through A-4-11).
Spill Response	The OSRA does not account for response, cleanup, or containment and therefore may overestimate the chance of a large spill contacting environmental resource areas (ERAs), land segments (LS) or grouped land segments (GLS). Cleanup is analyzed separately as mitigation or disturbance.

A subset of large spills is the Very Large Oil Spill (VLOS) which is sometimes also called a Catastrophic Discharge Event. For the 2017-2022 5-Year Program Final Programmatic Environmental Impact Statement (PEIS) (USDOI, BOEM, 2016), BOEM defined a reasonable range of potentially catastrophic Outer Continental Shelf (OCS) spill sizes by applying extreme value statistics to historical OCS spill data (Ji et al., 2014). Extreme value statistical methods and complimentary methods (Bercha Group, 2014) were used to quantify the potential frequency of different size spills (BOEM, 2016, Figure and Table 3.3-1). In combining the per well spill frequency with the number of wells, no very large spills are estimated to occur over the life of the development project.

With the exception of rare events, such as the 2010 *Deepwater Horizon* (DWH) explosion, oil spill, and response, the number of spills and the volume of oil entering the environment from accidental spills have been decreasing in recent decades, even as petroleum consumption has risen (USCG, 2011; USEIA, 2014). The DWH event is considered a low-probability, high-impact event and a spill of this volume is highly unlikely to occur during any activity phase, but if one did occur (as the DWH event), the impacts would be major. In Appendix A (posted at www.boem.gov/liberty), BOEM addresses the possibility of a VLOS occurring and uses historic data to assess the likelihood of a VLOS occurring. In Appendix A-7, BOEM analyzes the potential environmental effects of such an event.

4.1.1.3 Oil Spill Risk Analysis (OSRA)

BOEM studies how and where large offshore spills move by using an oil spill trajectory model with the capability of assessing the probability of oil spill contact to resource areas, known as the Oil Spill Risk Analysis (OSRA) model (Smith et al., 1982; Ji, Johnson, and Li, 2011). Potential impacts of a large oil spill are discussed for each resource presented in Chapter 4, where meaningful, resource-specific analyses of potential large spill impacts also consider the OSRA results. For conditional probabilities, BOEM estimates a spill occurs from the island or pipeline and estimates the chance of contact to a specific resource area within a given time. The transport of the spilled oil depends on the winds, ice, and ocean currents of the area. Combined probabilities are based on a) the chance of one or more large spills occurring, and b) the chance of one or more spills contacting a resource over the life of the project (conditional probabilities). Conditional probabilities are discussed within appropriate resource analysis sections listed in Table 4-4. Full discussion and the results are provided in Appendix A (posted at www.boem.gov/liberty). Within the regional OSRA study area (shown in Appendix A, Map A-2b), BOEM defines the following resource areas in Appendix A, Section A-1.3.1:

- **Environmental Resource Area (ERA).** Polygons representing spatial and temporal areas of social, economic, or biological resources or resource habitat areas
- **Land Segment (LS).** Coastline of Beaufort Sea and Chukchi Sea divided into 146 LSs
- **Grouped Land Segment (GLS).** Some LSs added together to form larger geographic or resource areas
- **Boundary Segment (BS).** 40 offshore boundary segments surround the study area

The presence of a particular environmental resource may be represented by one or all of these features (e.g., birds and ice seals are expressed using ERAs and GLSs), as summarized in Table 4-4.

Table 4-4 Resources Described in BOEM'S Oil Spill Risk Analysis

General Resource	Table (Appendix A)	ERA	LS	GLS	BS
Lower Trophic Level Organisms	Table A-2-11	X			
Fish	Table A-2-12	X	X	X	
Birds	Table A-2-13	X		X	
Marine Mammals (Whales)	Table A-2-14	X			X
Marine Mammals (Polar Bears and Walrus)	Table A-2-15	X	X	X	
Marine Mammals (Ice Seals)	Table A-2-16	X		X	
Terrestrial Mammals	Table A-2-17			X	
Subsistence Resources	Table A-2-18	X		X	

Notes: X designates the resources are described in the OSRA.

4.1.1.4 Oil Spill Response and Exercise Requirements

The Oil Pollution Act of 1990 (OPA 90) established new oil spill preparedness requirements for both the Federal government and the facility plan holder operating in the offshore. For the Federal government, the provisions of OPA 90 required the development of a National Contingency Plan (NCP) which would provide for efficient, coordinated, and effective action to minimize damage to the environment in the event of a release. The NCP assigned specific duties and responsibilities to Federal departments and agencies in coordination with State of Alaska (SOA) and local agencies.

Executive Order (EO) 12777 implemented the provisions of OPA 90 and made specific assignments regarding which Federal departments were responsible for specific portions of the Act.

Under the NCP the Federal government was charged with developing Area Contingency Plans for each designated geographic area of the country. The Area Contingency Plan describes the area covered along with areas of special economic or environmental importance that might be damaged by a discharge; describes in detail the responsibilities of a plan holder and of Federal, SOA, and local agencies in removing a discharge; provides a list of equipment, dispersants or other mitigating substances, and devices and personnel available to a plan holder; compiles a list of local scientists, both inside and outside Federal government service, with expertise in the environmental effects of spills; and describes how the plan is integrated into other Area Contingency Plans and vessel, offshore facility, and onshore facility-approved response plans.

EO 12777 assigned to the Department of the Interior the responsibility for the following: establishment of procedures, methods and equipment, and other requirements for containing discharges of oil and hazardous substances from offshore facilities, including associated pipelines, other than deepwater ports; issuance of regulations requiring owners or operators of offshore facilities, including associated pipelines, to prepare and submit response plans; the approval of which means to ensure the availability of private personnel and equipment; the review and approval of such response plans; and the authorization of offshore facilities, including associated pipelines, to operate without approved response plans. DOI in turn delegated these responsibilities to the Bureau of Safety and Environmental Enforcement (BSEE). BSEE promulgated regulations governing oil spill response (OSR) requirements which are found in 30 CFR 254, Oil Spill Response Requirements for Facilities Located Seaward of the Coast Line.

Permittees operating offshore are required to comply with the applicable Federal OSR requirements for each activity site. These regulations implement the provisions of OPA 90 for offshore oil and gas operations which place the responsibility for preparing for and responding to a spill on the operator. Each operator is required to prepare an oil spill response plan (OSRP) for their facilities seaward of the coastline. In the OSRP the operator must include an emergency response action plan, a worst-case discharge (WCD) volume and response scenario, an inventory of response equipment sufficient to respond to the WCD scenario, contractual agreements with oil spill removal organizations (OSRO) who will provide response services, a dispersant-use plan, an in-situ-burning plan, and a training and response drills plan. The OSRP must also be consistent with the requirements of the NCP and any applicable Area Contingency Plan for the area in which the facility is located. In the SOA the Area Contingency Plan is a combined Federal/SOA plan entitled the Unified Plan for Preparedness to Oil Discharges and Hazardous Substance Release (Unified Plan). The Unified Plan is further supplemented by 10 Subarea Contingency Plans covering the SOA. For activities located on the North Slope, the OSRP must also be consistent with the North Slope Subarea Contingency Plan. Prior to the start of drilling operations, the operator must have a BSEE-approved OSRP.

In developing the WCD scenario, operators are required to conduct an appropriate trajectory analysis for the area where the facility would be located. This analysis must identify onshore and offshore areas that a discharge potentially could impact and further identify resources of special economic or environmental concern that may be present. The operator must describe what strategies would be used to protect these areas and the resources required. BSEE may require operators to demonstrate proposed spill response strategies before approval of an OSRP is granted by conducting exercises of the OSRP and inspecting spill response equipment. When determining equipment requirements for the WCD, the operator is required to derate the throughput capacity of skimmers to 20 percent of the nameplate recovery rate to compensate for environmental factors such as sea state, temperature, available daylight, and emulsification of the oil to ensure sufficient recovery capabilities.

To ensure plan holder readiness, BSEE conducts routine inspections of the operator's facilities to ensure that the identified spill response resources are readily available and in the quantities and condition described in the OSRP. Inspections of response equipment owned by OSROs along with maintenance and inspection records are conducted to verify response readiness. Reviews of training records and spill drill reports are made to verify that response personnel have completed the mandatory training and that all parts of the OSRP have been exercised as required in the regulations.

BSEE also will conduct government initiated unannounced exercises (GIUE) to test the operator's ability to carry out the provisions of the OSRP. These exercises may take the form of functional exercises (FE) or full-scale exercises with response equipment deployment (FSE). GIUEs are conducted in accordance with the National Preparedness Response Exercise Program (NPREP) Guidelines. These guidelines were developed in cooperation with the U.S. Coast Guard (USCG), U.S. Environmental Protection Agency (EPA), Pipeline Hazardous Materials and Safety Administration (PHMSA), and BSEE to allow regulatory agencies the opportunity to evaluate various aspects of a plan holder's preparedness, including their emergency procedures and their contracted OSROs' capabilities for proper and timely equipment deployment. For BSEE regulated offshore facilities, the number of GIUEs is determined by the Oil Spill Preparedness Division (OSPD) Chief. A facility will not participate in a BSEE initiated unannounced exercise more than once every 36 months, unless the results of previous exercises indicate that follow-up drills are warranted due to inadequate performance during a drill.

In preparing for a GIUE, be it a FE or FSE, BSEE will coordinate their activities with other Federal, SOA, and local regulatory partners in an attempt to conduct a joint exercise to leverage scarce resources in order to more readily assess plan holder and OSRO capabilities within the local area. Based on the results of these drills, BSEE may require the operators to amend their OSRP to improve response operations.

A functional exercise would occur at the plan holder's incident command post and does not entail mobilization or deployment and operation of equipment. The FE is aimed at testing the capabilities of the incident management team (IMT) to organize, support, and direct a response. These exercises generally last from 2 to 8 hours depending on how quickly the IMT is able to complete BSEE's exercise objectives.

Full-scale exercises would involve the IMT and deployment of response equipment at either an onshore equipment depot or at the offshore facility if equipment is staged on-site. These exercises usually involve the deployment and operation of equipment from a single tactic cited in the OSRP but can involve multiple tactics. For open-water and broken ice conditions, a deployment will generally involve between one and three boats used to deploy and tow containment boom, deploy and operate a skimmer, and shuttle temporary storage devices to and from a lightering point. These exercises would normally be conducted in close proximity to the industrial area near West Dock or at the proposed LDPI so as to limit impacts on wildlife. In rare cases, BSEE, working with the USCG, may require operators to deploy near an identified sensitive resource cited in the Subarea Contingency Plan's geographic response strategies. The purpose of the deployment would be to ensure the operator can effectively implement the recommended protection strategy, and validate the geographic response strategy. Such deployments would be in close coordination with appropriate federal and state resource agencies. The deployment portion of the GIUE would last approximately 4 to 8 hours depending on the time to mobilize, deploy, and operate the equipment.

In the largest potential deployment GIUE the plan holder could be expected to deploy upwards of 20 vessels ranging in size from an oil spill response vessel (OSRV) or oil spill response barge (OSRB) and tug up to 300 feet to multiple smaller vessels ranging in length from 12 feet to 55 feet. The vessels are either jet propelled, propeller driven, or air boats. These vessels would be used to tow containment boom, deploy skimmers and conduct skimming operations, shuttle on-water storage devices like mini-barges and towable bladders to and from shore, and deploy shoreline protection booming in shallow waters and along the shoreline.

The size and amount of containment boom would vary based on the tactic, skimming platform, and water depth. For an OSRV or OSRB, these vessels would be used in deeper coastal waters and open ocean, boom size can range from 30 inches up to 79 inches in width, and deployed and towed in lengths of up to 2,000 feet. For smaller workboats conducting skimming operations, boom ranging from 38 inches to 50 inches would most likely be employed in lengths up to 500 feet. In a large scale exercise it is expected that up to three such vessels would conduct these operations at various locations around the exercise location. For nearshore and shoreline protection booming, shallow water and delta/river boom would be utilized. Most tactics call for lengths of up 200 feet to be deployed and anchored in position either offshore or on the shoreline. In a large scale drill it is anticipated up to two such tactic demonstrations would be required.

The skimmers deployed during the course of the exercises will be hydrophilic brush, and disk models. Because these skimmers are designed to recover oil with very little water uptake, only the disks or brushes would be rotated during operations and the pumps would not be employed other than in a brief burst to demonstrate they are operational. These skimmers are hydraulically driven.

BSEE may also require a plan holder to mobilize equipment used for non-mechanical response options such as in-situ burning (ISB), dispersant application, and source control operations. For ISB operations, an operator has the option of igniting a pool of collected oil using hand-held ignitors or a torch slung beneath a helicopter. BSEE may require the operator demonstrate their ability to mobilize and deploy the helicopter and helitorch and conduct simulated operations over a designated area offshore. A single sortie is expected to satisfy the operator’s capability. In addition to the aircraft, up to two vessels operating as spotters would provide feedback to the pilot and burn operations supervisor.

It is highly unlikely that the operator would request or receive approval for dispersant use for operations in the Beaufort Sea given the shallow water depths (approximately 20 feet) in the area of operations. Dispersants are typically not used in water depths less than 60 feet to ensure adequate dilution and to minimize exposure to the ocean floor. If HAK does establish the capabilities to apply dispersants, BSEE could require them to demonstrate their ability to carry out application utilizing fresh water as a dispersant stimulant. Dispersants may be applied via fixed wing aircraft, rotary wing aircraft with application equipment slung beneath, or by vessel.

Fixed wing application could be carried out using a large multi-engine cargo aircraft like a Hercules C-130 to small single-engine planes, such as a Cessna 188 AGWAGON. The application aircraft would make multiple passes at approximately 75 feet above the ocean surface to discharge their payload. The use of a spotter aircraft is also required to guide the dispersant aircraft over the designated area and to indicate when to begin and end dispersant application. Spotter aircraft would be single or multi-engine propeller planes, most likely a Cessna or Twin Otter. An on-water monitoring vessel would also be required to observe operations. BSEE may require the dispersant application aircraft to discharge fresh water to the ocean surface to demonstrate the operability of the application system provided the required approvals from Federal and SOA authorities are received prior to the exercise.

Rotary-wing application of dispersants is another option. This involves a helicopter with a dispersant application system slung beneath the aircraft. A spotter aircraft is also required for application along with a monitoring vessel as described for fixed-wing aircraft application. The helicopter would make multiple passes over the target area to simulate dispersant application.

The other option for dispersant application is from a vessel-based system. Spray arms are affixed to the vessel and the vessel then transits through the oiled surface applying the dispersants. Vessels used for application can range from an OSRV/OSRB to smaller vessels depending on the operating environment. Spotter aircraft are required to guide and observe application along with a monitoring vessel.

If applicable, BSEE may also require HAK to demonstrate their ability to deploy and test source control equipment and tactics listed in the OSRP. The deployment exercise would occur on the gravel island.

During winter, the ocean surface freezes solid thereby necessitating the use of winter tactics to respond to a discharge to the environment. A GIUE conducted during solid ice conditions would involve land-based tactics adapted for the ice environment. Depending on the scenario, the operator may be required to mobilize response equipment such as front-end loaders, dump trucks, vacuum trucks, loader-mounted ice trimmers, bobcats, snowmobiles, all-terrain vehicles (ATVs), and snow blowers to respond to a simulated blowout to solid ice.

For a simulated release from a pipeline, the operator would be required to deploy augers to bore through the ice to the water below, utilize a Rube Witch Trencher or chain saws to cut slots in the ice sheet to allow the oil to surface and pool, and then employ a skimmer such as a foxtail driven by a gasoline powered generator. Multiple ATVs, bobcats, trucks, and gasoline powered lighting systems would be required to support these response exercise operations.

If an oil spill occurs, the operator is required to immediately implement their OSRP and notify the National Response Center of the spill, regardless of volume. If the suspected volume of the spill is 1 bbl or greater, the operator must verbally notify the BSEE Regional Supervisor of Field Operations without delay. It is up to the operator to mobilize sufficient equipment and personnel to control, contain, and clean up the spill to the greatest extent possible. In the event that the spill volume is significant or there are critical resources at risk, a Unified Command (UC) may be stood up to direct cleanup operations. For incidents occurring on the North Slope, the UC would be composed of the Responsible Party (RP); the Federal On-Scene Coordinator (FOSC), who for offshore events is from the USCG; the State On-Scene Coordinator (SOSC), who is a representative from the Alaska Department of Environmental Conservation; and the Local On-Scene Coordinator (LOSC), who is a representative from the North Slope Borough (NSB). This group works jointly to establish spill response priorities and direct overall response activities. If the RP is unable to adequately carry out response activities, the FOSC has the option to assume command of the response to ensure appropriate response actions are taken.

Effectiveness of cleanup operations is highly dependent on volume, location, and time of year in Alaska. A small spill occurring during winter on solid ice and snow can be readily cleaned up using conventional land-based equipment such as shovels, snow blowers, and bulldozers, resulting in a near 100 percent recovery rate. Spills to open water and broken ice conditions result in lower recovery rates of 5 percent to 20 percent of the spilled oil. Removal of a spill on water requires the deployment of containment boom to corral and concentrate the oil into a recoverable thickness, skimmers to remove the oil from the water surface, temporary storage vessels to hold the recovered oil and water, and vessels to deploy the equipment and personnel. Recovery rates are lower on water because the oil can disperse rapidly throughout the area, and responders must first locate and contain the spill before it can be recovered.

4.1.1.5 Conclusion for Oil Spill Response and Exercise Requirements

Government initiated unannounced exercises (e.g., oil spill drills), are infrequent, of short duration, (less than 8 hours), and utilize existing equipment. GIUEs would not alter the impact conclusions for any of the resources analyzed in this EIS.

4.1.2 Measuring Impacts

4.1.2.1 Area of Effects

The area of effect varies by resource. For example, marine noise may carry outside of the immediate Proposed Action Area (the LDPI, pipeline, and onshore portions of the project) and can affect marine mammal behaviors outside of it; whereas birds, terrestrial mammals, and vegetation may be unaffected beyond a very short range. Therefore, each individual resource has a different area of effect for the impacts associated with the Proposed Action and the action alternatives.

4.1.2.2 Impacts Scale

The analyses in this chapter apply a scale to categorize the potential impacts to specific resources. The scale takes into account the context and intensity of the impact based on four parameters: detectability, duration (i.e., short-term or long-lasting), spatial extent (i.e., localized or widespread), and magnitude (i.e., less than severe or severe, where the term "severe" refers to impacts with a clear, long lasting change in the resource's function in the ecosystem or cultural context).

Subject matter experts used the best available information and their professional judgment to determine where a particular effect falls in the continuum on a relative scale from "negligible" to "major." For biological resources, impacts were determined based on changes in the stock or population, rather than the individual level.

The impacts scale applied in this EIS is as follows:

- Negligible: Little or no impact
- Minor: Impacts are short-term and/or localized, and less than severe
- Moderate: Impacts are long lasting and widespread, and less than severe
- Major: Impacts are severe

In applying this scale and the terms that describe impact categories (levels of effect), subject matter experts considered the unique attributes and context of the resource being evaluated. For example, in considering impacts to biological resources, attributes such as the distribution, life history, and susceptibility of individuals and populations to impacts were considered. Factors considered for subsistence activities include the fundamental importance of these activities to cultural, individual and community health, and well-being. Based on these unique characteristics, impacts to subsistence activities are considered severe, and thus, major, if they would disrupt subsistence activities, make subsistence resources unavailable or undesirable for use, or only available in greatly reduced numbers for a substantial portion of a subsistence season for any community.

4.1.3 Mitigation

Appendix C of this document describes lease stipulations, operator-committed design features and Best Management Practices (BMPs), and BMPs and other measures typically required by other agencies. BOEM's conclusions regarding impacts of the Proposed Action and Action Alternatives to the physical, biological, and human environment assumes implementation of, and compliance with, the measures and conditions described in Sections C-1 through C-3 of Appendix C.

Proposed mitigation measures that flow from the impacts analysis of specific resources are described and analyzed in that resource section. These measures are compiled within Section C-4 of Appendix C.

4.2 Physical Environment

4.2.1 Oil and Gas Geology/Petroleum Engineering

The DPP describes Hilcorp's reservoir model, depletion strategy, and predicted oil, water, and gas production rates. This section identifies and discusses impacts associated with the Proposed Action and Action Alternatives that affect the Liberty Field reservoir.

4.2.1.1 The Proposed Action

The Proposed Action's impacts to the Liberty Field reservoir would occur due to the drilling of wells into the reservoir, producing fluids from the reservoir, and injecting gas and water into the reservoir.

If the Liberty DPP is approved by BOEM, before drilling could commence HAK would be required to submit an Application for Permit to Drill (APD) for each individual well to BSEE. The APD describes the well design criteria, blowout preventer equipment program, casing program, mud program, directional drilling program (as applicable), and other relevant information. This permitting process would be the same for all Action Alternatives.

Active reservoir management would be used to optimize field performance and maximize both the ultimate economic recovery of hydrocarbons and the resulting cumulative oil production at field abandonment. As wells are drilled and tested, additional information would be gathered about the Liberty Field reservoir structure, including reservoir extent, rock properties, fluid properties, and well performance. This information would be used to make modifications to future Liberty Field development plans (including well completion designs, well placement, and well count). Economic factors (such as the price of oil, new technologies, and operating costs) and operating conditions would also affect production rates, ultimate recovery, and time of abandonment.

The Liberty Field reservoir would be accessed and produced through conventional slant wells (with tangent angles that are less than 53° from vertical) with well heads located on the Proposed LDPI. The wells would be directionally drilled, with a plan view distance from the surface well head locations to bottomhole locations of no greater than a radius of 2.6 miles (see Figures 8-6 and 8-7 in the HAK DPP). Initially, the DPP proposes 2 disposal wells, 1 gas injection well, 3 water injection wells, and 5 production wells. The total aggregate measured length of the 5 production wells is 76,254 feet. The total aggregate measured length of the 4 injection wells is 53,738 feet. See below for a comparison of this aggregate length to that of Alternative 3.

Data gathered from several of the wells already drilled in this area indicate the presence of permafrost. Hydrates may be associated with the base of the permafrost, which could create issues with well control. Wells would have to be specifically designed to address this issue. The Proposed LDPI, however, is located in an area deemed low risk for shallow gas, hydrates, and other shallow drilling hazards, as indicated by a shallow hazard report produced in 2014 for British Petroleum Exploration (Alaska), Inc. (BPXA). Information regarding BOEM's requirements for shallow hazards reporting is available on BOEM's website, under Notice to Lessee's (NTL) A-01.

Drilling operations in the Liberty Field will encounter the Canning Formation, Hue Shale, and Highly Radioactive Zone (HRZ), hereafter characterized as possibly unstable shale formations that may cause open wellbores to collapse. The physical and chemical properties of shale and clay lithologies characterizing these formations can change the drilling mud chemistry, which could clog the drill bit, lead to stuck pipe situations, or result in a chemical reaction between the surrounding formation and the drilling mud which would impede the drill string progression. The Proposed Action limits the wellbore's exposure to potentially complex overlying formations by minimizing the borehole angle and encountered length of each well through the possibly unstable shale formations.

4.2.1.2 Alternative 2 (No Action)

Under this Alternative, the Proposed Action would not be approved and the actions described in the Liberty DPP would not take place. No wells would be drilled to access the reservoir and no depletion of hydrocarbons in the reservoir would occur. There are no drilling risks associated with the No Action Alternative.

4.2.1.3 Alternative 3 (Alternate LDPI Locations)

Under this Alternative, the proposed LDPI would be relocated to one of two locations to reduce impacts to the Boulder Patch from sedimentation and increased turbidity during pipeline trenching and proposed LDPI construction.

As stated above, the proposed development plan is based on a depletion scheme of five producing wells and four water and/or gas injecting wells drilled into the Liberty Field reservoir. The relocation of the LDPI would alter reservoir access, production onset, production rates, and the ultimate recovery of hydrocarbons from the Liberty Field reservoir.

4.2.1.3.1 Alternative 3A: Relocate LDPI Approximately One Mile to the East

This alternative would allow the Liberty Reservoir to be accessed and produced through conventional slant angle wells directionally drilled from the LDPI. The wells would be directionally drilled, with a plan view distance from the surface well head locations to bottomhole locations of no greater than a radius of 2.4 miles. The resulting borehole angles through the reservoir section would allow for standard drilling and completions, but it would increase the borehole angles and measured lengths through overlying shales and clays. This increased exposure time through the possibly unstable shale formations could amplify issues as described above: stuck pipe (which generally requires the drilling of a sidetrack borehole if the pipe can't be freed; the rig would have to be moved some distance from the original well bore to drill a sidetrack), or sloughing shale which could cause the formation of mud balls that impede the circulation of drilling mud. Formation pressures through the higher angle sections of Alternative 3A could be highly variable, which would demand continuous monitoring of drilling muds to ensure the drill hole does not collapse. The drilling operations for Alternative 3A may also require additional weighting agents to mitigate formation pressures, prevent wellbore caving, and facilitate the pulling of dry pipe to maintain wellbore stability.

Alternative 3A would decrease the total aggregate measured length of the five production wells by 5,912 feet. The reduction in wellbore lengths would result in a smaller volume of rock cuttings and excess drilling mud generated for disposal. While the aggregate length is shorter, the borehole angles of these wells will be larger, making the frictional flow coefficient of those wells larger. A higher frictional flow coefficient means it takes more energy to push drilling mud through the drill string, and higher drilling mud flow rates would be required, which could potentially wash out formations. Borehole wash out increases the possibility of stuck pipe during drilling operations due to settling of drill cuttings if mud circulation is lost.

If the LDPI was moved one mile to the east, the well bores for the two production wells targeting the northwest portion of the field would increase. Seismic data interpretation indicates the reservoir is thickest in the northwest and thins down in the southeast direction. The two primary producer wells targeting the thickest reservoir section would be less efficient due to their increased flowing friction and associated pressure drop, as described above.

In general, it can be expected that longer wellbore lengths in production wells will result in decreased recovery rates. In this alternative location, even though the aggregated wellbore lengths have decreased, the increase in the wellbore lengths of the two main production wells targeting the northwest portion of the field dominates the predicted production rate of this development. Overall, the volume of ultimately recoverable product associated with this alternative would not be measurably reduced over the life of the field as compared to the Proposed Action.

4.2.1.3.2 Conclusion for Alternative 3A

Overall, the producing wells under Alternative 3A would have decreased borehole lengths resulting in increased wellbore angles while drilling the possibly unstable shale formations, which would amplify drilling risks as compared to the Proposed Action.

4.2.1.3.3 Alternative 3B: Relocate LDPI Approximately 1.5 Miles to the Southwest

Alternative 3B puts the LDPI into SOA waters.

The Liberty Field Development Area shallow hazard report indicates that the shallow stratigraphic section beneath this alternative LDPI location would be highly variable, with buried lagoonal deposits, buried channels, and buried erosion surfaces. These potentially hazardous near surface features and subsurface sediment variability would result in the same drilling hazards as described above in Alternative 3A.

Alternative 3B would allow the Liberty Field reservoir to be accessed and produced through conventional slant angle wells directionally drilled from the LDPI. The wells would be directionally drilled, with a plan view distance from the surface well head locations to bottomhole locations with a radius no greater than 3 miles. The resulting borehole angles through the reservoir section would allow for standard drilling and completions. However, due to subsurface sediment variability this scenario increases the borehole angles and measured lengths through overlying shales and clays. The higher angle sections of Alternative 3B encountered through the possibly unstable shale formations would result in increased formation exposure time, which could result in the types of impacts minimized by the Proposed Action: clogged drill bits, stuck pipe situations, or chemical reactions between the surrounding formation and the drilling mud which impede the drill string progression. The heightened risk of loss of wellbore stability created by increased wellbore angles and longer formation exposure times could necessitate sidetrack boreholes.

This alternative would increase the total aggregate measured length for all of the production wells by 18,717 feet as compared to the Proposed Action. The impacts of this increase are the same as described above.

The aggregate increase in the wellbore path lengths for all injectors and producers would be approximately 36,654 feet, an estimated increase of 28 percent above the Proposed Action’s planned total wellbore length. This alternative would require more time to drill, complete, and service these longer wells. As a result of the longer drilling times, production of fluids from the reservoir and initiation of water and gas injection into the reservoir would occur later and field development would take longer.

Moving the LDPI 1.5 miles southwest would increase the length of the two primary producers targeting the thickest reservoir section to the northwest. The longer total aggregate measured length of the flow path for the producers would result in an increased overall pressure drop due to flowing friction up the production tubing. More total reservoir energy would be required to overcome this flowing friction as reservoir fluids are produced.

In general, it can be expected that longer wellbore lengths in production wells will result in slightly decreased recovery rates over the life of the field.

4.2.1.3.4 Conclusion for Alternative 3B

At the Alternative 3B island location, the shallow hazard seismic report shows highly variable shallow sediments which could impact operational planning. Specifically, sediments under the 3B

Alternative may not compact evenly which means the island could settle unevenly, resulting in possible tilted wells or unstable storage tanks or buildings.

From the perspective of drilling safety, there are relative disadvantages associated with this alternative in comparison to the Proposed Action and Alternative 3A. The shallow hazard seismic shows a “shallow hazard anomaly” which would directly impact the drilling of the wells for Alternative 3B. The considerable lengthening of the wellbore paths would result in a substantial increase in drilling time and associated drilling risks. The increase in wellbore angles while drilling the possibly unstable shale formations would amplify the drilling risks associated with these complex lithologies.

4.2.1.4 Alternative 4 (Alternate Processing Locations)

4.2.1.4.1 Alternative 4A: Relocate Oil and Gas Processing to Endicott SDI

Alternative 4A would move oil and gas processing facilities from the LDPI to the existing Endicott Satellite Drilling Island (SDI) facility.

If appropriate pumping, processing, and return of gas and water enhanced oil recovery (EOR) fluids for reservoir management is achieved, then the types and potential for impacts to the Liberty Field reservoir due to Alternative 4 development and production operations are not expected to differ from the Proposed Action.

4.2.1.4.2 Alternative 4B: Relocate Oil and Gas Processing to a New Onshore Facility

Alternative 4B would move oil and gas processing facilities from the LDPI to new onshore facility.

If appropriate pumping, processing, and return of gas and water EOR fluids for reservoir management is achieved, then the types and potential for impacts to the Liberty Field reservoir due to Alternative 4 development and production operations are not expected to differ from the Proposed Action.

4.2.1.5 Alternative 5 (Alternate Gravel Sources)

Under this Alternative, the Proposed Action would be approved and the actions described in the Liberty DPP would take place using alternative gravel sources as described by Alternative 5A, 5B, or 5C. Development plans and production operations would remain the same under Alternative 5A, 5B, and 5C as for the Proposed Action.

The impact to the Liberty Field reservoir is not expected to differ between the Proposed Action and Alternative 5.

4.2.2 Water Quality

All action alternatives would result in impacts to marine, freshwater, and estuarine water quality during construction, production, and decommissioning. Construction of the LDPI would occur during the winter months thereby minimizing the impacts to water quality. During construction, water quality impacts to freshwater, estuarine, and marine environments would largely be a result of ice roads and pads, gravel mine dewatering, onshore facilities construction, vessel discharge, LDPI and pipeline construction, wastewater discharges, and accidental oil spills. The duration for these activities is expected to be short-term and temporary.

The primary source of water quality impacts to marine waters during production would be from the ongoing NPDES-permitted point-source wastewater discharge from the seawater treatment plant. Although HAK intends to discharge the waste streams into an approved underground injection control (UIC) disposal well, impacts to marine water quality may occur in the event that the UIC disposal well is unavailable (see Section 2.1.9).

The primary sources of marine, freshwater, and estuarine water quality impacts during decommissioning would result from the rehabilitation of the gravel mine site, the removal of the LDPI slope protection system, onshore facilities, and gravel pads.

Appendix C describes mitigation measures derived from lease stipulations, design features and BMPs the operator committed to, and requirements and BMPs that other agencies typically require. BOEM's conclusions regarding impacts of the Proposed Action and Action Alternatives to the physical, biological, and human environment assumes implementation of, and compliance with, the mitigation measures described in Sections C-1 through C-3 of Appendix C.

4.2.2.1 Assumptions for Water Resources

The State of Alaska Department of Natural Resources (ADNR) regulates and permits many aspects of winter travel on the Alaska North Slope (ANS). The Division of Mining, Land, and Water is responsible for permitting ice road construction, while the Water Resources Office (ADNR WRO) regulates temporary water withdrawal (used for onshore ice road construction) from rehabilitated and existing mine sites and tundra ponds. Typically, ADNR WRO allows for a 20 percent withdrawal of a water resource depending on its location and the habitat it provides, allowing for 1 or 2 years to pass between withdrawals for adequate recharge to occur.

HAK currently holds General Land Use Permit #LAS 29963 for ice road and ice pad construction on all SOA-owned lands on the Arctic North Slope bordered by the Canning River to the east, the Colville River to the west, and the Brooks Range to the south. HAK estimates that an estimated 20 million gallons would be needed for annual ice road construction and approximately 120 million gallons of freshwater for the 2-year construction period.

4.2.2.2 The Proposed Action

The Proposed Action's impacts to water quality would result from ice road and pad construction, gravel mine site development, construction of the LDPI and pipeline, and construction of facilities on the proposed LDPI and onshore facilities. Water quality impacts from these activities would be primarily related to temporary increases in turbidity.

Increased turbidity is evidence of an increase in total suspended solids (TSS). TSS is designated as a conventional pollutant (Clean Water Act [CWA] 304(a)(4) and 40 CFR 401.16), not a toxic pollutant. Turbid waters absorb more heat and water holds less dissolved oxygen as temperatures rise (Dodds, 2002). These effects are temporary, decreasing, and ending with settlement of the suspended sediments.

Water quality impacts during production would mainly result from point-source discharges from the proposed seawater treatment plant. See Section 2.1.9 for a thorough discussion of the EPA NPDES permit.

4.2.2.2.1 Construction Impacts

Ice Roads and Ice Pads

See Section 2.1.1 for more detail on the Proposed Action's ice road construction and routes. Ice roads and pads would be built during construction and continue to be used throughout production. Spring snowmelt can hasten melting of ice roads and ice pads and result in a temporary increase in turbidity in adjacent wetlands and at stream and river crossings.

Impacts to water quality would be seasonal during spring break-up. Increased turbidity of freshwater and estuarine streams could occur, as well as increased turbidity downstream to marine waters including surface, mid-depth, and bottom waters. The increase in turbidity would be temporary. Mitigation typically required by ADNR and NSB permits would include slotting ice roads at stream and river crossings to preclude ice-dam impoundments by providing outlets to allow streams to flow during snow-pack melt and break-up.

Suspended sediments and melt water from ice roads and ice pads may include pollutants from vehicular traffic and ice-pad operations. Pollutants are expected to settle and/or dilute to background levels.

Gravel Mine

All gravel needed to create the proposed LDPI would be obtained from the Proposed Action's new gravel mine site during one winter unless a second year of island construction is needed (Hilcorp, 2015, 2017). A source of approximately 1,250,000 cubic yards (cy) of gravel is required to meet immediate and potential long-term project needs.

The proposed creation of the 21-acre gravel mine site would result in a permanent loss of wetlands (Section 4.3.7). Wetland functions that affect water quality such as maintenance of natural sediment transport processes, production and export of organic matter, and the maintenance of the soil thermal regime would be eliminated within the gravel pit footprint. These impacts are long-term, but would be limited in extent to the 21-acre site.

Impacts to freshwater quality could occur from dust generated during mine excavation that would settle on the snow and enter the flows into adjacent lakes or streams during spring break-up. High levels of turbidity in the water column already occur naturally near the Proposed Action Area during spring break-up. The increase in turbidity from dust associated with gravel mining would represent a minor contribution to overall suspended sediments. The ice pad used for stockpiling of overburden from the gravel mine would have impacts similar to ice roads as discussed above.

Poor water quality at the gravel mine site would be avoided by adherence to a Long-Term Adaptive Management Plan, a requirement of ADNR. Regulation of discharges from dewatering the gravel during mining would also serve to minimize impacts to the water quality in adjacent bodies of water.

Onshore Gravel Pad and Related Construction

The Proposed Action requires approximately 3,500 cy of gravel for the 0.71-acre Badami tie in pad, and approximately 1,500 cy for the 0.15-acre Badami ice road crossing (Hilcorp, 2017, Section 10.3). About 1 acre of wetlands and their functional value would be permanently lost as a result of the gravel fill.

Vessel Discharge

Vessels greater than 79 feet in length operating as a method of transportation would require NPDES permit coverage for incidental discharges under the Final 2013 Vessel General Permit (VGP) for Discharges Incidental to the Normal Operation of Vessels (EPA, 2013). The VGP establishes effluent limitations to control materials from vessels that contain constituents of concern in the waste streams. Pollutant constituents in the VGPs may include nutrients, pathogens, oil and grease, metals, biochemical oxygen demand, pH, total suspended solids, aquatic nuisance species, and other toxic and non-conventional pollutants with toxic effects. The VGP, as certified by the State of Alaska in Section 401(d), requires that all discharges authorized by the VGP shall not result in a violation of Alaska water quality criteria for the protection of aquatic life and human health found in 18 Alaska Administrative Code (AAC) 70. In addition to complying with NPDES requirements, vessels discharging in the contiguous zone and ocean (seaward of the outer limit of the territorial seas) are subject to MARPOL 73/78, implemented by the USCG pursuant to 33 CFR 151. Vessels less than 79 feet in length that are operating as a method of transportation may be covered under the VGP, or may instead opt for coverage under the small VGP issued by the EPA.

4.2.2.2.2 LDPI and Pipeline Impacts

Construction of the proposed LDPI is planned for a 1 year period with gravel placement commencing the first winter of the development. Should the winter season be shortened by warm air temperatures thereby reducing the useful life of the ice road, it may become necessary to extend the island construction period to 2 years (Hilcorp, 2017). Approximately 927,000 cy of gravel would be needed to construct the proposed LDPI. Gravel placement operations would begin following ice road construction and artificial ice thickening at the island site. Gravel would be hauled from the gravel site on the proposed ice road to the island site for approximately 50 to 70 days ending by mid-April, weather conditions permitting.

During the process of construction, sections of sea ice would be cut and removed over the location of the island. Once the ice is removed, gravel would be poured through the water column to the sea floor, building the island structure from the bottom up (Hilcorp, 2015, page 54). A conical pile of gravel will form on the seabed floor until it reaches the surface of the ice. The construction would continue with a sequence of removing additional ice and pouring gravel until the surface size of 9.3 acres is achieved. It is estimated that the footprint of the island at the seafloor would be approximately 24 acres (Hilcorp, 2015, page 54).

The regional circulation pattern within Foggy Island Bay would not be notably altered by the presence of the completed LDPI. The predominant easterly winds in this area are the overwhelming driving force creating westerly currents as measured from comparing Acoustic Doppler Current Profilers (ADCP), land-based High Frequency Radars, and coastal meteorological stations (Weingartner et al, 2009; Potter and Weingartner, 2009). Prevailing current direction and velocities would deviate slightly as flow is diverted around the proposed LDPI. These slight deviations in current patterns and velocities would be in the immediate vicinity of the proposed island. The size of the proposed LDPI in relation to the overall area of Foggy Island Bay is small, and BOEM does not expect the proposed island to cause any changes to the regional circulation of Foggy Island Bay.

Proposed LDPI construction and installation of the subsea pipeline from the mainland to the LDPI are expected to increase sediment load in the water column. Reduction of light penetration by increased suspended sediment concentrations resulting from construction activities is of concern because of the close proximity of the proposed Project Area to the kelp beds residing in the Stefansson Sound Boulder Patch. In an effort to understand the generation and distribution of excess suspended sediment (XSS) on the Stefansson Sound Boulder Patch, Coastal Frontiers (2014) modeled the expected turbidity plumes and the effects of increased suspended sediment for winter/spring and summer construction scenarios. The XSS is the amount of excess suspended sediment determined to be above the ambient TSS at a location given the season and weather conditions. The XSS includes the sediment that is transported away from the excavation site by the ambient current (Ban et al., 1999). The scenarios under consideration included:

- Winter Island Gravel Placement
- Spring Island Slope Grading and Armoring
- Winter Pipeline Installation
- Summer Wave Winnowing, Island Slope Grading and Armoring
- Summer Wave Degradation of the Pipeline Backfill Mound

For the purposes of this analysis, only the data and graphics from the westerly currents that could potentially have suspended sediment impacts to the Stefansson Sound Boulder Patch have been included. BOEM understands that easterly flowing currents would produce an XSS plume east of the proposed Project Area. However because westerly flowing currents occur on the average 60 to 70 percent of the time (Ban et al, 1999), the impacts analysis provided is considered conservative and worst case.

Winter/Spring Construction Scenarios

During the winter/spring season, the nearshore waters of Foggy Island Bay are covered in ice sheets up to 6 feet deep (Coastal Frontiers, 2014). These ice sheets create a barrier to the winds resulting in low under-ice currents. The average current speed observed during the ice-covered season in the Project Area is 2 centimeters per second (Ban et al., 1999). The lack of wind-driven current and wave action results in naturally low sediment resuspension and turbidity levels. TSS concentrations during the ice-covered periods ranged from 0.1 mg/L to 0.6 mg/L in the Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) study area during 2001 and 2002 (BOEHM et al., 2001).

To estimate the suspended sediment concentrations and turbidity plumes for the construction of the LDPI, Coastal Frontiers (2014) refined the general methods used by Ban et al. (1999) in a previous study on an earlier proposed Liberty project. In both studies, Ban et al., (1999) and Coastal Frontiers (2014), placed particular emphasis on defining the area of the Stefansson Sound Boulder Patch impacted by increased TSS concentrations in excess of 10 mg/L, the threshold value assumed to negatively impact winter kelp growth.

The TSS concentrations and the nature of the plume are dependent on 1) the properties of the gravel fill, 2) the rate of fine particle introduction to the water, 3) the water depth, 4) current speed, and 5) current direction (BPXA, 1998). Values for these variables are provided in the report for each scenario along with the assumptions used in the modeling. Initial concentrations of suspended sediments for each scenario were calculated based on these values and assumptions. For a full description of these values and assumptions, see Coastal Frontiers (2014) and Ban et al. (1999).

During island gravel placement, a large portion of the suspended material would settle to the seafloor within or adjacent to the footprint of the island, while the finer fractions (less than 75 µm) are expected to be transported as a plume to the southeastern section of the Stefansson Sound Boulder Patch (Coastal Frontiers, 2014). The initial increase of TSS at the LDPI site is expected to be 250 mg/L (Ban et al., 1999). Figure 4-1 presents the anticipated sediment plume under the westerly flowing currents and illustrates the cone shape plume with segments indicating the reach of XSS at 100 mg/L, 50 mg/L, 20 mg/L and 10 mg/L.

The initial turbidity plume disperses below 10 mg/L within about 10,000 feet from the LDPI. The impact of winter LDPI construction would result in temporary (35 days maximum exposure) XSS increase (ranging from 10 mg/L to 100 mg/L) that would settle quickly from the origin at the proposed LDPI to the farthest calculated reach of the turbidity plume. Should the construction of the LDPI take two consecutive winters to complete, BOEM expects the impact to be similar in magnitude and duration.

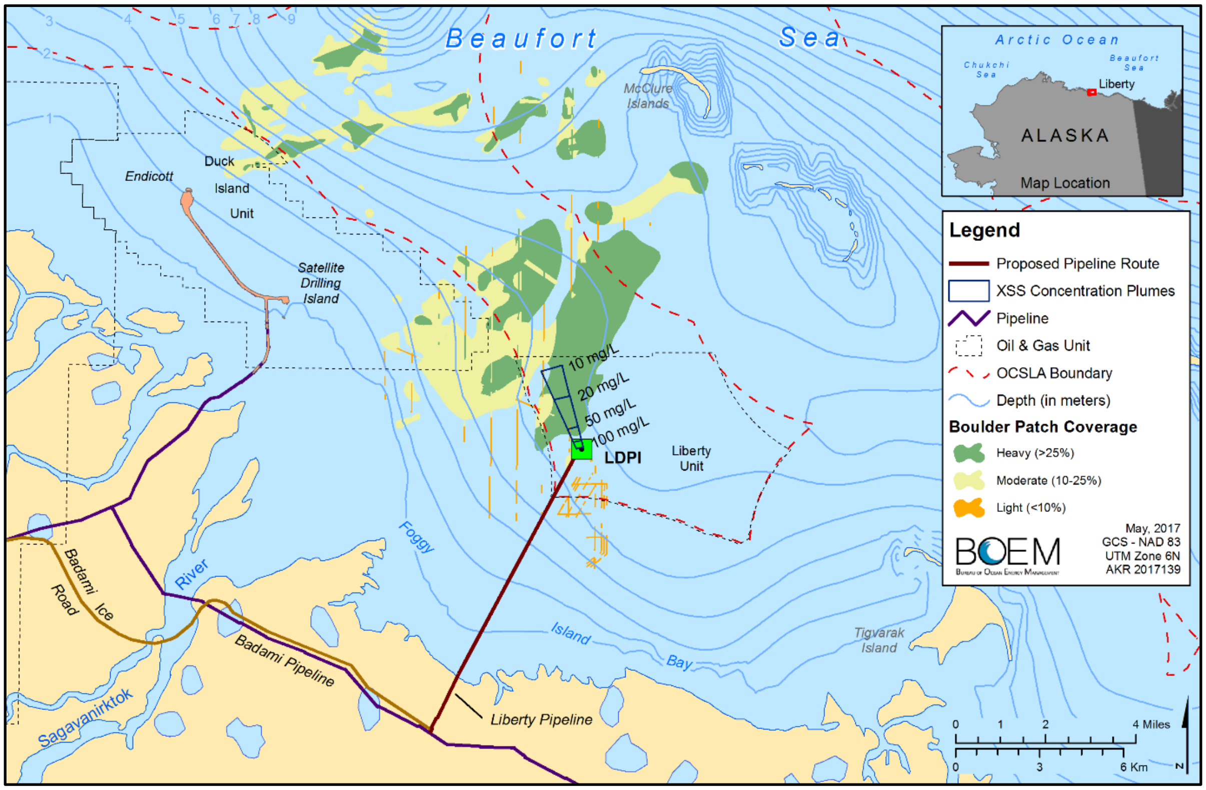

Figure 4-1 XSS Concentrations and Affected Boulder Patch Areas – LDPI Winter Construction
Source: Coastal Frontiers, 2014.

Spring Slope Grading and Armoring

Following completion of the winter gravel haul, grading of the exposed gravel slopes of the LDPI would be performed. The grading process utilizes a crane and dragline to reshape and prepare the LDPI perimeter for installation of the slope armor system (Coastal Frontiers, 2014). Performing the grading and armoring in later spring through a moat from which sea ice has been removed allows the side slope profiles to be shaped to their final configuration and armored in the absence of waves and currents (Coastal Frontier, 2014). Should a second season of island construction be required, temporary slope protection would be installed for that portion of the island for which gravel placement was not completed (Hilcorp, 2017).

The anticipated turbidity plume would impact a smaller area for a shorter duration than the plume resulting from winter construction of the LDPI (Figure 4-2). Figure 4-2 illustrates a 75-acre, cone-shaped plume projecting from the LDPI and the reach of the 100 mg/L, 50 mg/L, 20 mg/L, and 10 mg/L areas of XSS (Coastal Frontiers, 2014). Plume exposure would be limited to approximately 23 days (Coastal Frontiers, 2014). The initial XSS concentration of 598 mg/L (based on assumptions derived from earlier modeling efforts [Ban et al.,1999]) from the dragline construction activities would dissipate relatively quickly (100 mg/L to 10 mg/L) from the origin to the farthest calculated reach of the turbidity plume at 4,000 feet from the LDPI (Coastal Frontiers, 2014). Once the slope protection system is installed during either the first or second open-water season, the LDPI gravel would no longer contribute to XSS (Coastal Frontiers, 2014). Should the construction of the LDPI take two consecutive winters to complete, BOEM expects the impact to be similar in magnitude and duration.

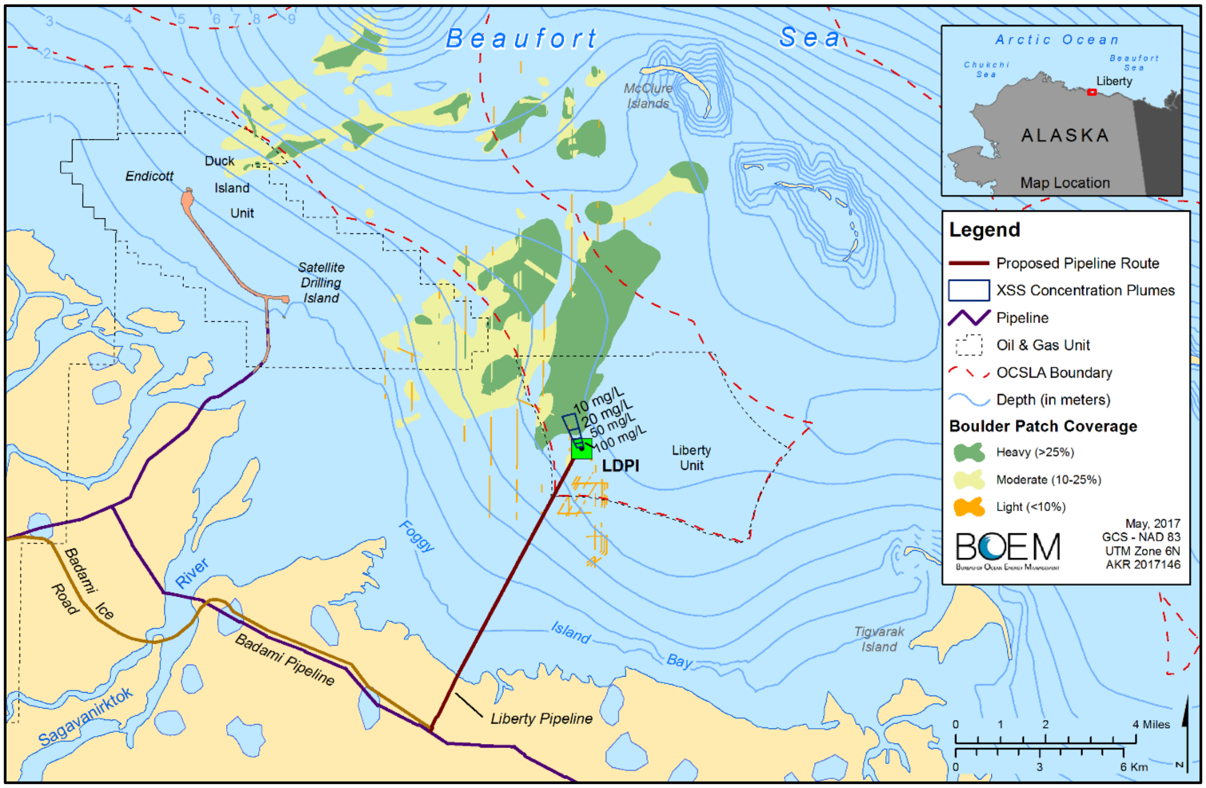

Figure 4-2 XSS Concentrations and Affected Boulder Patch Areas during Spring Moat Dragline Operations at the LDPI

Source: Coastal Frontiers, 2014.

Winter Pipeline Installation

The proposed pipeline connecting LDPI to the onshore facilities would be installed during winter following construction of the island. Pipeline installation would include seabed trench excavation through a slot in the ice sheet, placement of the pipeline, and backfill of the native material on top of the installed pipeline (Coastal Frontiers, 2014).

Reportedly, the top 16 feet of the seabed material is comprised of 88 percent fines content (Coastal Frontiers, 2014). The distribution of these seabed fine materials would be significantly different than the fines distribution for the gravel island fill (fines content at 10 percent [Coastal Frontiers, 2014]). Consequently, greater percentages of seabed material would remain suspended longer and can be transported further from the pipeline alignment (Coastal Frontiers, 2014). Approximately half of the pipeline alignment route would be in grounded ice due to shallow water depths landward of the LDPI (Coastal Frontiers, 2014). The anticipated turbidity plume would, therefore, be generated from only that portion of the pipeline exposed to open-water.

Suspension of the fine fractions of sediment would occur during the trench excavation and the backfill of the excavated material into the pipeline trench. The sediment plume from the trench excavation would be short-lived, lasting less than 3 days for the deepest portions of the pipeline. Initial re-suspended sediment concentrations would range from 1,671 mg/L near the LDPI, to 7,160 mg/L at the approximate midpoint of the pipeline route to shore (Coastal Frontiers, 2014). Figure 4-3 illustrates the maximum concentration of the XSS plumes for the excavation activity under westerly current conditions. The irregularly shaped plume extends over 991 acres of the southeastern portion of the Stefansson Sound Boulder Patch in reaches of 100 mg/L, 50 mg/L, 20 mg/L, and at the furthest reach, 10 mg/L of XSS. The cross hatching on Figure 4-3 indicates the landward portion of the proposed pipeline where construction activities would take place in grounded ice. No suspended sediments are expected to occur from this portion of the pipeline due to the absence of water and currents.

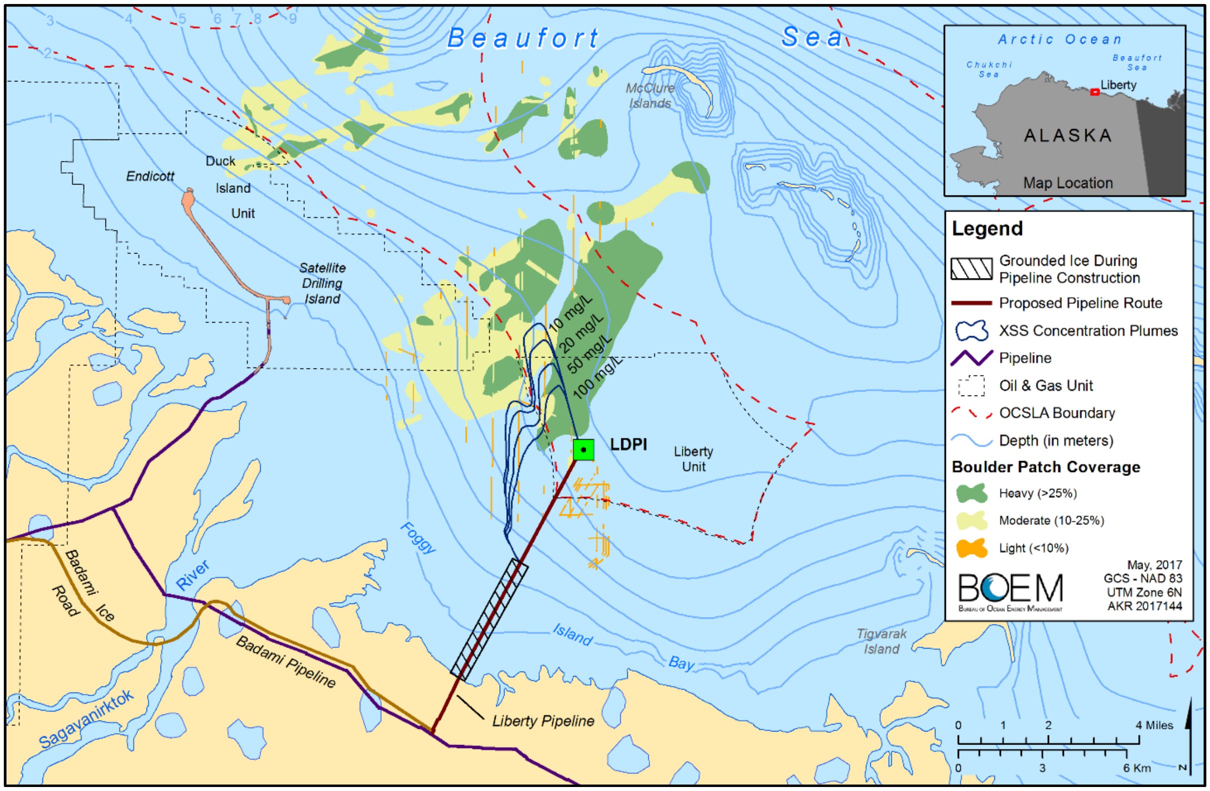

Figure 4-3 XSS Concentrations and Affected Boulder Patch Areas during Winter Pipeline Trench Excavation, Westerly Current

Source: Coastal Frontiers, 2014.

Backfill of the excavated trench would be conducted following installation of the subsea pipeline over a period of approximately 7 days (Coastal Frontiers, 2014). During the backfill of the pipeline trench, 2 percent of the entire sediment volume is estimated to be suspended into the water column based on previous North Slope subsea pipeline installations and assumes that the backfill is frozen prior to being placed into the trench. Although a significantly smaller fraction of fines is introduced into the water column during backfill activities, the spatial extent of the XSS plumes are still quite large. The trench backfill XSS concentration impacts 679 acres of Stefansson Sound Boulder Patch and the initial concentrations of XSS are estimated at 301 mg/L to 1,289 mg/L depending upon the effective water depth at each backfill region (Coastal Frontiers, 2014). The maximum time of exposure ranges from 18 to 53 hours (Coastal Frontiers, 2014).

Figure 4-4 shows the anticipated XSS plumes from the winter trench backfilling activities under the westerly wind conditions. As stated previously, the conditions depicted in Figure 4-3 and Figure 4-4 are relevant when the ocean currents are westward, which occurs on average 60 to 70 percent of the time (Ban et al., 1999).

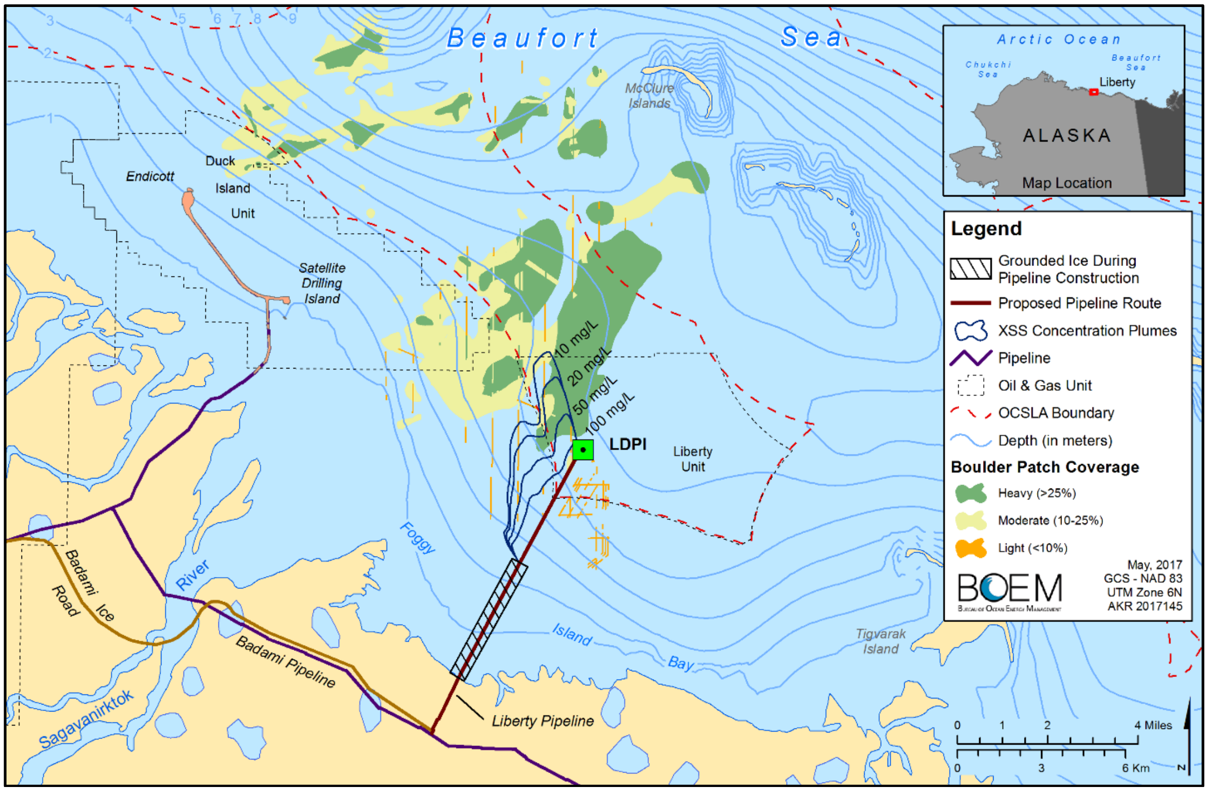

Figure 4-4 XSS Concentrations and Affected Boulder Patch Areas during Winter Pipeline Trench Backfill, Westerly Current

Source: Coastal Frontiers, 2014.

Summer Wave Winnowing, Island Slope Grading and Armoring

The summer following construction of the LDPI, side slope armoring and armor installation would continue until completed. Open-water conditions would allow waves to winnow fine-grained sediments from the gravel fill on the unarmored portions of the slopes, and variable wind/wave-driven currents would disperse the suspended sediments into the marine environment. Coastal Frontiers (2014) modeled the anticipated plumes associated with both the wave winnowing and the island slope grading and armoring for XSS concentrations of 1, 5, 10, 15 and 20 mg/L. A probabilistic wind method based on historic wind speeds in the vicinity of the project was used for the analysis.

The results of this study showed that the largest area of Stefansson Sound Boulder Patch impacted was 441 acres for approximately 10 days at the 1 mg/L concentration level (Figure 4-5 through Figure 4-9; Coastal Frontier, 2014).

Summer Wave Degradation of the Pipeline Backfill Mound

During the summers following the completion of pipeline construction, a backfill mound of semi-frozen seabed material over the pipeline would rise above the surrounding seafloor. Warmer summer waters would thaw the mound, and waves and wind-driven currents would degrade the mound until it conforms to the grade of the surrounding seafloor. Coastal Frontiers (2014) used the Probabilistic Wind Method to project the dispersal of XSS from the pipeline backfill mound. Figure 4-5 through Figure 4-9 show the dispersal areas for the 1, 5, 10, 15, and 20 mg/L XSS concentrations for this activity.

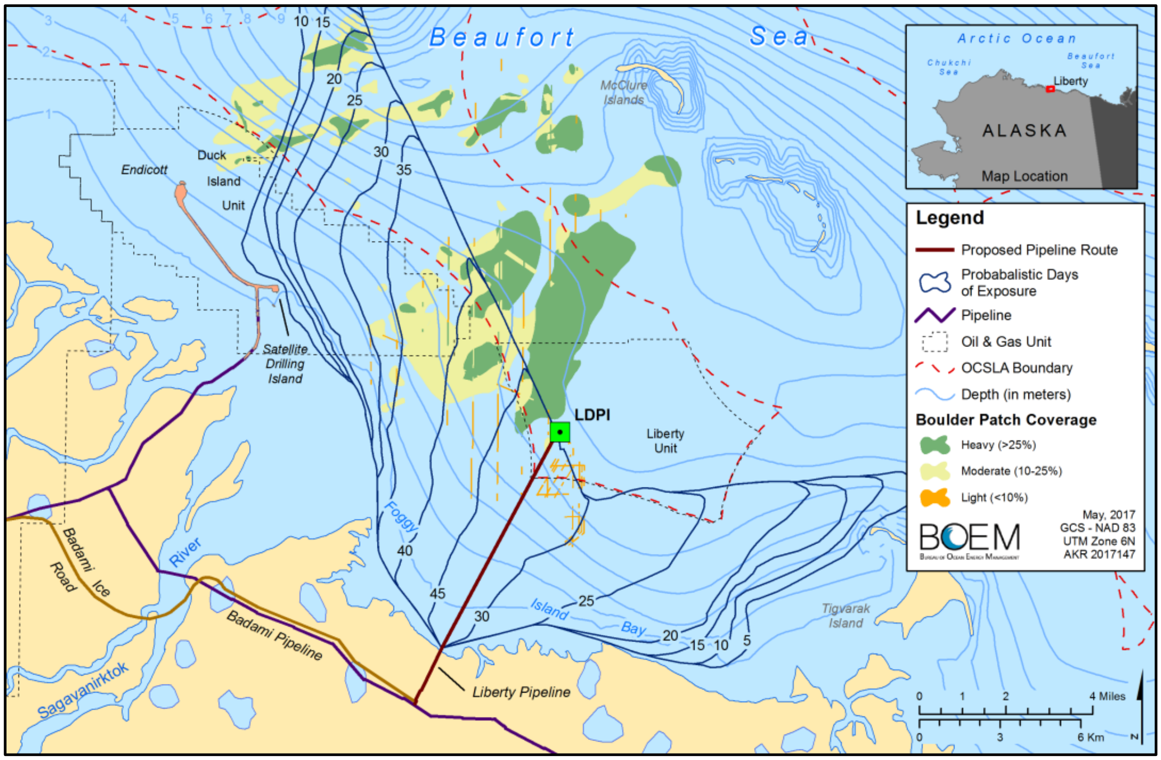

Figure 4-5 Affected Boulder Patch by 1 mg/L XSS from Backfill Mound Degradation
Units are Probabilistic Days of Exposure.
Source: Coastal Frontiers, 2014.

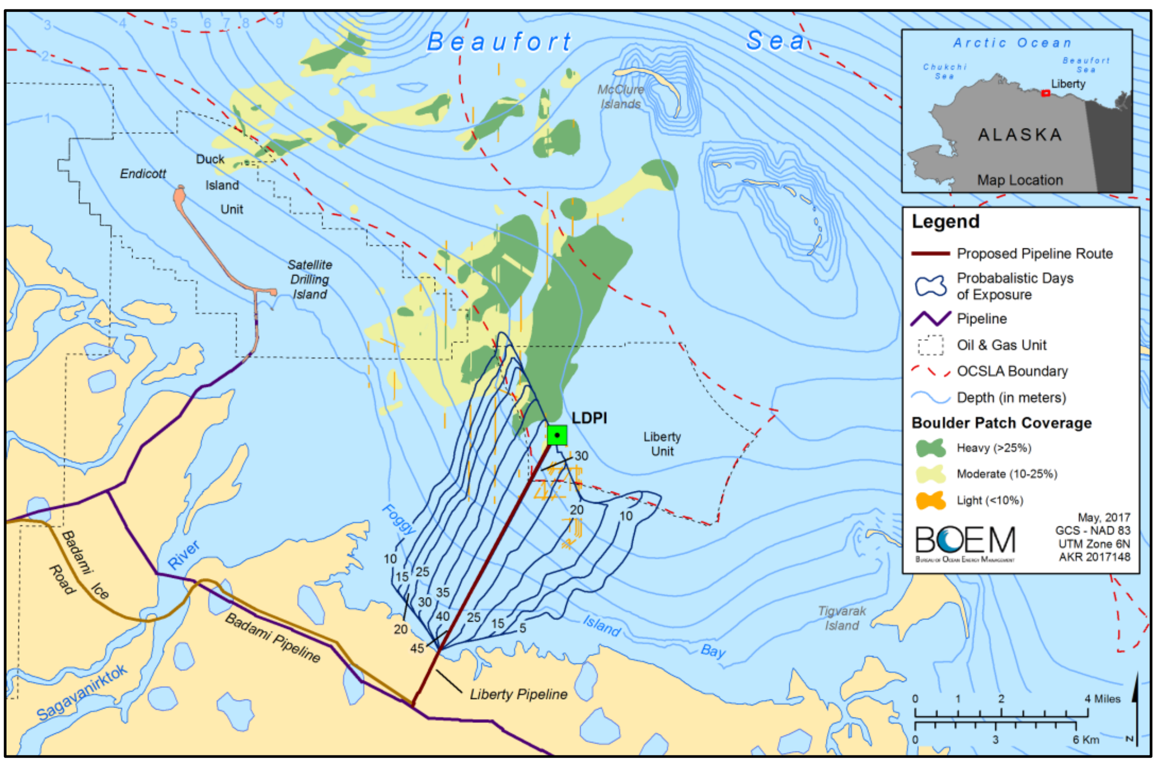

Figure 4-6 Affected Boulder Patch by 5 mg/L XSS from Backfill Mound Degradation
Units are Probabilistic Days of Exposure.
Source: Coastal Frontiers, 2014.

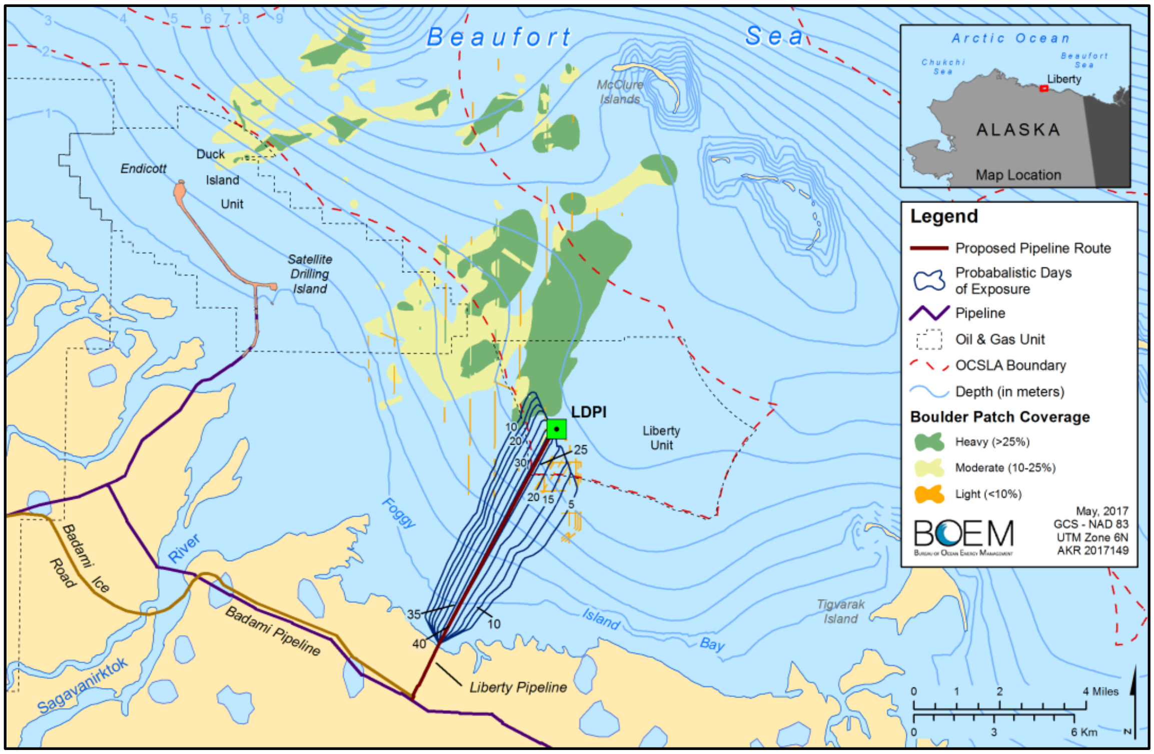

Figure 4-7 **Affected Boulder Patch by 10 mg/L XSS from Backfill Mound Degradation**
Units are Probabilistic Days of Exposure.

Source: Coastal Frontiers, 2014.

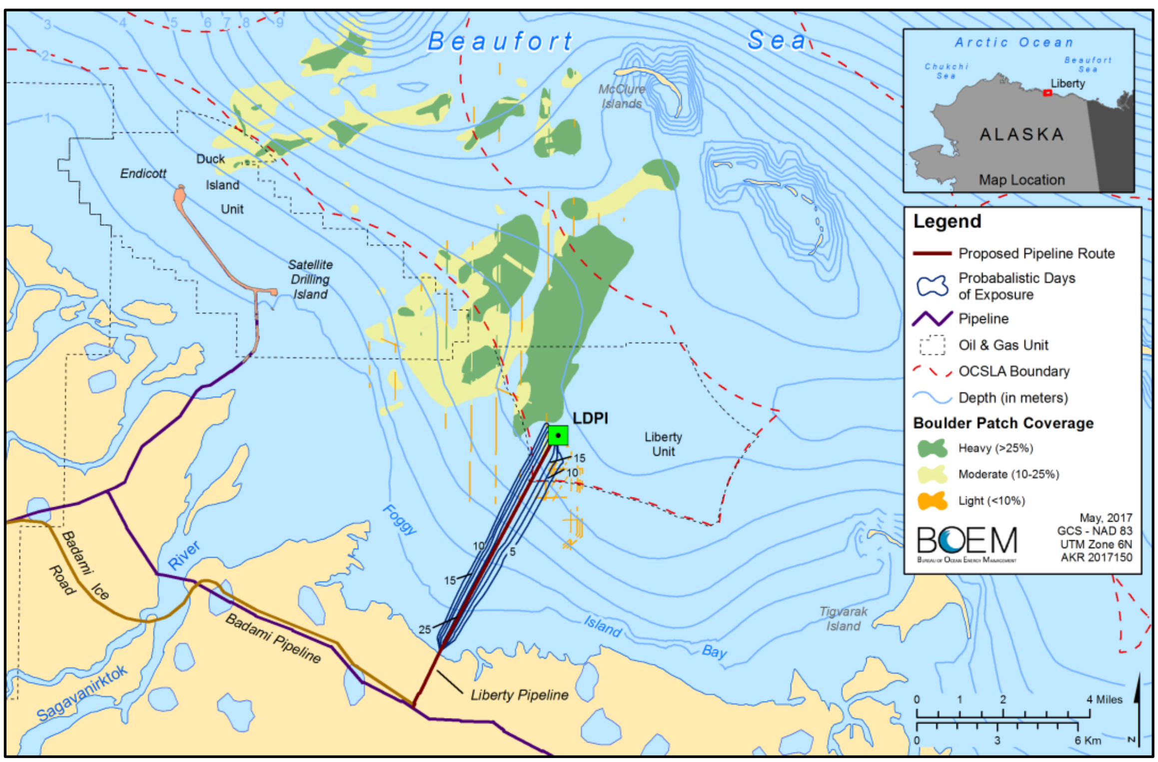

Figure 4-8 **Affected Boulder Patch by 15 mg/L XSS from Backfill Mound Degradation**
Units are Probabilistic Days of Exposure.

Source: Coastal Frontiers, 2014.

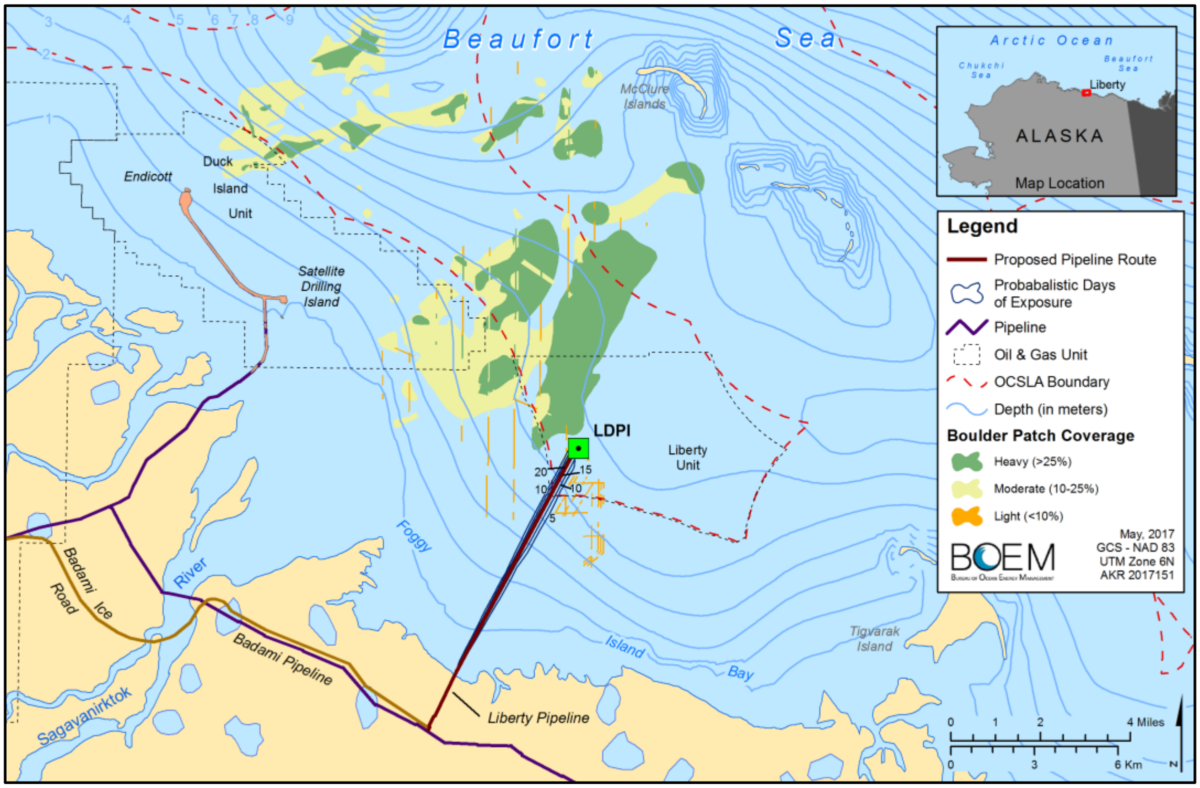

Figure 4-9 Affected Boulder Patch by 20 mg/L XSS from Backfill Mound Degradation
Units are Probabilistic Days of Exposure.
Source: Coastal Frontiers, 2014.

The summer dispersal of the backfill mound would impact the largest region of the Stefansson Sound Boulder Patch as the mounded backfill material erodes to the approximate elevation of the surrounding seafloor (see Figure 4-5 and Figure 4-6). Although large in overall size, the XSS values are estimated to be 1 mg/L and 5 mg/L. Summer wind-driven currents are larger, the seabed material contains a higher percentage of fine-grained sediments (80 percent) and the northerly portion of the pipeline route traverses across a small section and is in close proximity to the southeast boundary of the Stefansson Sound Boulder Patch (Coastal Frontiers, 2014).

Wastewater Discharges

During construction at the LDPI, there would be no discharges of sanitary and domestic wastewater, potable water treatment reject wastewater, or seawater treatment plant wastewater. However, HAK anticipates discharging construction dewatering wastewater and secondary containment dewatering wastewater intermittently.

During construction of the project, sanitary and domestic wastewater would be hauled offsite to an onshore disposal facility and potable water would be brought to the project location from an existing onshore source. The seawater treatment plant (STP) facility installation on the LDPI would not begin until late in the second year or early in the third year of the project. For purposes of this analysis, it is assumed that discharges from the STP would not occur until construction has been completed and production activities have been initiated.

The only wastewater discharges from the LDPI during development construction would be from construction dewatering and secondary containment dewatering. No discharge volumes have been specified for either the construction dewatering or secondary containment dewatering discharges because the volume and frequency is driven by storm events and seasonal snowmelt during the spring thaw (May through June). The pollutants associated with these discharges may include TSS and oil and grease. Total aromatic hydrocarbons (TAH) and total aqueous hydrocarbons (TAqH) may be present in the secondary containment dewatering wastewater if there are storage tanks containing bulk fuel and petroleum products.

Since the waste streams would be discharged on an infrequent basis during construction prior to the availability of the disposal well, any impacts to water quality would be intermittent, localized, and short-term in nature. This conclusion takes into consideration that the discharges of construction dewatering and secondary containment dewatering are short-term and infrequent, and subject to the terms and conditions of the NPDES permit. EPA's analysis and determinations within the Ocean Discharge Criteria Evaluation (ODCE) concludes there would be no unreasonable degradation of the marine environment as a result of these NPDES discharges. Additionally, construction activities are scheduled to occur during winter months when marine productivity is lowest and photosynthetic opportunity is minimal.

4.2.2.2.3 Production Impacts

Wastewater Discharges

The first well to be drilled at the LDPI would be a disposal well. HAK has stated that the drilling waste generated from this activity would be containerized onsite until the disposal well is available, or transferred to a shore-based facility. Once the disposal well is completed, all drilling wastes would be injected downhole. There would be no discharge of drill cuttings, drilling fluids, or other wastes associated with drilling the injection or production wells.

As discussed in Section 2.1.9, once the disposal well is available, and the facility installation processes have been completed, the sanitary and domestic wastewater, potable water treatment reject wastewater, construction dewatering wastewater, and the secondary containment dewatering wastewater would be injected into the disposal well. Although HAK does not intend to discharge these waste streams to the receiving environment, they have requested authorization from EPA on a contingency basis, in the event that the disposal well is unavailable. The seawater treatment plant wastewater discharge would be the only ongoing discharge from the LDPI, which would begin after construction has been completed.

In the event that the disposal well is unavailable, the contingency waste streams may be discharged to the receiving environment. However, the resulting impacts to water quality are expected to be intermittent, localized, and short-term in nature, and all discharges would be required to meet the terms and conditions of the NPDES permit.

The primary source of water quality impacts from NPDES discharges during production is from TSS associated with operation of the STP. TSS is a non-toxic conventional pollutant that naturally occurs in the water column and local benthic sediments. Any TSS-related impacts from the STP discharge are expected to be intermittent and localized because local tidal movements and currents are expected to rapidly dilute and disperse elevated concentrations of TSS to background levels. TSS does not bioaccumulate or persist in the environment. In addition, the concentration and quantity of TSS discharged from the STP is not expected to be great enough to result in significant smothering of sessile marine organisms such as those occurring in the Stefansson Sound Boulder Patch, or to significantly reduce the photosynthetic opportunities of marine organisms on a large scale. Therefore, negligible to minor impacts to water quality are anticipated as a result of the NPDES-permitted discharges during production at the LDPI. This conclusion takes into consideration the terms and conditions of the NPDES permit and analysis and determinations within the ODCE, which concludes there would be no unreasonable degradation of the marine environment as a result of NPDES-permitted discharges.

Other potential impacts to water quality during production include seasonal ice roads, water extraction, gravel mine dewatering, and incidental oil/pollutant discharges. These same impacts have been evaluated and analyzed above under the Construction section.

4.2.2.2.4 Decommissioning Impacts

Project decommissioning activities that have a potential to impact water quality include:

- Rehabilitation of the gravel mine site
- Decommissioning the LDPI, subsea pipeline, and onshore facilities

Rehabilitation of Gravel Mine Site

When mining at a site is completed and connected to a channel, the connection may be either permanent or temporary. In the case of a permanent connection, the site is connected to the river or stream regardless of water level in the river or stream. For a temporary connection, the site is connected to the river or stream only during high water. Connections with a river or stream may include either inlet and outlet connections to allow stream or river water to flow through the site, or a single connection that allows stream or river water to flow into the site during flooding, or out when water levels at the site are higher than in the river or stream. Erosion could enlarge the connecting channels and divert more water from the stream/river through the site. During floods, some of the increased flow in the stream/river may divert through the site. The rehabilitation of the gravel mine site would be performed and approved by the appropriate regulatory state agencies.

Decommissioning LDPI, Subsea Pipeline, and Onshore Facilities

Decommissioning and removal of the LDPI slope protection system would expose the island gravel fill material to erosion by ice, waves, and currents. Exposed fine-grained particles would be resuspended resulting in an increase in turbidity in the water column. Heavier materials would settle rapidly from the water column while finer-grained materials would be transported over some distance before settling to the seafloor. Transport distances of finer-grained materials would be a function of the strength of the ambient currents and settling rates of the clasts, but are not expected to exceed EPA’s water quality criterion for solids and turbidity: “Settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life” (EPA, 1986). Abandonment activities are not expected to introduce or add any chemical pollutants.

After the pipeline is cleaned, decommissioned, capped on both ends, and left in place no water quality impacts would be expected.

Onshore facilities and gravel pads would be removed. Localized impacts from erosion of exposed fine-grained particles would be temporary and stabilized by restoration efforts. Loss of wetland function at the sites of onshore facilities would affect small areas and would likely be permanent. In cases on the North Slope where gravel pads have been removed, vegetated wetlands seldom return. The sites usually become either an upland characterized by vegetation adapted to dry conditions or an unvegetated pond.

4.2.2.2.5 Accidental Oil Spills

**Note: This document refers to “bbl” or barrels of oil. One bbl of oil = 42 gallons.*

Accidental discharges of crude, refined oil, or other petroleum products that reach the marine environment would affect water quality by introducing chemical pollutants into the water. The Alaska State Water Quality Standards (WQS) applicable ambient-water-quality standards for “Petroleum Hydrocarbons, Oils and Grease for Marine Water Uses” provides the readiest comparison and is used in this discussion of water quality. Provided below are the applicable criteria, found in the State of Alaska Chapter 18 AAC 70, WQS (ADEC, 2016):

- Total aqueous hydrocarbons (TAqH) in the water column may not exceed 15 micrograms per liter (15 μg/L).
- Total aromatic hydrocarbons (TAH) in the water column may not exceed 10 micrograms per liter (10 μg/L).
- There may be no concentrations of petroleum hydrocarbons, animal fats, or vegetable oils in shoreline or bottom sediments that cause deleterious effects to aquatic life. Surface waters and adjoining shorelines must be virtually free from floating oil, film, sheen, or discoloration.

The WQS provide both numeric criteria for TAqH and TAH and narrative criteria for observable oils in both waters and sediments. The numeric criteria of 10 μg/L (TAH) and 15 μg/L(TAqH) are protective of the marine water use class for the "Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife", the highest use class designated for the SOA waters. Background concentrations of hydrocarbons in the Beaufort Sea are generally less than or equal to 1 μg/L, or about 15 times less than the SOA's water quality criterion of 15 μg/L for TAqH.

Small Oil Spills

Small refined (e.g., diesel fuel) oil spills could occur throughout the Proposed Action from drilling rigs and support vessels. Refined oils such as gasoline and diesel are not persistent, do not form emulsions, and usually evaporate rapidly provided they are exposed to air. Refined oils contain only light fractions and primarily weather through evaporation. Evaporation increases with temperature and as wind speed increases.

Small spills reaching the water may be contained by booms or absorbent materials. The impacts to water quality from small refined oil spills include contamination of the surface water by hydrocarbons causing potential short-term levels of toxicity in the immediate vicinity of the small spill.

The fate of a small diesel spill would depend on meteorological and oceanographic conditions at the time of the event. As noted in Section 3.1.2.1, the ocean currents in Foggy Island Bay are primarily wind driven. Depending on wind direction and speed, water in the vicinity of the LDPI would be transported through the barrier islands within 1 to 2 days (Figures 3-4 and 3-5). A small spill is unlikely to persist long enough to be transported through the barrier islands. For small spills occurring under broken ice conditions, more oil would remain in the water compared to the same time intervals for open-water spills because of adherence to the ice and diminished wind effects related to shorter fetch between iced areas. The water quality effects of a spill occurring under broken ice conditions would endure longer than those for an open-water spill.

A meltout spill occurs during the transition period from frozen to open-water conditions. If a spill occurred in broken ice conditions as the winter season is beginning or occurs on ice, oil could be frozen into the ice. When melting begins, the unweathered oil would enter the water column. As the ice melts, water temperatures increase and the winds play an increasing role in generating currents and waves because of more open water. With these changes, oil evaporation and dispersion rates would approach those of the open-water conditions.

If a small spill occurs under the ice, the oil would become frozen into the ice and not weather until meltout begins. The processes affecting oil and the concentrations of hydrocarbons dispersed in the water would be the same as those described for a meltout spill. Small spills of crude oil would persist longer in the environment and could result in greater impacts than spills of refined products because small spills of crude oil likely would be transported farther and affect larger areas of the water column. A small crude oil or condensate spill in open water would introduce hydrocarbon pollutants of various weights into the surface water, causing a temporary decrease in water quality and conditions for potential toxicity. Lighter weight hydrocarbon fractions would volatilize more rapidly than heavier hydrocarbon fractions; however, lighter weight fractions on the water surface would present greater potential for toxicity for surface-dwelling organisms. During ice season, small crude oil and condensate oil spills could affect the localized surface quality of ice and surface water quality if the spill occurred in broken ice.

The magnitude of the impacts would depend on the specific location affected and the nature and magnitude of the activity/accident; however, small spills would be expected to result in short-term minor impacts to small areas.

Large Oil Spills

Hydrocarbons spilled into the ocean can behave in several ways depending on the types of hydrocarbon compounds and the depth and temperature at which the spill occurs. Hydrocarbons can volatilize into the air, dissolve into the water column or water surface, oxidize via ultraviolet radiation or microbial activity, emulsify and float, or sink to the subsurface depending on the water uptake plus initial density of the spilled oil (NRC, 2003). Water quality would be affected by hydrocarbons until the processes of dispersion, dilution, degradation, and weathering reduce oil concentrations.

Hydrocarbon concentrations in water have been measured during oil spills that indicate generally rapid removal of hydrocarbons from the water column. The concentration of dissolved and dispersed oil within the upper water column under the spreading oil slick of the Exxon Valdez Oil Spill (EVOS) was estimated to be 800 parts per billion (ppb) in the top 33 feet using the NOAA oil weathering model corresponding to less than 0.1 percent of the volume of water in Prince William Sound (Wolfe et al, 1994). More than 90 percent of the water samples from the spill path analyzed for hydrocarbons contained less than 1 ppb total polycyclic aromatic hydrocarbons (PAHs) one month after the spill. Additionally, most water samples taken a month after the spill contained less than 0.1ppb total PAHs (Wells, Buler, and Hughes, 1995).

Total PAHs in 45 seawater samples collected between May and October 2010 during the DWH Oil Spill averaged 47 ppb (Sammarco et al., 2013). In more than 6,000 whole unfractionated offshore water samples, 85 percent were at or near background levels – less than 0.1ppb – for total PAH concentrations.

In an oil slick, it is usually the aromatic volatiles that are the most toxic and of more concern. In-situ, cold-water measurements demonstrate that it takes hours to several days for individual compounds of an oil slick to significantly decrease in concentration. However, the bulk of these volatile compounds diminish in less than 3 days, and therefore, it is the 3-day trajectories that have been judged the appropriate length of time to approximate the initial, higher toxicity of spills in Alaskan waters (Payne et al, 1984).

For additional explanation of the fate and behavior of an oil spill, refer to Appendix A-5.4, Fate and Behavior of an Oil Spill (posted at www.boem.gov/liberty).

The Proposed Solid Ice Condition (Section 2.5.1) would shift much of the risk associated with a large oil spill from summer months to winter months. A large spill which occurred during the solid ice conditions of winter would likely have less overall impacts to water quality than a summer spill into open water, because the spill would cover a smaller area, and decomposition and weathering processes for oil are much slower in cold conditions. Oil weathering rates are slower because there is less evaporation loss.

This measure would not change impacts from a pipeline spill. Pipeline spills in first-year ice that were not cleaned up would melt out in late spring. Spills released from the ice would be unweathered and have the characteristics of fresh oil. Similarly, an oil spill that occurs in broken ice or under pack ice during the deep winter that is not cleaned up would freeze into the ice, move with the ice, and melt out of the ice the following summer.

Restricting reservoir drilling to winter months would also extend the time period required to complete the overall drilling program. An extended drilling time period is unlikely to change impacts on water quality, however, because although there would be a potentially larger window of time in which a spill could occur, the spill would be during solid ice conditions and would impact a smaller area.

4.2.2.3 Conclusion for the Proposed Action

The primary impact to water quality as a result of the Proposed Action is increased TSS. TSS is a non-toxic, non-bioaccumulative, conventional pollutant that is naturally present in the receiving environment. TSS affects water quality through increased turbidity, reduced light availability and annual production, and the possible introduction of entrained contaminants.

EPA evaluated the wastewater discharges for the potential to cause unreasonable degradation of the marine environment within its ODCE (see Section 2.1.9). The ODCE concludes that issuance of an NPDES permit for the LDPI would not result in unreasonable degradation of the marine environment. With the exception of discharges from the STP, all discharges would occur on a contingency basis in the event the disposal well is unavailable. HAK estimates that the average daily TSS concentration would be 250 mg/L and the maximum daily TSS concentration would be 1,000 mg/L (Hilcorp, December 2016 NPDES Permit Application). As discussed previously, ambient TSS concentrations in Stefansson Sound are near 15 mg/L during open-water conditions. The highest concentrations of TSS in the coastal Beaufort Sea occur during spring runoff, when maximum TSS concentrations in the Sagavanirktok River during the spring flood ranges from 244 mg/L to 609 mg/L (Dunton et al., 2009 and Trefry et al., 2009). The TSS concentration in the STP discharge exceeds the measured TSS concentrations in the receiving environment, therefore this would result in a localized effect on water quality. Any discharge of residual chemicals (i.e., sodium hypochlorite, biocides, oxygen scavengers, scale/corrosion inhibitors, etc.) would be required to meet the terms and conditions of the NPDES permit and any impacts are anticipated to be intermittent, short-term, and localized. In summary, EPA's NPDES-permitted discharges under the Proposed Action are anticipated to result in negligible to minor impacts to water quality.

The Proposed Action to build the LDPI would not have water quality impacts when compared to ambient TSS concentrations from the Sagavanirktok River that range from 60 mg/L to 106 mg/L during spring break-up (Trefry et al., 2009). The duration for the complete decommissioning of the LDPI is not known and could take several open-water seasons for the island gravel fill to completely erode away.

Overall, adverse water quality impacts from TSS throughout the duration of the Proposed Action would be local for short periods of time.

The Proposed Action would result in localized loss of wetlands and wetland function at the sites of onshore facilities.

Small oil spills would affect local water quality for short periods of time.

Overall, impacts to Water Quality from the Proposed Action would be negligible.

4.2.2.4 Alternative 2 (No Action)

Under this Alternative, the Proposed Action would not be approved and the actions described in the Liberty DPP would not take place. Impacts to water quality would continue from activities unrelated to the Liberty project.

4.2.2.5 Alternative 3 (Alternate LDPI Locations)

4.2.2.5.1 Alternative 3A: Relocate LDPI Approximately One Mile to the East

This alternate location is in deeper water than the Proposed Action and, therefore, the seafloor footprint of the gravel LDPI would be bigger by about 0.6 acres. The volume of gravel necessary to construct the LDPI would increase by 72,000 cy. The offshore pipeline would be approximately 0.5 miles longer. Each of these changes would slightly increase the volume of associated sediments introduced into adjacent waters. Under Alternative 3A, impacts on water quality would be slightly greater than those under the Proposed Action, but would remain locally moderate and regionally negligible. While the discharge location would change (see Section 2.2), the overall impacts to water quality as a result of NPDES-permitted discharges under Alternative 3A would be the same as the Proposed Action, which are negligible to minor.

4.2.2.5.2 Alternative 3B: Relocate LDPI Approximately 1.5 Miles to the Southwest

This alternate location is in shallower water than the Proposed Action and, therefore, the seafloor footprint of the gravel LDPI would be smaller by about 0.6 acres. The volume of gravel necessary to construct the LDPI would decrease by 72,300 cy. The gravel pit might also decrease in size by 1 acre. The offshore pipeline would be 1.5 miles shorter. Each of these changes would slightly but not notably decrease the volume of associated sediments introduced into adjacent waters. Under this Alternative, the impacts on water quality would be slightly less than those under the Proposed Action, but remain locally moderate but regionally negligible. While the discharge location and permitting jurisdiction would change (see Section 2.2), the overall impacts to water quality as a result of NPDES-permitted discharges under Alternative 3B would be the same as the Proposed Action, which are negligible to minor.

4.2.2.6 Alternative 4 (Alternate Processing Locations)

4.2.2.6.1 Alternative 4A: Relocate Oil and Gas Processing to Endicott

The surface area of the LDPI would be reduced from 9.3 acres to 5.4 acres; the seafloor footprint of the LDPI would be reduced from 24 acres to 17.2 acres. The volume of gravel necessary to build the smaller LDPI would be about 387,000 cy less than under the Proposed Action. The size of the gravel mine would be reduced by 3 acres. Temporary increases in sediments into adjacent waters associated with gravel mining and construction of the LDPI would be of shorter duration as the time required for construction would be shorter and the volume of associated sediments introduced into adjacent waters would decrease.

Extensive work at Endicott and Endicott SDI would be required to update the existing facilities and install additional equipment. Dust from this work could temporarily increase the TSS of water in the vicinity.

Additional offshore pipelines would be needed between the LDPI and Endicott. Impacts associated with emplacement of offshore pipeline would increase. TSS would temporality increase along the pipeline route during and for a short time after pipeline emplacement.

Under Alternative 4A, the impact levels associated with gravel mining and construction of the LDPI would be reduced from the Proposed Action but remain negligible to moderate. While the discharge location and permitting jurisdiction would change for certain waste streams (see Section 2.2.5.1), the overall impacts to water quality as a result of NPDES-permitted discharges under Alternative 4A would be the same as the Proposed Action, which are negligible to minor.

4.2.2.6.2 Alternative 4B: Relocate Oil and Gas Processing to a New Onshore Facility

Under this Alternative, the working surface area of the LDPI would be reduced from 9.3 acres (Proposed Action) to 6.1 acres. The disturbance to the seafloor would be reduced from 24 acres (Proposed Action) to 18.4 acres. This smaller LDPI would require 15 to 20 days less time to construct and up to 700,000 cy of gravel, as compared to 927,000 cy for the Proposed Action. As a result, temporary increases in sediments into adjacent waters associated with gravel mining and construction of the LDPI would be of shorter duration.

The route of the subsea pipeline bundle would remain the same as under the Proposed Action.

The additional onshore Liberty Processing Pad would be 4.05 acres of working surface area. The estimated gravel required for construction is 44,800 cy. The impact to onshore water quality during construction of the pad would be locally and temporarily moderate. The areal extent of the impacts would remain limited.

The footprint of the gravel mine site would decrease, proportionally decreasing impacts to water quality as discussed for the Proposed Action. All other impacts on water quality would remain the same as discussed for the Proposed Action and overall water quality impacts would remain negligible to moderate. While the discharge location and permitting jurisdiction would change for certain waste streams (see Section 2.2.5.2), the overall impacts to water quality as a result of NPDES-permitted discharges under Alternative 4B would be the same as the Proposed Action, which are negligible to minor.

4.2.2.7 Alternative 5 (Alternate Gravel Sources)

4.2.2.7.1 Alternative 5A: East Kadleroshilik River Mine Site #2

This alternative gravel mine site is immediately east of the Kadleroshilik River in wetlands vegetation similar to that at the Proposed Action gravel mine site. Impacts from sediments entering the waters adjacent to this site would be similar to those described for the Proposed Action. The loss of wetlands and wetlands function would be similar to that at the Proposed Action gravel mine site.

Overall, water quality impacts would be negligible to minor.

4.2.2.7.2 Alternative 5B: East Kadleroshilik River Mine Site #3

This alternative gravel mine site is in wetlands vegetation similar to that at the Proposed Action gravel mine site. Impacts from sediments entering the waters adjacent to this site would be similar to those described for the Proposed Action. The loss of wetlands and wetlands function would be similar to that at the Proposed Action gravel mine site.

Overall, water quality impacts would be negligible to minor.

4.2.3 Air Quality

BOEM analyzed impacts of the Proposed Action and Alternatives 2 through 5 in this section. BOEM considered information and analysis contained within the following documents, which are summarized throughout this air quality assessment:

- 2015 Liberty Development and Production Plan (Hilcorp, 2015)
    - Section 9.4, Proposed LDPI Air Emissions
    - Section 13.3.3, Air Quality Mitigation Measures

- 2015 Liberty Environmental Impact Analysis (EIA) (Hilcorp, 2015, Appendix A)
  - Section 3.4, Affected Environment: Air Quality
  - Section 4.1.4, Environmental Consequences: Air Quality
- Air Quality Impact Analysis
  - Air Quality report posted at www.boem.gov/liberty: Emissions Inventories and Summaries
- Dispersion Model Report (Hilcorp, 2015, Appendix F)

The criteria and precursor pollutants detailed in Section 3.1.5 can cause harm to human health and the natural environment (40 CFR Section 52.21[b]). The action alternatives would elevate concentrations of those pollutants in the ambient air during construction and, to a smaller degree, throughout the life of the Proposed Action. The emissions projected for the Proposed Action and the action alternatives include the following criteria and precursor pollutants:

- Carbon monoxide (CO), a criteria pollutant
- Nitrogen oxides (NO_X), a criteria pollutant and ozone precursor pollutant
- Sulfur dioxide (SO_2), a criteria pollutant
- Particulate matter (fine particles, $PM_{2.5}$ and coarse particles, PM_{10}), criteria pollutants
- Lead (Pb), a criteria pollutant
- Volatile organic compounds (VOC), an ozone precursor pollutant but not a criteria pollutant
- Greenhouse gases (GHG) including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O); not criteria pollutants, but gases that EPA has determined endanger human health and the environment (75 FR 66496, December 15, 2009)

4.2.3.1 Background

Ozone (O_3) is a criteria pollutant but is not directly emitted by any source. Rather, O_3 is formed through a photochemical process that depends on available VOC and NO_X, abundant sunlight, and heat. Because of this photochemical process, there is no practical way to measure or control "tailpipe" emissions of O_3 or, at the Proposed Action level, predict where O_3 would form as a result of emissions of the O_3 precursor pollutants (VOC and NO_X). Therefore, O_3 formation is usually predicted by computer simulation (modeling) on a large regional or even hemispheric scale (Godowitch, Gilliam, and Rao, 2011). However, the EPA finds that project-level emission rates of VOC and NO_X may be used to estimate O_3 formation (40 CFR Section 93.158[b][1] and [2]). The relationship between O_3, NO_X, and VOC is driven by complex nonlinear photochemistry, where some atmospheres are NO_X sensitive, and others VOC sensitive:

- NO_X sensitive atmospheres (or NO_X limited) have low concentrations of NO_X and high concentrations of VOC, wherein O_3 increases with increasing NO_X and changes little in response to increasing VOC from new sources.
- VOC sensitive atmospheres (or VOC limited) have high concentrations of NO_X and low concentrations of VOC, wherein O_3 increases with increasing VOC and changes little in response to increasing NO_X from new sources; in these types of atmospheres, O_3 can actually increase with decreasing NO_X emissions.

The ambient ratio of new VOC:NO_X emissions appears to directly relate to instantaneous O_3 production. The production rate of O_3 can be loosely estimated based on the emissions of VOC and NO_X (Sillman, 1999; Liang and Jacobson, 1999; Godowitch, Gilliam, and Rao, 2011). The location of such formations, however, would not be predictable. This relationship is discussed in detail in the 2015 Liberty EIA, Section 4.1.4.3, Ozone, incorporated here by reference.

The atmospheric conditions over the Beaufort Sea OCS or over the adjacent lands of the Proposed Action Area do not generally favor ozone production (sunlight, ozone precursors, and background emissions of VOC that would produce an NO_X sensitive atmosphere). Therefore, ozone is not a pollutant of concern for air quality impacts on the eastern ANS due to the Proposed Action or action alternatives.

Primary sources of airborne lead are ore and metals processing and combustion of fuels containing lead-based additives. None of the fuels used for the project contain lead additives and only trace levels of lead would originate from equipment lubricants containing lead or engine wear. Therefore, lead emissions from the project would not cause nor contribute to a violation of the lead National Atmospheric Air Quality Standards (NAAQS).

4.2.3.1.1 Air Quality Regulatory Program (AQRP)

Under the Proposed Action, Hilcorp would proceed with the development and production activities described in their proposed Liberty DPP. The Liberty DPP entails operation of the proposed LDPI, which would be located on the Federal OCS and qualify as a “facility” under the jurisdiction of BOEM’s Air Quality Regulatory Program (AQRP). BOEM regulates emissions from such facilities for compliance with National Ambient Air Quality Standards to the extent that those emissions significantly affect the air quality of any State. BOEM regulations at 30 CFR Section 550, Subpart C set forth the process for determining whether air pollutant emissions from such facilities must be controlled. The first step in BOEM’s AQRP analysis of a proposed facility is to determine whether the facility is exempt from further review. This determination is based on a calculation that accounts for anticipated emissions as well as the distance of the proposed facility from shore. Here, BOEM has determined that the LDPI is not exempt from further review under the AQRP. The next step in BOEM’s AQRP analysis of a proposed facility is to determine whether the facility’s anticipated emissions of SO_2, particulate matter (PM)/total suspended particles (TSP), NO_2, CO, or VOC would result in an onshore ambient air concentration above a specified significance level. Here, BOEM reviewed modeling of the ambient air concentrations that would occur from emissions sources on the LDPI. The results of this modeling indicate that the applicable significance level would not be exceeded for any of these air pollutants. As such, BOEM’s AQRP does not require the control of emissions from the LDPI facility.

Emissions Sources

This analysis of potential impacts to air quality assumes the operation of all proposed emissions sources as described in the DPP, without further regulatory controls. BOEM’s National Environmental Policy Act (NEPA) analysis accounts for emissions from sources associated with the proposed LDPI facility as well as from all other emissions sources described in the DPP, regardless of whether those sources are included within a facility that is subject to regulation and control under BOEM’s AQRP. Relevant air emissions sources are:

1) mobile sources associated with proposed LDPI and offshore pipeline construction activities;
2) mobile sources associated with onshore facilities and pipeline construction activities;
3) stationary sources associated with drilling operations;
4) stationary sources associated with production operations;
5) propulsion and auxiliary engines operated onboard vessels;
6) helicopters and light aircraft; and
7) mobile and stationary sources associated with accidental oil spills and gas releases.

While in the DPP the drilling unit is described as a 2,100 horsepower unit, in an effort to produce very conservative impacts the drilling unit modelled in the EIA has a combined rating of over 12,000 horsepower.

Diesel-powered engines would be the main source of emissions during construction. Most diesel engines would operate on the proposed LDPI, with near complete conversion to natural gas engines as the production wells came on-line. Equipment and vessels used during onshore and offshore pipeline construction would produce substantial emissions and are considered here. Diesel-fueled engines emit mostly NO_X, CO, and particulate matter. Behavior of the pollutants would vary depending on whether the source is stationary or mobile, location of the source, duration, and timing of the source throughout the Proposed Action. Stationary sources usually create steady emissions from a fixed location, whereas mobile sources produce emissions relative to the thrust and power rating of individual sources (e.g., vehicle, boat, aircraft) dispersed by source movement in addition to atmospheric mixing over distance caused by winds and turbulence. Moving sources result in emissions discharged over some distance, with elongated plumes of pollutants expanding horizontally and vertically, diffusing as they mix with the surrounding air. The effects of dispersion and diffusion decrease the ground-based impact of all emissions as distance from the source increases.

Helicopters and other aircraft create emissions at varying elevations with respect to the ground. Due to dispersion, emissions from aircraft cruising at altitudes higher than 1,500 feet above ground level (AGL) would not influence concentrations measured at the surface (Kadygrov et al., 1999). Therefore, only emissions that occur during landing and takeoff operations are considered here. All types of offshore and onshore stationary sources associated with oil and gas operations emit pollutants each day for as long as the operation continues. Pollutants from stationary sources tend to affect the same downwind areas continuously, and thus could deteriorate air quality at downwind locations more than mobile sources.

Dispersion Analysis of Project Emissions

The latest version of AERMOD-COARE and AERMET were used to model and assess project impacts on ambient levels of NO_2, CO, PM_{10}, $PM_{2.5}$ and SO_2 from project-related activities during the open-water period (July through October) and during periods when the project surface area is covered with snow and ice (November through June), respectively. AERMOD is a steady-state, Gaussian dispersion model developed by the American Meteorological Society and EPA and is the recommended dispersion model for characterizing transport of emissions over land at distances less than or equal to 31 miles from the source under 40 CFR 51, Appendix W.

Figure 4-10 shows the modeling domain and near field receptors (blue dots) centered over the proposed LDPI, Endicott SDI, and gravel mine location. This grid will characterize and locate the maximum pollutant impacts from the planned construction, development, and production activities. In this Section (4.2.3) and its subsections, the Proposed Action Area is defined as the modeling grid shown in Figure 4-10. This analysis considers impacts to geographic areas located at least 546 yards from the edges of the LDPI; it is anticipated that Hilcorp will apply for, and the USCG will establish, a safety zone prohibiting the public from approaching any closer to the LDPI. The maximum modeled impacts described here are those located at the 1,640-foot safety zone. This is an approach used to provide an overly conservative estimate of potential impacts. If the NAAQS and/or maximum allowable increases (MAIs) are not exceeded at the 1,640-foot boundary, then it is safe to assume any impact to the shoreline (4.1 miles away) will be far less.

Background concentrations stem from local natural processes, anthropogenic (human made) sources, and pollutants transported into the area from other sources. This differs from the existing emissions described in Section 3.1.5.3 and Table 3-6 which describe the annual gross tonnage of pollutants emitted into the atmosphere throughout the course of the year. Background concentrations are derived from the evaluation of data sampled and analyzed using air monitoring devices, and estimate the likely magnitude, spatial, and temporal variability of pollutants across an area (McKendry, 2006). Monitoring data may be obtained from EPA-, state-, or industry-owned devices that use EPA-approved equipment and methods. Table 4-5 summarizes background concentrations used in these analyses.

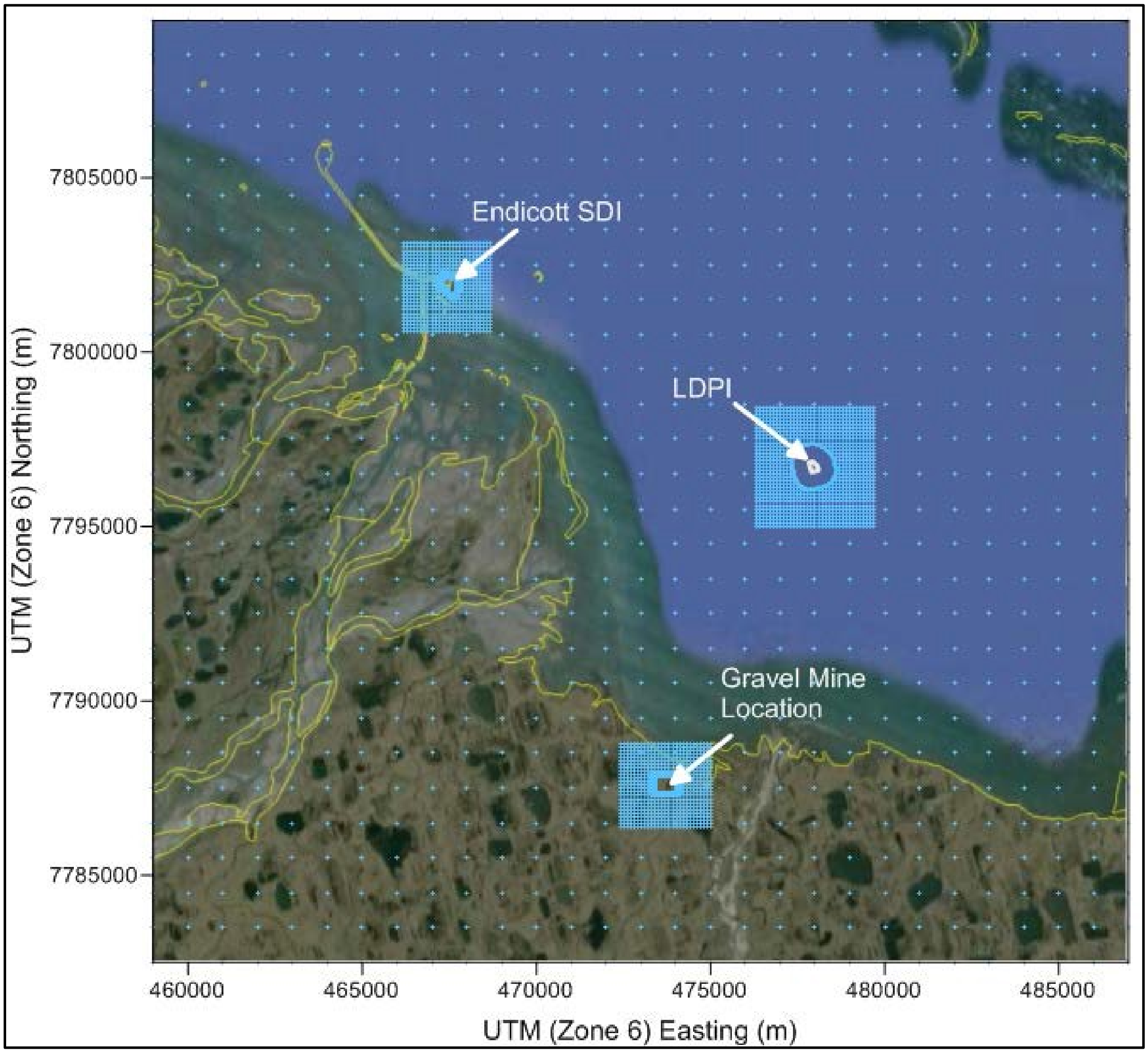

Figure 4-10 Proposed Action Modeled Receptors
Source: 2015 Liberty EIA.

Emissions Impact Analysis

Computer simulation of air dispersion is the second step in discerning the potential impact of new emissions. This analysis uses the most conservative case, wherein every emitter (generator, drill rig, vehicle vessel, etc.) is assumed to run at full capacity for 24 hours of each day that particular piece of equipment is used. The analysis is based on the maximum annual emissions projected to occur during the following stages outlined in the Liberty DPP and summarized in Chapter 2 (Table 2-1):

- LDPI Construction (Year 2)
- Flowline Construction (Year 3)
- Facilities Installation (Years 2 through 4)
- Drilling and Development (Years 3 through 5)
- Production Operations (Year 3 through decommissioning)

The projected emissions, not including GHGs and VOCs, are translated into pollutant concentrations using the computer simulated dispersion models described above. Since the primary NAAQS are designed to protect human health, BOEM analyzes the impacts of the Proposed Action and action alternative emissions on the primary NAAQS (summarized in Table 4-5). Also, as mentioned in Section 3.1.5, the North Slope Borough is a Class II area and as such BOEM will draw comparisons of the projected increase to the MAI for a Class II area (Table 4-5). The MAI applied in the analysis acts as a conservative estimate of the maximum prevention of significant deterioration (PSD) increment consumption that could occur if the project was constructed and actually emitted at the projected emission rates. A true increment analysis would require an account of both creditable emission increases and decreases for each triggered pollutant after the baseline date. Exceedance of the MAI by the Proposed Action does not necessarily mean the project would violate the PSD increment or would result in a significant impact to air quality. This analysis does not constitute a PSD increment analysis (which is not required) but is presented as an additional impact determinant. A PSD increment consumption analysis is required for permitting of new major sources or major modifications of existing sources where ADEC and/or EPA have jurisdiction. Since the Proposed Action is under BOEM jurisdiction and would not be a major source, PSD increment consumption analysis will not be required under ADEC's air permitting program (baseline dates and PSD increments promulgated in 18 AAC 50.020). Additional information on MAI/PSD increments is available in the Air Quality report posted at www.boem.gov/liberty.

The potential for adverse air quality effects is assessed by combining the concentrations of the modeled emissions together with the existing concentrations of background pollution, collectively the "design concentration." The modeled emissions used in this comparison are the maximum modeled concentration at any receptor over state lands within the modeling domain. The design concentrations are then divided by their respective NAAQS to determine what percentage of the NAAQS the resulting concentration may lead to. As another impact determinant, the concentration of projected emissions for available MAI-listed pollutants will also be shown, defining what percentage of the MAIs the project would be within. In both cases, if the resulting concentration reaches 100 percent, it would mean that the pollutant has the likelihood of exceeding the NAAQS and/or the MAI. For the following NAAQS comparisons, Year 1 impact percentages are from the background concentrations alone. If the impact of the Proposed Action and the alternatives when combined with the background concentrations are below 25 percent, there is no potential to violate the NAAQS. Thus, only impacts where the resulting impact is greater than 25 percent of the NAAQS will be displayed. See the Air Quality report posted at www.boem.gov/liberty for more information on air quality impacts. Other air quality impact criteria describing intensity, duration, potential, and geographic extent are also used to frame the conclusions. More detailed NAAQS impact tables and impact criteria definitions can be found in the Air Quality report posted at www.boem.gov/liberty.

Table 4-5 Background, NAAQS and MAI concentrations of Criteria Air Pollutants

Pollutant	Averaging Period	Background	NAAQS[1]	MAI[2]
NO_2	1-Hour[3]	80.7 varies by month μg/m³	188 μg/m³	NA[4]
NO_2	Annual	5 μg/m³	100 μg/m³	25 μg/m³
CO	1-Hour[5]	1,742 μg/m³	40,000 μg/m³	NA[4]
CO	8-Hour[5]	1,094 μg/m³	10,000 μg/m³	NA[4]
SO_2	1-Hour[6]	11.3 μg/m³	196 μg/m³	NA[4]
SO_2	3-Hour[5]	7.9 μg/m³	1,300 μg/m³	512 μg/m³
SO_2	24-Hour[5]	7.3 μg/m³	365 μg/m³	91 μg/m³
SO_2	Annual	1.7 μg/m³	80 μg/m³	20 μg/m³
PM_{10}	24-Hour[7]	49.0 μg/m³	150 μg/m³	30 μg/m³
PM_{10}	Annual[8]	NA[9]	NA[9]	17 μg/m³
$PM_{2.5}$	24-Hour[10]	7.9 μg/m³	35 μg/m³	9 μg/m³
$PM_{2.5}$	Annual[8]	2.9 μg/m³	15 μg/m³	4 μg/m³

Notes:
[1] National Primary and Secondary Ambient Air Quality Standards, 40 CFR Part 50,
[2] Maximum Allowable Increase based on PSD Class II Increment Levels.
[3] The standard is based on the 3-year average of the 98th-percentile of the annual distribution of 1-hour daily maximum NO_2 concentrations.
[4] NA = Not Applicable. No MAI (Class II PSD Increment Limit) for the designated pollutant averaging period exists.
[5] Not to be exceeded more than once per year.
[6] The form of this standard is the 3-year average of the 99th percentile of the annual distribution of 1-hour daily maximum SO_2 concentrations.
[7] Not to be exceeded more than once per year on average over three years.
[8] Annual arithmetic mean, averaged over 3 years.
[9] NA = Not Applicable. No annual PM_{10} NAAQS exists.
[10] The form of this standard is the 3-year average of the 98th percentile of annual 24-hour average concentrations.

4.2.3.2 The Proposed Action

The construction activities and production operations associated with the Proposed Action would generate the criteria and precursor pollutants listed in Section 4.2.3.1. The types and amounts of air pollutants generated would vary based on the phases of the project. Tables with the types and amounts of air pollutants generated by phase and alternatives are available in the Air Quality supplemental information on the BOEM Liberty website at www.boem.gov/liberty.

The first three phases modeled are the projected emissions due to major construction activities that would occur over the first 4 years of the Proposed Action. Phase 1 includes the construction activities in the first and second years, specifically ice road construction; gravel mining activities including blasting, gravel processing and gravel hauling; and the installation of protective sheet piles, concrete slope armor, and vertical support members for module foundations. Phase 2 includes the construction activities in Year 3 including the installation of the single-phase subsea pipeline between the LDPI, and transitioning onshore to tie into the Badami pipeline. Phase 3 includes Year 4 construction activities, such as the transport and installation of prefabricated facility modules and the mobilization of drill rig and support equipment to the proposed LDPI. Phase 4 modeled is the projected emissions from the initial drilling and development (Years 3 through 5) and production operations that would continue throughout the lifetime of the Proposed Action, to include annual ice road construction and maintenance throughout the life of the project.

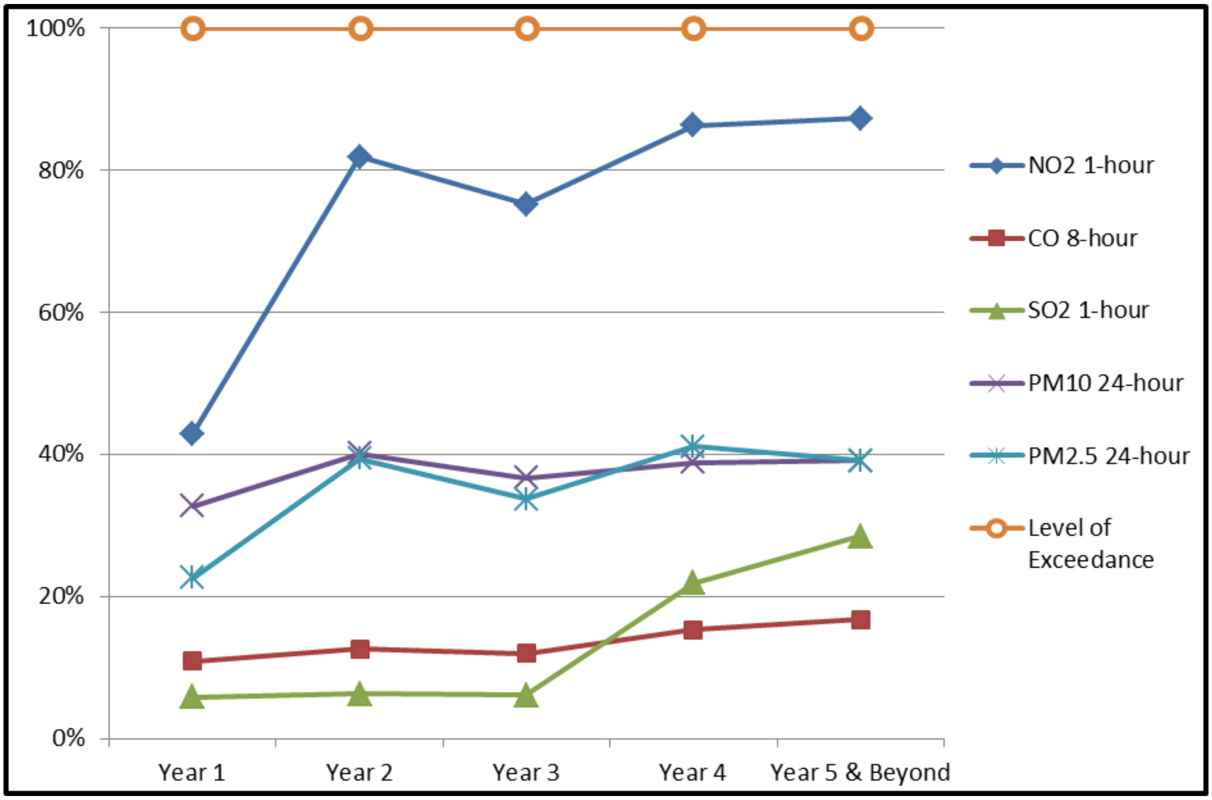

Figure 4-11 Proposed Action NAAQS Comparison

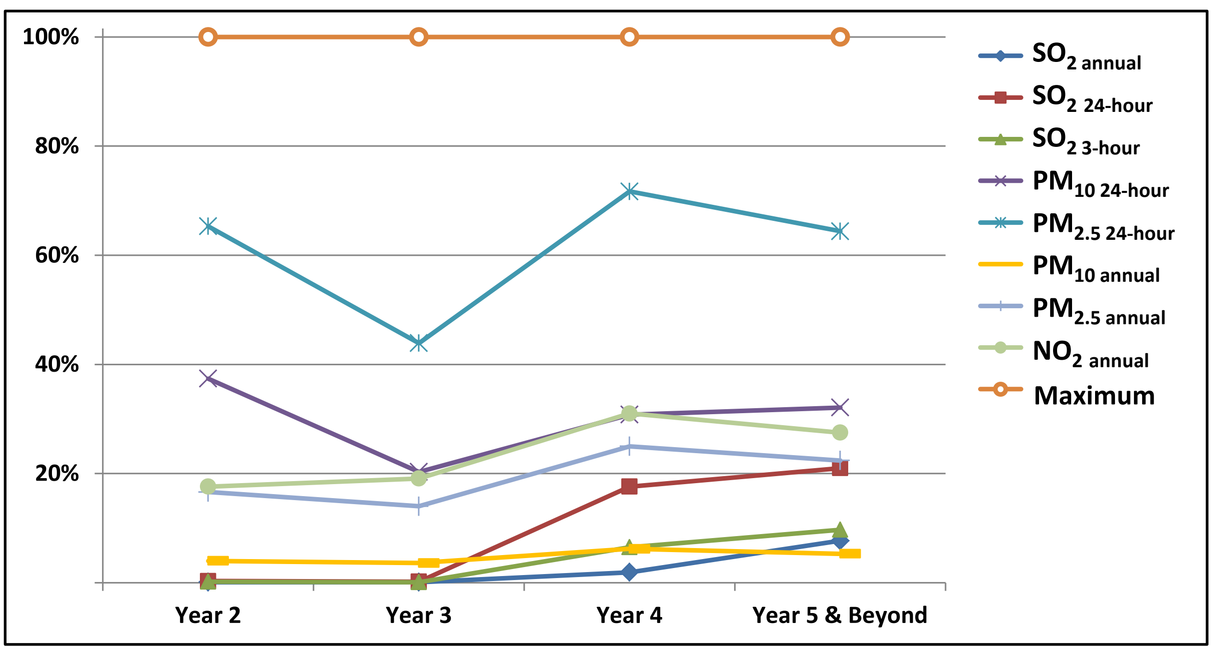

Figure 4-12 Proposed Action Class II MAI Comparison

The Proposed Action would not result in any criteria pollutant exceeding the NAAQS during any stage or phase of development and production at the shoreline as shown in Figure 4-11. The highest potential pollutant impact relative to its respective NAAQS is 1-hour NO_2, which is based on the 98th

percentile of the annual maximum daily 1-hour NO_2 concentration, (also called the 1-hour NO_2 design concentration). Figure 4-12 shows that for the Proposed Action the increase due to the project would not exceed any MAI for a Class II area during the lifetime of the project. Also, considering that the closest permanent community is over 60 miles west of the Proposed Action Area, any emissions produced as a result of the Proposed Action would be dispersed and well mixed with the ambient air to at or below normal background concentrations before reaching those communities. Subsequently, the Proposed Action would not result in any degradation to the human health conditions of those communities.

4.2.3.2.1 Small Oil Spills (Less than 1,000 bbl)

Evaporation of small accidental refined oil spills would result in temporary localized increases in VOC. The volatile components of the fuel would evaporate within the first 24 hours for a spill 3 bbl or less and would take 3 days for a spill of 200 bbl, potentially causing localized air quality degradation in the immediate vicinity of the spill. Ambient hydrocarbon concentrations in the air would be higher than those of a crude oil spill of similar size but would persist for a shorter time. Small spills of crude oil would persist longer in the environment and result in greater air quality impacts than spills of refined products. The impacts at a given location would depend on the time of year, size, location, and duration of the spill, and meteorological conditions such as wind speed and direction. The possible impact from increased emissions of VOCs from any oil spill is the formation of ozone. However, the volume of VOC emissions resulting from such small spills, when considering the levels of NO_X emissions likely already emitted during development and production, is not expected to be sufficient to create conditions favorable for the formation of ozone. VOC emissions from small spills are not likely to cause a violation of the NAAQS and the level of evaporative emissions would not likely impact onshore air quality. Cleanup and response activities also would have a minor impact by increasing emissions.

4.2.3.2.2 Large Oil Spills (Greater than or equal to 1,000 bbl)

See Section 4.1.1.3 and Table 4-3 for the oil spill analysis assumptions used in this discussion. A large spill would result in increased emissions of VOC over an area larger than from a small spill, and evaporation would continue for a longer period of time until the mass of oil is evaporated or removed from the water surface.

A large oil spill on the Beaufort Sea OCS, if released from the proposed LDPI where oil and gas activities are anticipated as described in the Proposed Action, could occur about 6 statute miles from shore. Or, the release could be from a pipeline—anywhere between the Badami tie-in point and the proposed LDPI. Assuming no oil would freeze into the sea ice, the distance combined with the wind conditions over the Beaufort Sea would likely disperse the VOC. The gases could be picked up by upper-level winds and transported away from the Arctic. However, this would depend on how far and how fast the oil slick spreads. Assuming a large oil spill occurs within the Beaufort Sea OCS, the greatest amount of VOC that could potentially evaporate from the kind of large oil spill described in Appendix A (posted at www.boem.gov/liberty) would be 249.2 and 462.7 short tons during the summer and meltout spills, respectively.

Summer Spills

The Arctic experiences more frequent summertime precipitation, which removes some atmospheric pollutants. Arctic summer weather is driven by two semi-permanent pressure systems—the Icelandic low over Greenland and the Pacific high in the Gulf of Alaska (Ahrens, 2013). The interaction of these systems causes northeast winds over the Arctic in summer; breezes can be moderate, up to 6.7 to 17.8 miles per hour (mph), with higher winds during storms (BOEM, 2013). There could be 4 to 6 storms a month over the Arctic increasing the precipitation over sea and land (NSIDC, 2000).

The windy, rising air and precipitation destabilize the lower atmosphere, allowing the dispersion of pollutants. Gaseous pollutants rise with the surrounding air and are caught up in higher steering winds that allow maximum diffusion of pollutants. Summertime impacts from a large oil spill would occur if northeast winds drove pollutants over Alaska's northern coastline and the tundra of the North Slope. Impacts would be less likely if northwest winds directed pollutants parallel to the coastline on the west side of the North Slope or transported pollutants out to sea.

While the opportunity for ozone formation exists, given the short-term existence of a relatively low amount of VOC evaporated into the lower atmosphere from a large oil spill, the impact to air quality, as determined relative to Section 4.1.2, Measuring Impacts, would likely be negligible to minor both offshore and onshore, and although short-lived, could occur over a large area.

Winter Spills

Arctic winter weather is dominated by the Beaufort high pressure system and the semi-permanent Aleutian low, which occurs over the Bering Sea (Ahrens, 2013). Northern hemisphere high pressure systems tend to rotate clockwise, while heavy cold air tends to flow down and away from such pressure centers creating stable, cold, dry conditions. Conversely, low pressure system air tends to lift warmer air which becomes buoyant; air rises counterclockwise toward the center of lower pressure systems causing precipitation and unstable conditions. The interaction of these two systems results in light to moderate (5 mph to 18 mph) east to northeast winds with some strong breezes (25 mph) from the east during storms. Higher winds tend to peak during October through December when there is little to slow down the wind over open water (Veltkamp and Wilcox, 2007). While the wind does not affect evaporation rate of VOCs from spilled oil, it does increase dispersion of VOCs once evaporated into the lower atmosphere.

Formation of ozone, which is used to measure the adverse impacts of increased VOC emissions, is unlikely to occur in the winter over the Arctic due to the months without sunlight, which is a necessary ozone formation component. Therefore, impact to air quality would likely be negligible to minor both offshore and onshore, and although short-lived, could occur over a large area.

The Proposed Solid Ice Condition (Section 2.5.1) would shift much of the risks associated with a large oil spill from summer months to winter months. A large spill which occurred during the solid ice conditions of winter would likely have less impacts to air quality than a summer spill into open water for the reasons described above. Restricting reservoir drilling to winter months would extend the time period required to complete the overall drilling program, but, as indicated above, one or two additional seasons of drilling during winter (solid ice conditions) would not be enough to contribute to a meaningful change in air quality impacts because formation of ozone is unlikely in these conditions.

Spill Response

Two OSR activities that may impact air quality are in-situ burning and mechanical recovery.

In-Situ Burning

In-situ burning as part of a cleanup of spilled crude oil or diesel fuel would increase emissions of NO_X, SO_2, $PM_{2.5}$, PM_{10}, and CO, but would decrease VOC emissions as compared to evaporation. Concentrations of $PM_{2.5}$ and PM_{10} would temporarily increase in the burn area; its level of effect would ultimately be controlled by local meteorological conditions. Fingas et al. (1995) describes an oil spill test burn at sea monitoring program. The authors took extensive ambient measurements during two burns in which approximately 300 barrels of crude oil were burned *in-situ*. During the burn, NO_X, SO_2, and CO concentrations were measured only at background levels and frequently were below detection limits. For small spills, because of the small volume of oil and the quick methods of cleanup that are available, the level of effect on air quality likely would be negligible.

In general the use of wellhead ignition as a response measure will have similar impacts as those described in in-situ burning. Where In-situ burning would increase emissions of NO_X, SO_2, $PM_{2.5}$, PM_{10}, and CO, but would decrease VOC emissions as compared to evaporation. The only difference is that with wellhead ignition the burn area is more concentrated and would lead to a higher temperature burn than an in-situ burn spread over a larger area. The higher temperature would allow for a more efficient combustion but would also increase the buoyancy of the plume. The rising plume of pollutants would become increasingly diluted with height and surface concentration levels would not be as high in the immediate vicinity of the fire (Evans et al., 1991). The location of high pollutant concentrations due to the smoke depends on the stability of the atmosphere at the time of the response. Over time, the smoke would be transported by the wind and would eventually affect surface areas at a distance from the fire. Due to the more concentrated plume, the impacts of wellhead ignition would occur over a smaller area than an in-situ burn, but would have increased adverse effects onshore although short-lived.

Cleanup of a large oil spill would likely result in detectable impacts to air quality conditions when considering the emissions from the oil, by either evaporation or burning, combined with all the emissions from vessels, equipment, and personnel needed to remove the oils. Thus, the methods and consequences of the process, and methods used to remove oil from a large spill, may actually outweigh the air effects of the oil itself. From this perspective, a large oil spill would be likely to have a minor effect both offshore and onshore, and although short-lived, could occur over a large area.

Mechanical Recovery

Mechanical recovery physically removes oil from the ocean and is accomplished with devices such as containment booms and skimmers. A containment boom is a rope-like device that floats and is deployed in the water and positioned to contain and concentrate spilled oil into a pool thick enough to permit collection by a skimmer. The skimmer collects the oil and transfers it to a storage vessel (storage barges or oil tankers) where it would eventually be transferred to shore for appropriate recycling or disposal. As mentioned in Section 4.2.3.1.1, Emissions Sources, most mobile emissions including those of vessels participating in recovery operations have a negligible impact to the air quality of any specific ground-based location. The dispersion of emissions from a moving source makes the accumulation of pollutants less of a concern at any specific downwind location.

4.2.3.3 Conclusion for the Proposed Action

Routine activities under the Proposed Action that are expected to have a measurable impact on air quality include air emissions from vessel traffic, drill rigs, construction activities, production operations, and other offshore and onshore infrastructures developed for the purpose of supporting offshore oil and gas operations. The emissions of these criteria pollutants from the Proposed Action would increase concentrations to some extent in various locations within the region.

Due to the characteristics of pollutant transport by the wind and movement of sources, emissions from vessels, helicopters, and onshore vehicles associated with the Proposed Action would have a negligible impact to the air quality of any specific ground-based location. The dispersion of emissions from a mobile source makes the accumulation of pollutants less of a concern at any specific downwind location with a decrease in pollutant accumulation with increasing distance from the source.

Large spills are likely to have minor levels of effect on air quality. Air quality impacts immediately following a large spill would be short-term. OSR practices are described in Appendix A-6, Recovery and Cleanup (Appendix A is posted at www.boem.gov/liberty). GIUE (oil spill drills) are not expected to alter impact conclusions for air quality for routine activities or accidental spills because they are infrequent, of short duration (less than 8 hours), and utilize existing equipment. The potential effects of OSR activities on air quality include a negligible impact from mechanical recovery operations, in-situ burning of small spills, and a minor impact from in-situ burning of large spills.

Routine activities, which include small spills under the Proposed Action, would have a measureable impact on air quality. The impacts would be low to medium intensity due to one of the modeled pollutants being estimated at greater than 50 percent but less than or equal to 100 percent of the NAAQS. The impacts would be temporary and interim, over the 25-year lifetime of the Proposed Action. Construction emissions and their resulting impacts would be limited to the first 3 to 5 years of the project. Once the process of drilling has been largely completed (2nd Quarter Execute Year 5) and the operation shifts toward production, emissions associated with the operation and support of the rig(s) would decrease considerably, reducing the overall impact of operations.

Impacts resulting from the Proposed Action would be localized within the Proposed Action Area as captured by the modeling domain (Figure 4-10), with the highest level of impacts at the shoreline area closest to the LDPI and lessening moving inland. Due to the lessening level of impacts moving inland, BOEM concludes that there would be negligible air quality impacts to the community of Nuiqsut, which is over 60 miles west of the Proposed Action Area. Except where noted otherwise, this conclusion applies to all action alternatives. The air quality in the areas surrounding the project would recover and return to pre-project levels shortly after the completion of the project. The overall impact on Air Quality from the Proposed Action are expected to be minor.

4.2.3.4 Alternative 2 (No Action)

Under this alternative, the Proposed Action would not be approved and no new direct or indirect emissions would occur. As such, this alternative would have no new impacts to air quality and not result in any degraded human health conditions.

4.2.3.5 Alternative 3 (Alternate LDPI Locations)

Under this alternative, the proposed LDPI would be relocated to one of two locations. Alternative 3A would relocate the LDPI one mile to the east, keeping the proposed LDPI in Federal waters.

Alternative 3B would relocate the LDPI 1.5 miles southwest, placing the proposed LDPI into SOA waters, changing the air quality jurisdiction. Emissions from the LDPI facilities would be regulated and potentially controlled by ADEC. There are differences in drilling unit sizes, and vehicle and vessel trip distances between these two sub-alternatives and the Proposed Action. The modeling, however, used an extremely conservative approach that assumed an approximately 12,000 horsepower drilling unit and all engines associated with the project running at full capacity for 24 hours/day. BOEM anticipates that emissions from the drilling unit, vehicles, and vessels under these two sub-alternatives are sufficiently captured in models for the Proposed Action, despite slight differences in trip distances and drilling unit capacities.

4.2.3.5.1 Alternative 3A: Relocate LDPI Approximately One Mile to the East

The plan changes outlined in Section 2.2.4.1 would impact Phases 1, 2, and 4 of the Air Quality impact scenarios. Under this alternative, changes to the LDPI and the drilling unit would necessitate review of a revised emission inventory (and potentially, a revised modeling analysis) under the AQRP. Variations in emissions from the Proposed Action changes are summarized below and illustrated in Figure 4-13 and Figure 4-14.

- **Phase 1:** An additional 10 days of construction time would lead to a 6.67 percent increase in emissions.
- **Phase 2:** An 8 percent increase in time and materials would lead to an 8 percent increase in emissions.
- **Phase 3:** There is no change in potential emissions from the Proposed Action.

- **Phase 4:** An additional 35 days of construction time would lead to a 9.72 percent increase in construction emissions.

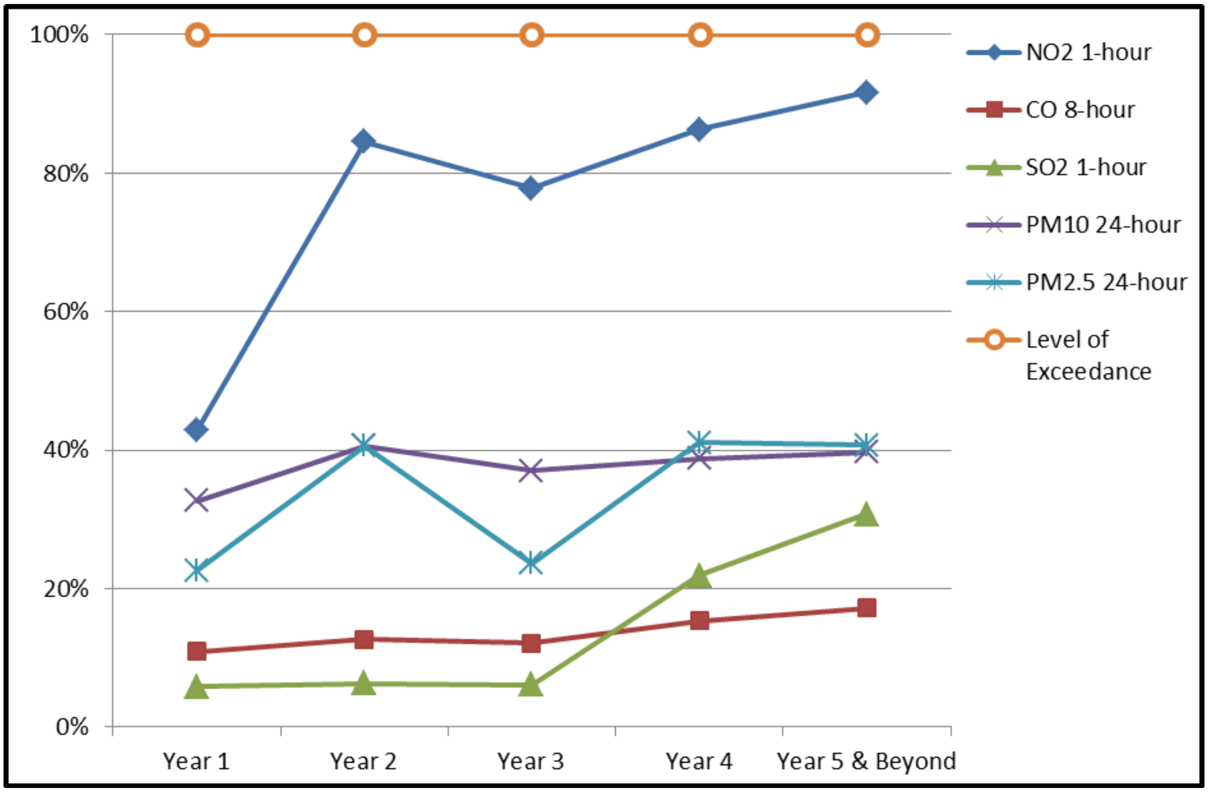

Figure 4-13 Alternative 3A NAAQS Comparison

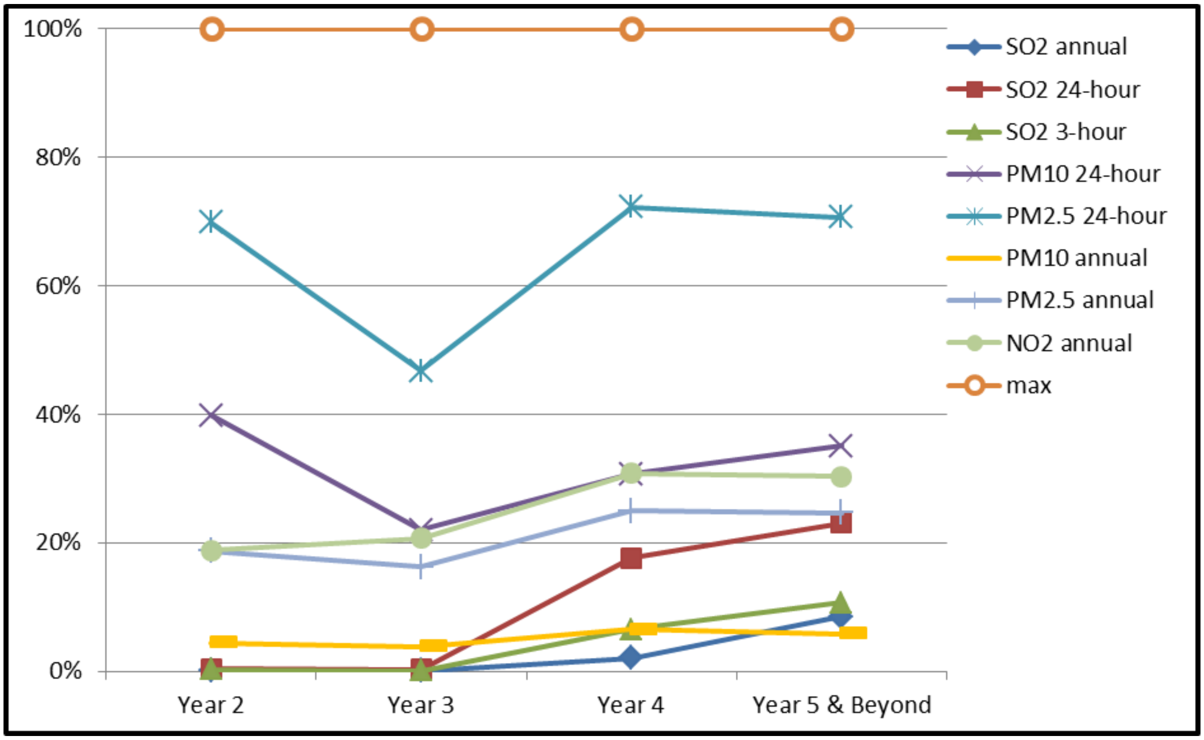

Figure 4-14 Alternative 3A Class II MAI Comparison

4.2.3.5.2 Conclusion for Alternative 3A

Figure 4-13 and Figure 4-14 show that emissions from Phases 1 through 3 (Years 2 through 4) would not differ substantially from those described for the Proposed Action (Alternative 1). However, Phase 4 (Year 5) for this alternative, which describes production operations from Year 5 through the lifetime of the project, shows a slight increase in the 1-hour standard NAAQS for $NO_{2.}$ This increase brings the estimated impact close (within 5 percent) but does not exceed the NAAQS or Class II MAI for any criteria pollutant.

Impacts of Alternative 3A on air quality would be essentially the same as those for the Proposed Action. Routine activities under Alternative 3A would have a measureable impact on Air Quality with low to medium intensity due to NO_2 1-hour being estimated at greater than 50 percent but less than 100 percent of the NAAQS. The impacts would be temporary and interim, over the 25-year lifetime of the Proposed Action. Construction emissions and their resulting impacts would be limited to the first 3 to 5 years of the project. Once the process of drilling has been largely completed (2nd Quarter Execute Year 5) and the operation shifts toward production, emissions associated with the operation and support of the rig(s) would decrease considerably, reducing the overall impact of operations. Impacts resulting from the Proposed Action would be localized within the Proposed Action Area as captured by the modeling domain (Figure 4-10), with the highest level of impacts at the shoreline area closest to the LDPI and lessening moving inland. The air quality in the areas surrounding the project would recover and return to pre-project levels shortly after the completion of the project. Due to these impact criteria, the overall impact on Air Quality from Alternative 3A are expected to be minor.

4.2.3.5.3 Alternative 3B: Relocate LDPI Approximately 1.5 Miles to the Southwest

The plan changes outlined in Section 2.2.4 would impact Phases 1, 2, and 4 of the Air Quality impact scenarios. There would be emissions variations from the Proposed Action due to increases and decreases in construction. Also, due to the change in proposed LDPI location, there would be a 1.5-

mile decrease in distance between the island and the shoreline. Also, emissions from the LDPI facilities would be regulated and potentially controlled by ADEC. Since the proposed actions' modeled dispersion impacts were from the 1,640-foot safety boundary, there is no concern of increased impacts due to the reduction in distance between the LDPI and the shoreline. The following are estimated changes to the proposed plan. Again, if this alternative was selected, the SOA and/or ADEC would take over the lead on the regulation of air quality.

- **Phase 1:** A decrease of 6 days of construction time would lead to a 4 percent reduction in construction emissions.
- **Phase 2:** A 20 percent reduction in time and materials would lead to a 20 percent decrease in emissions.
- **Phase 3:** There is no change in potential emissions from the Proposed Action.
- **Phase 4:** An additional 75 days of construction time would lead to a 20.83 percent increase in construction emissions.

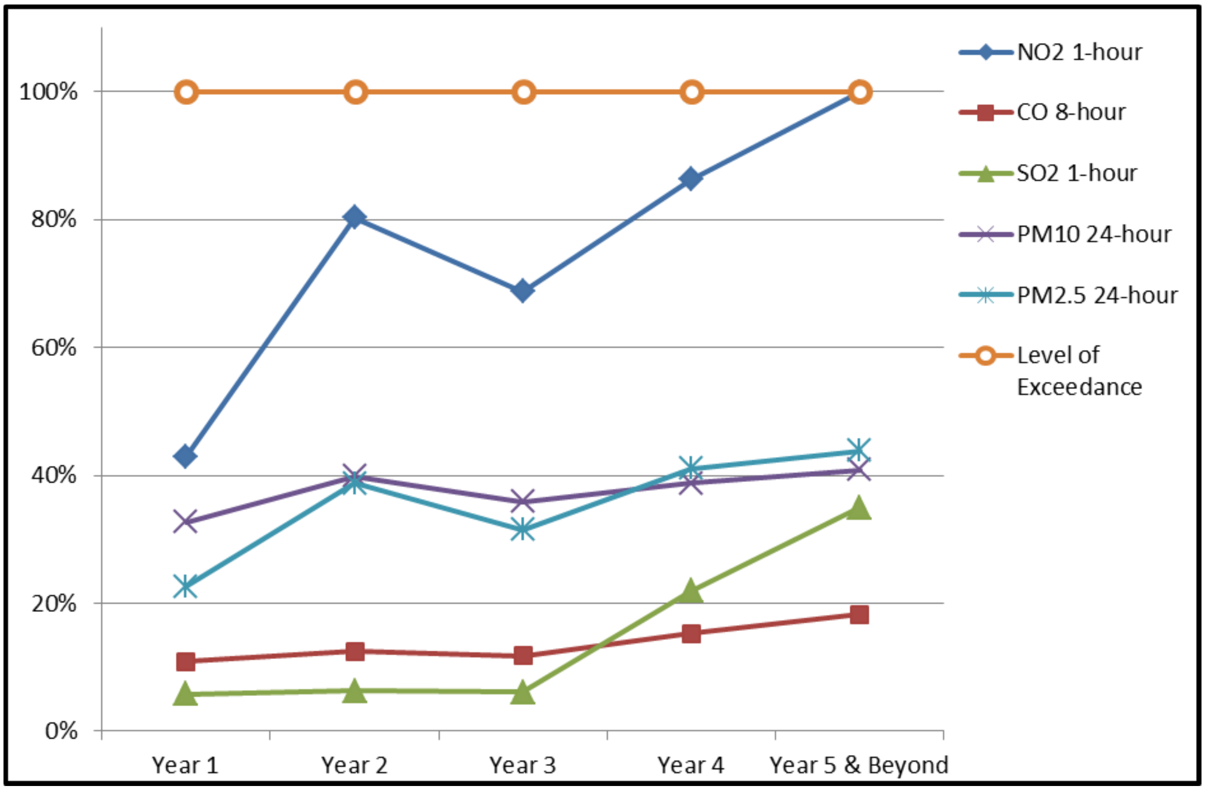

Figure 4-15 Alternative 3B NAAQS Comparison

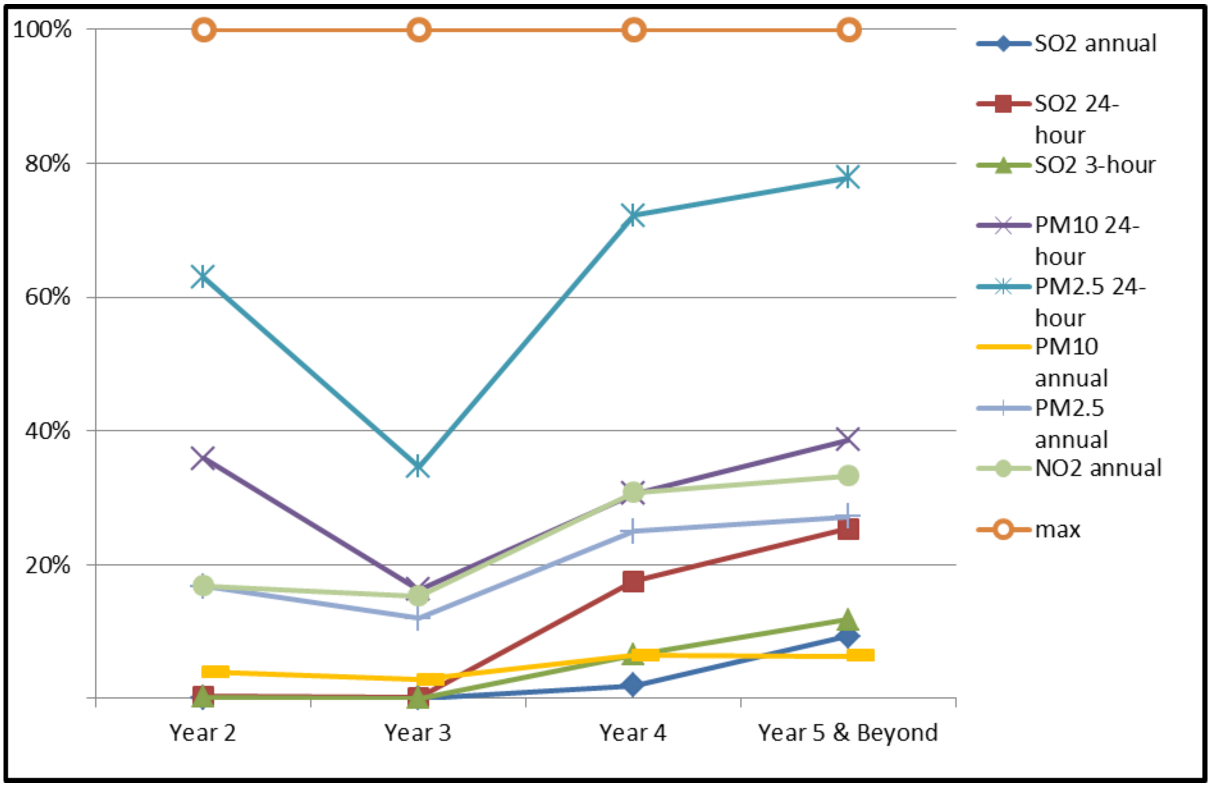

Figure 4-16 Alternative 3B Class II MAI Comparison

4.2.3.5.4 Conclusion for Alternative 3B

Impacts of Alternative 3B on air quality would be higher than those for the Proposed Action. Routine activities under Alternative 3B would have a measureable impact on Air Quality with medium to high intensity due to NO_2 1-hour being estimated at greater than or equal to the NAAQS. The impacts would be temporary and interim, over the 25-year lifetime of the Proposed Action. Construction emissions and their resulting impacts would be limited to the first 3 to 5 years of the project. Once the process of drilling has been largely completed (2nd Quarter Execute Year 5) and the operation shifts toward production, emissions associated with the operation and support of the rig(s) would decrease considerably, reducing the overall impact of operations. Impacts resulting from the Proposed Action would be localized within the Proposed Action Area as captured by the modeling domain (Figure 4-10), with the highest level of impacts at the shoreline area closest to the LDPI and lessening moving inland. The air quality in the areas surrounding the project would recover and return to pre-project levels shortly after the completion of the project. The air quality impacts of this alternative are not expected to lead to effects on human health for those populations in or near the surrounding Proposed Action Area at this level of analysis. Due to these impact criteria, the overall impact on Air Quality from Alternative 3B are expected to be minor to moderate for routine activities.

As mentioned above, this alternative would change the jurisdiction of air quality such that ADEC would be the permitting authority for this location and the applicant would need to submit an updated application and modeling following the regulation and guidelines of ADEC and the SOA. ADEC, through its process and analyses, would require additional controls if necessary to ensure that the stationary sources and associated activities would not result or contribute to a violation of any ambient air quality standards or air quality increment standards.

4.2.3.6 Alternative 4 (Alternate Processing Locations)

Under this alternative, oil and gas processing would be relocated to one of two onshore locations. Emissions from the onshore processing facilities located on SOA lands or within SOA waters would be regulated and potentially controlled by ADEC, rather than BOEM.

4.2.3.6.1 Alternative 4A: Relocate Oil and Gas Processing to Endicott

The plan changes outlined in Section 2.2.5 would impact Phases 1 and 2 of the air quality impact scenarios. Under this alternative the jurisdiction of air quality would change such that ADEC is the permitting authority of the Endicott Production Facility and existing permits may need to be revised due to this Alternative. BOEM would retain jurisdiction to control air emissions from the LDPI. BOEM would re-conduct its AQRP review using a revised emissions inventory.

- **Phase 1:** A decrease of 20 days of construction time would lead to a 13.3 percent reduction in construction emissions.
- **Phase 2:** Due to the increase in pipeline length there would be an approximately 50-day increase in pipeline construction time leading to a 27.8 percent increase in pipeline construction emissions.
- **Phase 3:** There is no change in potential emissions from the Proposed Action.
- **Phase 4:** There is no change in potential emissions from the Proposed Action. The largest emitter (the drilling rig) would remain offshore and the emitters that would be relocated onshore (natural gas power generators) are very small in comparison.

Under Alternative 4A, during Phase 1, Figure 4-17 shows that there is a decreased likelihood of violating the NAAQS for the 1-hour NO_2 standard as compared to the Proposed Action. During Phase 2, Figure 4-17 shows that there is a small increase in the likelihood of violating the NAAQS for the 1-hour NO_2 standard.

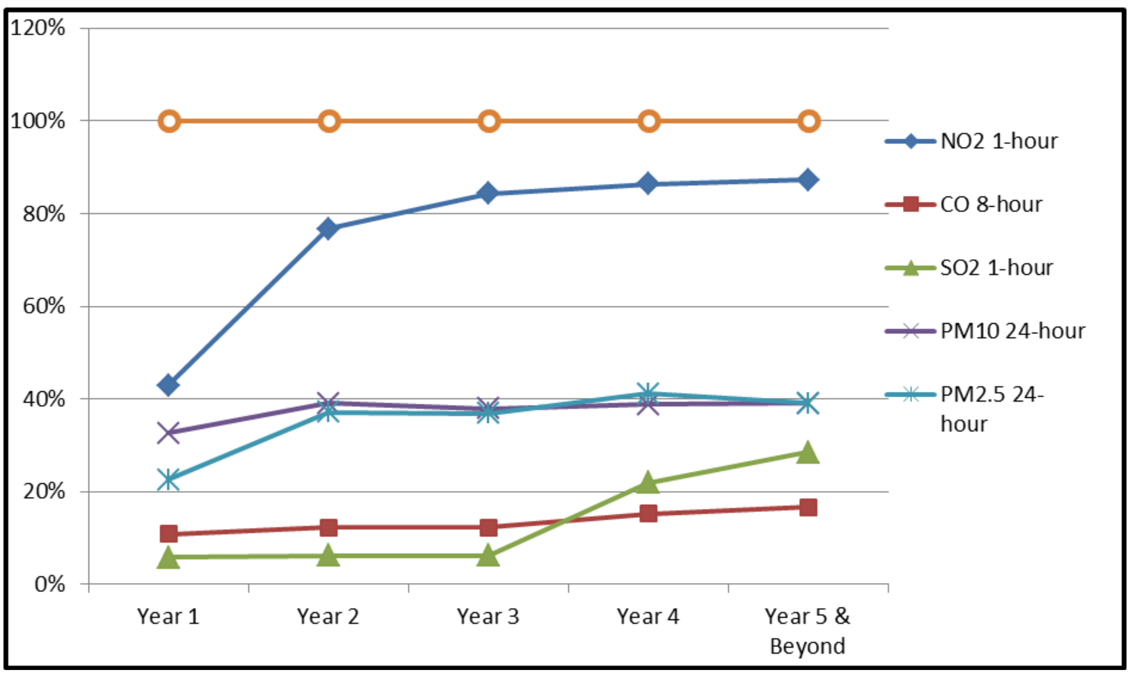

Figure 4-17 Alternative 4A NAAQS Comparison

Figure 4-18 shows that although there is a slight increase and decrease of emissions during the project, no pollutant comes near the Class II MAI limit. Overall, with no estimated change in the emissions from Phase 4, the impacts of Alternative 4A on air quality would be essentially the same as those for the Proposed Action.

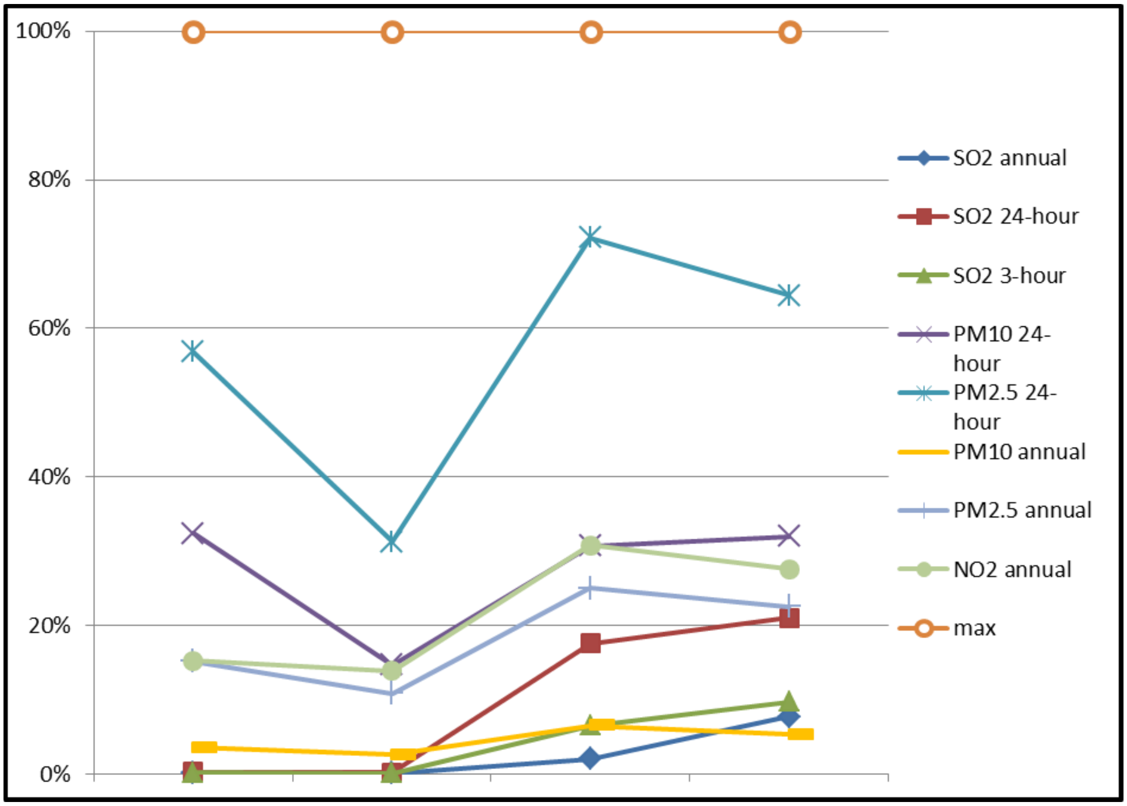

Figure 4-18 Alternative 4A Class II MAI Comparison

4.2.3.6.2 Conclusion for Alternative 4A

Impacts of Alternative 4A on air quality would be essentially the same as those for the Proposed Action. Routine activities under Alternative 4A would have a measureable impact on Air Quality with low to medium intensity due to NO_2 1-hour being estimated at greater than 50 percent but less than 100 percent of the NAAQS. The impacts would be temporary and interim, over the 25-year lifetime of the Proposed Action. Construction emissions and their resulting impacts would be limited to the first 3 to 5 years of the project. Once the process of drilling has been largely completed (2nd Quarter Execute Year 5) and the operation shifts toward production, emissions associated with the operation and support of the rig(s) would decrease considerably, reducing the overall impact of operations. Impacts resulting from the Proposed Action would be localized within the Proposed Action Area as captured by the modeling domain (Figure 4-10), with the highest level of impacts at the shoreline area closest to the LDPI and lessening moving inland. The air quality in the areas surrounding the project would recover and return to pre-project levels shortly after the completion of the project. Due to these impact criteria the overall impact on Air Quality from Alternative 4A are expected to be minor.

4.2.3.6.3 Alternative 4B: Relocate Oil and Gas Processing to a New Onshore Facility

The plan changes outlined in Section 2.2.5 would impact Phases 1 and 2 of the Air Quality impact scenarios. Under this alternative the jurisdiction of Air Quality would change such that ADEC would be the permitting authority for the new onshore facility. BOEM would retain jurisdiction to control air emissions from the LDPI. BOEM would re-conduct its AQRP review using a revised emissions inventory.

- **Phase 1:** Due to a net 8 days less construction time (20 days less for proposed LDPI construction; 12 additional days for onshore pad construction) there would be a 5.3 percent decrease in construction emissions.
- **Phase 2:** Due to additional pipeline and facility requirements about 15 additional days of construction would lead to an 8.3 percent increase in construction emissions.
- **Phase 3:** There is no change in potential emissions from the Proposed Action.
- **Phase 4:** There is no substantial change in potential emissions from the Proposed Action. The largest emitter (the drilling rig) would remain offshore and the emitters that would be relocated onshore (natural gas power generators) are very small in comparison.

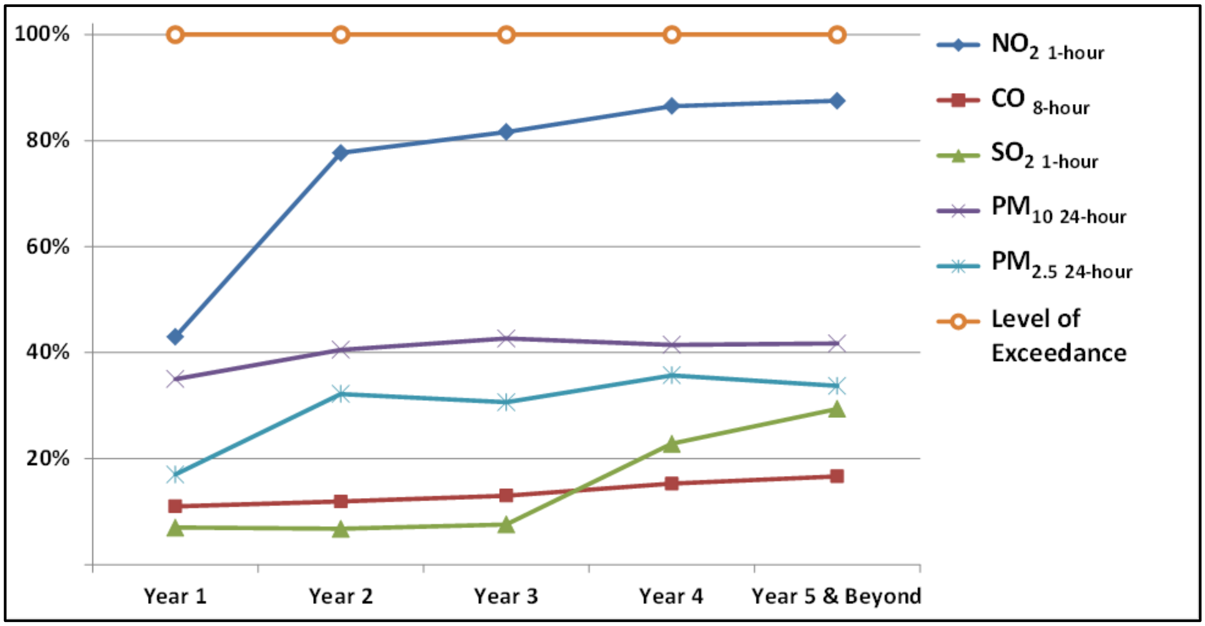

Figure 4-19 Alternative 4B NAAQS Comparison

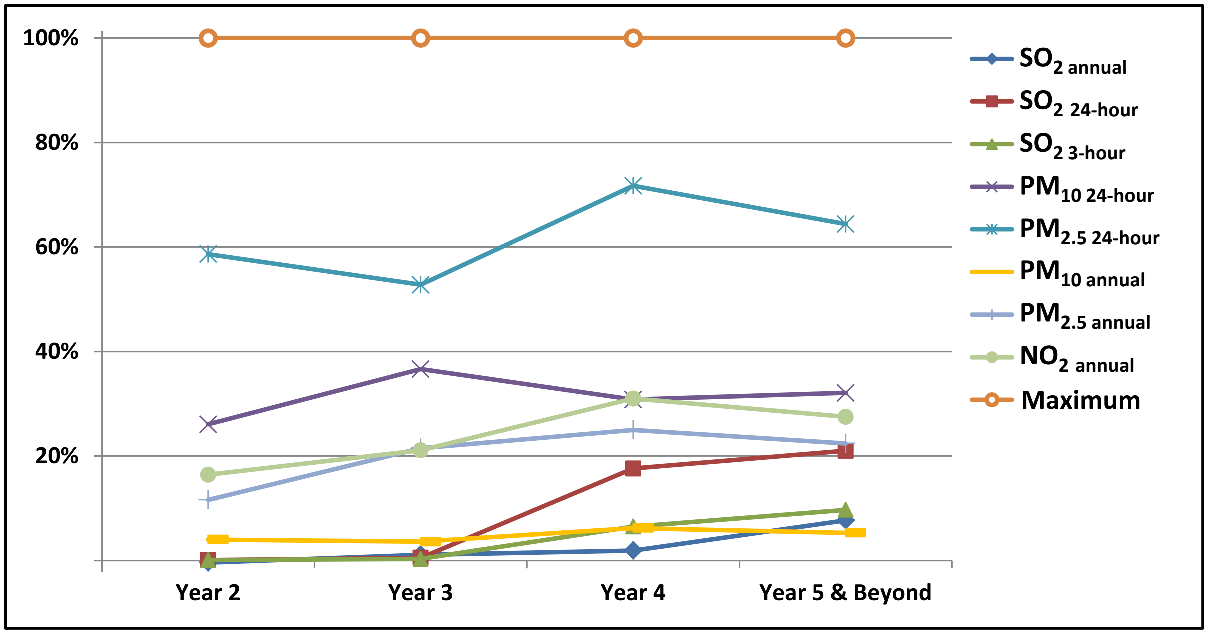

Figure 4-20 Alternative 4B Class II MAI Comparison

4.2.3.6.4 Conclusion for Alternative 4B

During Phase 1, Figure 4-19 shows that there is a decreased likelihood of violating the NAAQS for the 1-hour NO_2 standard as compared to the Proposed Action. During Phase 2, Figure 4-20 shows that there is a small increase in the likelihood of violating the NAAQS for the 1-hour NO_2 standard. Figure 4-20 shows that although there is a slight increase and decrease of emissions during the project, no pollutant came near the Class II MAI limit. Overall, with no estimated change in the emissions from Year 4 and all subsequent years of this project, the impacts of Alternative 4B on air quality would be essentially the same as those for the Proposed Action.

Impacts of Alternative 4B on air quality would essentially be the same as those for the Proposed Action. The routine activities under Alternative 4B would have a measureable impact on Air Quality. The impacts would have low to medium intensity due to NO_2 1-hour being estimated at greater than 50 percent, but less than 100 percent of the NAAQS. The impacts would be temporary and interim, over the 25-year lifetime of the Proposed Action. Construction emissions and their resulting impacts would be limited to the first 3 to 5 years of the project. Once the process of drilling has been largely completed (2nd Quarter Execute Year 5) and the operation shifts toward production, emissions associated with the operation and support of the rig(s) would decrease considerably, reducing the overall impact of operations. Impacts resulting from the Proposed Action would be localized within the Proposed Action Area as captured by the modeling domain (Figure 4-10), with the highest level of impacts at the shoreline area closest to the LDPI and lessening moving inland. The air quality in the areas surrounding the project would recover and return to pre-project levels shortly after the completion of the project. Due to these impact criteria the overall impact on Air Quality from Alternative 4B are expected to be minor.

4.2.3.7 Alternative 5 (Alternate Gravel Sources)

Potential impacts on air quality under Alternative 5A, 5B, or 5C would not differ substantially from those described for the Proposed Action, Alternative 1. The air quality impact analysis from the Proposed Action mine site included an estimated 24 trucks hauling gravel to the proposed LDPI. This is greater than the estimated truck use at 12, 15, and 22 trucks for Alternatives 5A, 5B or 5C, respectively.

4.2.3.8 Conclusion for Alternative 5

Impacts of Alternative 5A and 5B on air quality would be minor; essentially the same as those for the Proposed Action.

4.2.4 Climate Change

The activities under the Proposed Action and its alternatives would produce black carbon emissions. A small portion of the $PM_{2.5}$ and PM_{10} emissions estimated in the previous subsection would consist of black carbon emissions. Some of the black carbon emitted from the proposed development and production activities would be dispersed within the local environment, which for much of the year features snow and sea ice. In general, black carbon deposited on snow and sea ice tends to absorb heat and hasten melt while decreasing the earth's ability to reflect the warming rays of the run. While it is not possible to determine what fraction of the Proposed Action's $PM_{2.5}$ and PM_{10} emissions would qualify as black carbon without doing experiments at the proposed facility once it is built, context and a recent study indicate that any impact of such black carbon on the local environmental would be negligible. BOEM's recent Arctic Air Quality Study estimated a baseline emissions inventory for the North Slope and adjacent offshore areas, to include oil and gas and non-oil and gas sources. The estimated baseline PM emissions for this region are roughly 4,700 tons per year (Field Simms, P. et. al., 2014). No observable increase in the rate of snow or sea ice melt has been attributed to these emissions. By way of comparison, the Proposed Action here would entail roughly 40 tons of PM emissions per year, i.e., less than 1 percent of an existing baseline that is not believed to have any measurable impact on snow or sea ice melt. The Proposed Action is therefore not expected to measurably increase snow or ice melt by virtue of its black carbon emissions.

The activities under the Proposed Action and its alternatives would produce GHG emissions, including CO_2, CH_4, and N_2O. These GHG emissions would contribute to climate change. The analysis below quantified projected GHG emissions that would occur from the Proposed Action. These projected GHG emissions serve as a proxy for assessing the Proposed Action's contribution to climate change. For this analysis the potential GHG emissions for the action alternatives are expressed as CO_2 equivalents (CO_{2e}) which are based on potential CO_2, CH_4, and N_2O emissions and their respective global warming potential values (40 CFR 98, Subpart A, Table A-1).

Using the same assumptions and analysis from Section 4.1.2 and their respective subsections, Table 4-6 lists the estimated greenhouse gas emissions from the Proposed Action and action alternatives.

Table 4-6 Potential Annual Greenhouse Gas Emissions of Liberty DPP (tons of CO_{2e})

Phase	Proposed Action	Alternative 3A	Alternative 3B	Alternative 4A	Alternative 4B	Alternative 5
Phase 1 (Year 2)	44,818	47,807	43,025	38,857	42,443	44,818
Phase 2 (Year 3)	59,453	64,209	47,562	75,981	64,388	59,453
Phase 3 (Year 4)	174,820	174,820	174,820	174,820	174,820	174,820
Phase 4 (Year 5 and above)	517,325	567,609	625,084	517,325	517,325	517,325

Some of the Alternatives have no estimated change in GHG emissions from the Proposed Action; the estimated emissions of GHG from the Proposed Action are 517,325 tons of CO_{2e} per year. The emissions from Phase 4 of the Proposed Action and each action alternative is the estimated annual emission from Year 5 through the life of the project. The physical change in location has negligible levels of effect on greenhouse gases as GHG analysis focuses on gross tonnage of emissions, not concentrations of pollutants onshore. Because some GHG gases, such as CO_2, may persist in the atmosphere for up to a century, the potential impacts of any source may extend well beyond the active lifetime of the Proposed Action. How these emissions would impact the Proposed Action Area would depend on emissions from the Proposed Action together with emissions on a national and global scale. According to the EPA’s Greenhouse Gas Reporting Program (GHGRP), in 2015 the U.S. oil and gas industry as a whole released 231 million metric tons (MMT) of CO_{2e} (EPA, 2016). The contribution to the 2015 GHGRP oil and gas segment from offshore production was 7 MMT CO_{2e} (EPA, 2016).

4.2.4.1 Lifecycle Greenhouse Gas Emissions

This subsection estimates lifecycle GHG emissions associated with the Proposed Action. The term "lifecycle GHG emissions" here refers to GHG emissions from the Proposed Action (i.e. GHG emissions from all phases of the proposed development and production activities described in the Liberty DPP) plus GHG emissions from the transportation and consumption of oil produced at Liberty. These emissions are expressed in Table 4-7 in terms of CO_{2e}.

BOEM derived this estimate using methods originally developed for a programmatic analysis conducted for its 2017-2022 5-Year Programmatic EIS (USDOI, BOEM, 2016a). Additional information on the methodologies and assumptions behind that programmatic analysis are available in Section 4.2.1.2 of the 2017-2022 5-Year Programmatic EIS. However, rather than estimating the emissions associated with upstream activities (i.e., exploration, development, production, and transport of resources) using the Offshore Environmental Cost Model (OECM), BOEM used the GHG emissions reported in the Liberty DPP. BOEM imported these estimated upstream GHG emissions into its lifecycle model and then calculated the remaining emissions from downstream activities (i.e., refining and consumption).

The estimate of lifecycle GHG emissions associated with the Proposed Action is also representative of lifecycle GHG emissions associated with each of the other action alternatives, i.e. Alternatives 3A, 3B, 4A, 4B, 5A, 5B, and 5C. This is because the overall lifespan of development and production activities, as well as the total amount of oil produced from the Liberty prospect, would not vary significantly among action alternatives.

This subsection also estimates lifecycle GHG emissions associated with the No Action Alternative. Under the No Action Alternative, no development or production activities would occur at the Liberty prospect, and no oil from the Liberty prospect would be transported or consumed. However, market forces dictate that if oil were not produced from the Liberty prospect, energy would be procured from other sources to keep energy supplies in step with energy demand. BOEM's analysis accounts for this concept, known as market substitution. The estimated lifecycle GHG emissions associated with the No Action Alternative reflect the lifecycle GHG emissions associated with the other fuels (anticipated to be primarily oil imports, along with a mix of natural gas, renewables, and coal) that would be produced and consumed in lieu of oil from the Liberty prospect. BOEM's analysis does not assume that "perfect" substitution would occur. Rather, BOEM ran its market Simulation Model (MarketSim) (which incorporates assumptions made by the U.S. Energy Information Administration) to estimate and account for the marginal reduction of energy demand that would occur in the event that supplies are reduced (Industrial Economics, Inc., 2015). Here, lifecycle GHG emissions associated with the No Action Alternative are estimated to be higher than those associated with the Proposed Action, despite the model's assumption that a slightly lower amount of energy would be consumed domestically overall. This is because the lifecycle GHG emissions associated with the mix of replacement fuels estimated to be consumed under the No Action Alternative are, on average, greater than the lifecycle GHG emissions associated with oil produced from the Liberty prospect, largely due to comparatively weaker environmental protection standards associated with exploration and development of the imported product and increased emissions from transportation.

Table 4-7 Lifecycle GHG Emissions

Alternative Type	Metric tons of CO_{2e}
Proposed Action and Action Alternatives	64,570,000
No Action	89,940,000

4.2.4.2 Proposed Mitigation Measures

BOEM also evaluated potential mitigation strategies that might reduce the Proposed Action's contribution to climate change. The ideal theoretical mechanism for reducing GHG emissions in the Proposed Action, or any of the action alternatives, would be the use of Carbon Capture Storage/ Sequestration devices. However, these devices are currently in their early stages of development and are both cumbersome and expensive. BOEM proposes a simpler, more cost-effective approach to the overall reduction in GHG emissions in the form of carbon offsets via reforestation.

The basis of this offset is that the average mature tree can sequester (consume and retain) up to 48 pounds of CO_2 per year through its 40-year lifetime. When reforesting, an average acre can hold up to 1,500 new trees. In its 2017 budget justification, the U.S. Forest Service (USFS) declared that it had identified over a million acres of National Forest System lands that could benefit from reforestation (USFS, 2016). In the preceding year the USFS reforested over 190,000 acres of public land and has a goal of reforesting 180,000 in the upcoming year. These efforts are accomplished with the help of non-profit partners such as the National Forest Foundation (NFF) and civic groups who contribute to the agency's capacity for reforestation through partnerships and matching fund agreements. Through these partnerships, the NFF and the USFS have been able to reforest areas of public land at a 1:1 ratio of dollar to tree.

A total project carbon offset could be achieved if the Lessee directly or indirectly (via NFF or USFS) assists in the reforestation of 9,000 acres of public lands. This proposed offset again assumes the average acre of reforested land can hold 1,500 new trees, and that each tree at maturity can sequester 48 lbs of CO_2. During the lifespans of the Proposed Action and that of trees at 25 and 40 years, respectively, it would only require 9,000 acres of mature forest to reduce the lifetime carbon emissions of the facility at LDPI to zero.

4.3 Biological Environment

4.3.1 Lower Trophics

4.3.1.1 The Proposed Action

4.3.1.1.1 Development

In the marine and estuarine environment, habitat alteration would occur during development activities. Construction of the LDPI and pipeline trenching would affect benthic, epontic, and pelagic invertebrates (discussed below). The Boulder Patch in particular is expected to be impacted by construction activities. Until the disposal well is drilled, most wastewater would be hauled offsite for disposal at a permitted facility. The only ongoing discharge during development is wastewater from the STP. Construction and secondary containment dewater would likely occur during the first 2 years of construction, after which they would be injected in the disposal well. All discharges would be required to comply with the terms and conditions of the NPDES permit.

4.3.1.1.2 Production

Habitat alteration is generally not expected to occur during the production phase of the Proposed Action, as production activities are based on the proposed LDPI and would not require changes to the seafloor. Maintenance of existing structures would occur. Physical presence of the LDPI may provide new hard-substrate habitat for benthic invertebrates. Water intake structures for seawater treatment could affect organisms in the water column, such as zooplankton and fish larvae. The only ongoing NPDES discharge anticipated during the production is wastewater from the STP. As discussed in Section 3.2.1, the current lower trophic community may be altered by climate change processes. However, the impacts described below are not expected to differ as a result of those climate change processes.

4.3.1.1.3 Decommissioning

The removal of LDPI armoring and gradual erosion of the LDPI base are expected to result in habitat alterations. The subsea pipeline would be flushed of all contaminants, have its ends sealed, and be left in place. Decommissioning activities are expected to increase the turbidity through resuspension of sediments as the proposed LDPI is worn away by currents.

4.3.1.1.4 Impacts

Habitat Alteration

For the purposes of this EIS, BOEM uses several estimates of acreage in the Proposed Action Area. NOAA waterbody data (https://encdirect.noaa.gov/) was used to estimate the area of Stefansson Sound as approximately 229,000 acres. The University of Texas estimates that the area of the Boulder Patch is approximately 20,800 acres. More areas of the Boulder Patch community may occur in other parts of Stefansson Sound or the Beaufort Sea, but BOEM uses the historic data from the University of Texas. A model of sediment dispersal provided the area of the Boulder Patch affected by different phases of LDPI construction (Table 4-8; Figure 4-1, Figure 4-3, Figure 4-4, and Figure 4-7) (Coastal Frontiers, 2014). Ban et al. (1999) used 10 mg/L excess turbidity as the threshold for impacts to kelp; BOEM has used that same designation in this EIS.

Table 4-8 Sediment Plume Acreage Estimate[1]

Action	Acres of Boulder Patch Habitat Affected	Percent of Boulder Patch Affected	Figure Reference
Island Construction (winter)	330	1.59%	Figure 4-1
Trench Excavation (winter)	991	4.76%	Figure 4-3
Trench Backfill (winter)	679	3.26%	Figure 4-4
Trench Backfill Degradation (summer)	200	0.96%	Figure 4-4 through Figure 4-7

Note: Estimated areal impacts to the Boulder Patch of increased turbidity >10mg/L as a result of LDPI construction activities. Trenching activities would impact the same areal extent and are not additive.

Source: Coastal Frontiers, 2014.

Gravel deposition during LDPI construction would alter the seafloor habitat and could crush benthic invertebrate species resulting in injury or mortality to individual organisms present in the 24-acre footprint. Pipeline trenching and potential maintenance activities on the trenched backfill would also disturb the seafloor and would disturb habitat for benthic species. Many benthic species are sessile (fixed in one place; immobile) or slow-moving, and are not expected to vacate the area. Any invertebrate present during construction activities would likely be killed or injured. Effects of gravel deposition are expected to be short-term and limited to the footprint of the LDPI and the pipeline (backfill deposition). The proposed LDPI would be a long-term alteration to 0.01 percent of the overall habitat in Stefansson Sound. Removal of the armor plating on the LDPI during decommissioning would result in complete removal of habitat for any species that had colonized the proposed LDPI during the production life of the Proposed Action. This nearshore region is frequently exposed to ice scouring and habitat disturbance on an annual basis (Reimnitz and Kempema, 1982; Pritchard, 1980), so the organisms present are adapted to a highly dynamic environment and are expected to recover quickly.

Gravel deposition and pipeline trenching is expected to increase turbidity temporarily as sediments on the seafloor are resuspended in the water column. Localized increases in turbidity and a turbidity plume are expected around the proposed LDPI and pipeline corridor. The plume is expected to move offshore, away from the Sagavanirktok River (Figure 4-1, Figure 4-3, Figure 4-4, and Figure 4-7). This could affect marine benthic and zooplankton species by decreasing visibility, which impacts both predator and prey interactions (De Robertis et. al., 2003), and also by potentially clogging gills and smothering seafloor communities. Changes in water clarity, especially from turbidity, can affect primary productivity and the spring algal bloom (Aumack et al., 2007; Dunton, Schonberg, and

McTigue, 2009). In the ice-covered season when construction activities are mostly occurring, the sediment plume (Figure 4-1) is expected to be limited by the low currents and ice bonding of silt (Toimil and England, 1982; Newbury, 1983). During the spring thaw, sediment from the pipeline trenching may be transported northward towards the Boulder Patch. Currents during the open-water season are higher due to greater impacts from winds (Trefry, et al., 2009; Coastal Frontiers Corporation, 2014), and so the area affected by elevated turbidity would increase. Monitoring of turbidity from previous gravel island constructions in the Beaufort Sea showed increased turbidity around installations during the summer, but detection of increased suspended sediments was unlikely beyond 1,640 feet from the site (Coastal Frontiers Corporation, 2014). Turbidity would likely return to ambient levels once construction activities are completed, which means that for the majority of the life of the project, local turbidity would not be increased. During the production phase, localized turbidity would likely be increased above ambient levels as a result of TSS concentrations in the ongoing STP discharge. However, any elevated TSS or turbidity is expected to be quickly diluted to background levels by local currents and tides. Decommissioning activities are expected to increase the turbidity through resuspension of sediments as the proposed LDPI is worn away by currents (Section 4.3.1.1.3). Impacts on benthic and planktonic invertebrate communities from changes in turbidity are expected to be short-term and localized compared to the greater area of Stefansson Sound.

In contrast to the general benthic communities of Stefansson Sound, impacts to the Boulder Patch from construction activities are expected to be more pronounced. The Boulder Patch is a specialized type of habitat that hosts some of the most diverse biological communities in the entire Beaufort Sea (Dunton et.al., 1982). Given the estimated boundaries of the Boulder Patch, modeling of the sediment plume suggests that a relatively small area of heavy Boulder Patch coverage would be affected (approximately 6.35 percent total, Table 4-8; Figure 4-1, Figure 4-3, Figure 4-4, and Figure 4-7; Coastal Frontiers, 2014). The amount of light available in the marine environment is an important factor in annual production, particularly for the Boulder Patch, although a great deal of growth occurs in naturally dark conditions (Dunton et al., 1982; Dunton et al., 2009). Excess turbidity would decrease the amount of light, which could alter and decrease primary productivity. Growth of kelp in the Boulder Patch would be impacted, and this would have cascading effects on the biota that rely on the Boulder Patch for habitat and feeding. Studies on the Boulder Patch have shown that recovery after a disturbance is a long-term process (Martin and Gallaway, 1994; Konar, 2007; Konar 2013). Recovering from the impacts from excess turbidity, including limited primary productivity as well as sediment smothering, could take decades. Habitat loss in the Boulder Patch could be mitigated slightly by addition of new hard-bottom habitat from the LDPI, which is a key characteristic of Boulder Patch distribution. Decommissioning activities may again temporarily increase turbidity in the Boulder Patch, however, the severity of the impact is expected to be minor because the island would be worn down through natural processes (see Section 4.3.1.1.3), and the majority of fine sediment suspension would primarily occur during construction.

Ice habitat for epontic organisms would be affected by cutting excisions in the ice to allow for gravel deposition and subsea pipeline installation. This would remove some ice algae and alter the habitat of ice-associated species like amphipods (Lonne and Gullikson, 1989; Gradinger and Bluhm, 2004), though there is a large area of other available ice habitat for epontic communities.

Overall, the initial construction of the LDPI would have the most adverse impact on benthic invertebrates, zooplankton, and the Boulder Patch. Outside of the Boulder Patch, these impacts (crushing, smothering, and increased turbidity) are not expected to have a population level effect as the size of the area impacted relative to the overall amount of benthic habitat available in Stefansson Sound is small (0.01 percent of the overall habitat in Stefansson Sound). Once the proposed LDPI is in place and construction activities are over, benthic communities around the LDPI are expected to recover within a few years. The proposed LDPI itself may mitigate adverse impacts by providing habitat for species that prefer hard-bottom substrates. Because of the duration of the Proposed Action, the general habitat alteration impacts are expected to be long-term though the footprint would be limited and localized to the immediate vicinity of the LDPI.

The Boulder Patch, due to its low tolerance for habitat disturbances, would not recover as quickly. Although the effects of sedimentation from proposed LDPI construction and decommissioning would affect only a relatively small portion of the known Boulder Patch area, it could have long-term impacts on this specialized environment.

Physical Presence

Numerous vessel roundtrips would occur between the offshore facilities and the onshore facilities in open-water months during the life of the Proposed Action. Pressure waves from vessel hulls could displace plankton and cause injury or mortality. Ice roads are not expected to impact lower trophic organisms, as the roads would be outside of the normal habitat of this resource. The number of individual planktonic organisms that are expected to be impacted by vessels is small relative to the overall number in Stefansson Sound. Additionally, one to two barge trips per year may transit through Dutch Harbor, and would occur in areas outside of the region described in Section 3.2.1. Impacts from these limited barge trips to the Chukchi Sea are the same as described in the BOEM Chukchi Sea Planning Area Lease Sale 193, Second Supplemental Environmental Impact Statement (SEIS) (USDOI, BOEM, 2015).

Although the LDPI is a long-term addition to Stefansson Sound, it is a highly localized impact. Benthic organisms are expected to resume use of the area around and on the base of the proposed LDPI after initial construction has been completed. It is expected that the LDPI, once constructed, could provide hard substrate habitat for benthic species. This could mitigate the impacts to the Boulder Patch due to the initial habitat loss by providing new substrate for colonization. Lights on the proposed LDPI during all phases may attract predators of zooplankton and fish (Shaw et al., 2002). The impact from the physical presence of the LDPI would gradually disappear during decommissioning as the gravel is carried away by currents, but that process would take many seasons (see Section 4.3.1.1.3). The proposed pipeline would be buried and covered with the trenched material, so little to no impacts are expected on invertebrate communities after the initial construction disturbance and recovery.

The addition of the LDPI in Stefansson Sound is unlikely to alter currents or wind patterns (see Section 4.2.2.2). The presence of the island is not expected to impact the distribution or movement of plankton because these organisms are wind and current driven.

Water intake structures can result in the entrainment and/or impingement of all life stages of fish, shellfish, and plankton. Entrainment is defined as any life stages of fish and shellfish in the intake water flow entering and passing through an intake structure, which excludes those organisms that are collected or retained by a sieve with a maximum opening dimension of 0.56 inches. Impingement is defined as entrapment of any life stages of fish and shellfish on the outer part of an intake structure or against a screening device during periods of intake water withdrawal, which includes those organisms collected or retained on a sieve a with maximum distance in the opening of 0.56 inches and excludes those organisms that pass through the sieve. EPA’s NPDES permit requires HAK to develop and implement a BMP Plan to minimize the entrainment and impingement mortality of fish and shellfish. Specifically, the NPDES permit requires HAK to ensure the seawater treatment plant intake structure and operational measures minimize the impingement mortality and entrainment of fish and shellfish. This requirement is consistent with the Cooling Water Intake Regulations found at 40 CFR Part 125.84(c)(4), which regulates cooling water intake facilities with design flows greater than 2 million gallons per day (MGD). Although the proposed STP facility would not be designed for cooling purposes, it would withdraw approximately 4.4 MGD, and, without proper design controls, could have the potential to cause entrainment and impingement mortalities. Compliance with these NPDES permitting requirements would minimize the effect of water intake structures on all life stages of fish and shellfish, and plankton.

The wastewater discharges associated with the LDPI consist of conventional pollutants, which are designated under Section 304(a)(4) of the CWA as biological oxygen demand (BOD), TSS, pH, fecal coliform, and oil and grease. These conventional pollutants are not expected to bioaccumulate or persist in the environment. With the exception of the ongoing discharges from the STP during the life of the project, all other authorized discharges would be temporary and short-term.

Pollutants not classified as conventional or toxic, such as temperature, are considered to be “nonconventional.” The potable water treatment and the STP processes may result in elevated temperatures in the effluent, as compared to the ambient receiving waterbody conditions. To ensure those discharges would not result in an unreasonable degradation of the marine environment, the NPDES permit requires weekly temperature monitoring of the influent and effluent for those systems.

Additionally, wastewater discharges from the potable water treatment system and the STP may contain trace amounts of chemicals. HAK has indicated that both systems may require the use of maintenance chemicals, such as biocides, clarifying agents, descalers, and/or chlorination/ dechlorination chemicals. The STP has been designed to minimize the release of these chemicals to the environment and the potable water treatment reject wastewater is expected to be disposed of through the disposal well. However, the NPDES permit requires whole effluent toxicity testing semi-annually and quarterly on effluent samples from the potable water treatment reject wastewater and the STP, respectively, during periods when chemicals are used and when the applicable waste streams are discharged to surface waters. It is expected that the discharged water would rapidly dilute, mixing to background levels. Effects of water intake and discharge would be localized to the LDPI and are not expected to have population-level impacts.

The proposed LDPI, once constructed, could provide hard substrate habitat for benthic species. This could affect the Boulder Patch by providing new substrate for colonization, which could mitigate the impacts of the initial habitat loss. Lights on the proposed LDPI during all phases may attract predators (Shaw et al., 2002). The impact from physical presence of the LDPI would gradually disappear during decommissioning as the gravel is carried away by currents, but that process would take many seasons. Although the LDPI is a long-term addition to Stefansson Sound, benthic organisms are expected to resume use of the area around and on the base of the proposed LDPI after initial construction has been completed. The pipeline would be buried and covered with the trenched material, so little to no impacts are expected on invertebrate communities after the initial construction disturbance and recovery.

Water intake structures can entrain zooplankton and phytoplankton, which can result in various adverse impacts on plankton communities, including decreased biomass and productivity of entrained heterotrophic bacteria and phytoplankton, reduced survival of entrained zooplankton and other metazoans, and reduced diversity of the zooplankton community (Choi et al., 2012). NPDES permit requirements ensure that the best available technology is used to minimize impingement and entrainment, including reduced water flow and technological controls designed to decrease mortality of organisms less than 0.56 inches. Adherence to permitting regulations would minimize the effect of water intake structures on plankton and fish larvae. Discharged water may be a different temperature than the ambient levels, and may contain trace amounts of chemicals. However, discharged water would rapidly dilute, mixing to background levels. Effects of water intake would be localized to the LDPI and are not expected to have population-level impacts.

Overall, invertebrates would be affected by the physical presence of vessels and the proposed LDPI in the marine and coastal environments. The LDPI may affect the movements of plankton, but the impacts would be negligible. Water intake and discharge impacts would be minor. The physical presence of ice roads used for winter construction activities is not expected to impact marine or estuarine invertebrates. The existence of the LDPI would span at least three decades, but would also provide habitat for benthic invertebrates. The pipeline would be buried, and aside from habitat alteration impacts discussed earlier, is not expected to impact invertebrate communities. General impacts are expected to be localized to the proposed LDPI and gravel mine sites.

4.3.1.1.5 Oil Spills

Accidental events could include small (less than 1,000 bbl) and large (greater than or equal to 1,000 bbl) spills stemming from the LDPI or the pipeline. Small and large oil spills are considered accidental events. The CWA and OPA 90 include regulatory and liability provisions designed to reduce damage to natural resources from oil spills. Oil spills are further discussed in Section 4.1.1. A solid ice condition could reduce the risk of spills occurring in open-water conditions during the initial drilling phase of the project. A large spill during solid ice conditions would be easier to contain and clean up, and would reduce the impacts to lower trophic organisms.

Small Oil Spills (Less than 1,000 bbl)

Many factors determine the degree of damage from a spill on plankton and benthic communities, including the size and duration of the spill, geographic location of the spill, and season. In whatever quantities, accidental oil spills can affect lower trophic organisms and their habitats. For much of the year, Stefansson Sound is covered in first year ice. Small spills are expected to be contained on either the LDPI or landfast ice. Clean up of oil spills before they enter the water column would mitigate the impacts of oil spills on lower trophic organisms. In open-water conditions, small spills tend to evaporate and disperse within hours to days in the marine environment, although a small proportion of the heavier fuel components could adhere to particulate matter in the upper portion of the water column and sink.

Benthic and planktonic invertebrates are exposed to oil in different ways and vary in their ability to avoid exposure (Blackburn et al., 2014).

Plankton. Mortality of zooplankton has been shown to be positively correlated with oil concentrations (Lennuk et al., 2015). Spills that are not immediately lethal can have short- or long-term impacts on biomass and community composition, behavior, reproduction, feeding, growth and development, immune response, and respiration (Auffret et al., 2004; Bellas et al., 2013; Blackburn et al., 2014). Zooplankton are especially vulnerable to acute crude oil pollution, showing increased mortality and sublethal changes in physiological activities (e.g., egg production) (Lee, Winters, and Nicol, 1978; Linden, 1976; Moore and Dwyer, 1974). Zooplankton may also accumulate Polycyclic Aromatic Hydrocarbons (PAHs) through diffusion from surrounding waters, direct ingestion of micro droplets (Berrojalbiz et al., 2009; Lee, Koster, and Paffenhofer, 2012), and by ingestion of droplets that are attached to phytoplankton (Almeda et al., 2013). Bioaccumulation of hydrocarbons can lead to additional impacts on higher trophic level consumers that rely on zooplankton as a food source (Almeda et al., 2013; Blackburn et al., 2014).

Oil spill impacts to phytoplankton include changes in community structure and increases in biomass, attributed to the effects of oil contamination and decreased predation due to zooplankton mortality (Abbrian et al., 2011; Ozhan, Parsons, Bargu, 2014). Ozhan, Parsons, Bargu (2014) reported that the formation of oil films (or slicks) on the water surface can limit gas exchange through the air-sea interface and can reduce light penetration into the water column by up to 90 percent, which would limit phytoplankton photosynthesis (González et al., 2013). The toxicity of oil is affected by weathering, and varies with temperature and light; the sensitivity of phytoplankton to oil toxicity may increase under these nutrient limited conditions. Additionally, some phytoplankton species are more tolerant of oil exposure than others, and the tolerance to low and high concentrations varies among species. Phytoplankton populations can change quickly on small temporal and spatial scales making it difficult to predict how a phytoplankton community as a whole would respond to an oil spill.

González et al. (2013) concluded that the assessment of the impact of oil spills on phytoplankton communities should not be a priority of environmental monitoring efforts after a spill, since impacts can be very subtle or even undetectable.

Zooplankton communities from coastal habitats (i.e., inlets, estuaries, enclosed bays) with restricted hydrodynamics are considered more susceptible to long-term effects. Planktonic communities also have a higher capacity for recovery from the effects of oil spill pollution over the long-term due to their short lifecycle and high reproductive capacity (Abbrian et al., 2011). Planktonic communities drift with water currents and recolonize from adjacent areas; these attributes and short life cycles of plankton facilitate relatively rapid recovery of the population following a disturbance. Several studies found that zooplankton communities reestablish several weeks to months after an oil spill, indicating a high capacity for recovery (Al Yamani et al., 1993; Varela et al., 2006).

The microbial community also can be affected by an offshore oil spill. Changes in the microbial community because of an oil spill could have substantial impacts on the rest of the marine ecosystem. However, several laboratory and field experiments and observations have shown that impacts to planktonic and marine microbial populations generally are short lived and do not affect all groups evenly, and in some cases stimulate growth of important species (González et al., 2009; Graham et al., 2010; Hing et al., 2011).

Benthic Invertebrates. The zooplankton community also contains free-floating embryos and larvae of invertebrates that inhabit the sediment as adults, including sea urchins, mollusks, and crustaceans. The planktonic stages of benthic invertebrates are more sensitive to pollutants than adults and their survival is critical to the long-term health of the adult populations (Anselmo et al., 2011; Bellas et al., 2013; Blackburn et al., 2014). The eggs and larvae of planktonic oysters exposed to oil show impaired development and decreased settlement of juveniles (Blackburn et al., 2014). A Blackburn et al. (2014) review of studies conducted after the *Prestige* oil tanker spill off the northwest coast of Spain reported that sea urchin embryo development was inhibited by as much as 50 percent when fuel oil content in the water was greater than 3.8 percent; that oil-polluted seawater collected from coastal sites was more toxic than contaminated sediment to embryos and larvae of bivalves and echinoderms; and that oil impaired the growth of sea urchin and oyster larvae and development of mussel embryos.

Impacts of oil to benthic invertebrates vary depending on life history, feeding behavior, and ability of a species to metabolize toxins (Blackburn et al., 2014). Oil would affect benthic communities as it washes ashore or as it sinks and becomes bound to sediments. Benthic invertebrates impacted by an oil spill can occur in habitats from the intertidal coastal areas to the barrier islands; some are mobile, while others are sessile. Oil and its weathered byproducts bind and become buried in sediment resulting in long-term persistence in the environment, increasing exposure time of benthic invertebrates (Blackburn et al., 2014; Peterson et al., 2003). Benthic invertebrates are susceptible to long-term exposure and can accumulate higher levels of sediment-bound contaminants (NRC, 2003; Peterson et al., 2003). Chronic exposure to oil and its byproducts can cause cellular damage and impair reproduction, growth, and development in marine invertebrates (Bellas, 2013; Blackburn et al., 2014). Benthic invertebrates exposed to hydrocarbons for long periods may accumulate higher levels of hydrocarbons than pelagic organisms (Blackburn et al., 2014). Exposure to hydrocarbons is amplified for invertebrates that are part of the pelagic zooplankton as embryos and larvae, and live in the sediment as adults. These life habits potentially lead to an increased risk of long-term population-level impacts as these species are exposed to oil in multiple habitats and life stages (Blackburn et al., 2014). Filter-feeding invertebrates such as mussels and oysters can ingest oiled organic particles and uptake oil dissolved in the water column, which then bioaccumulates in their tissues (NRC, 2003). Bellas et al. (2013) studied the impacts of weathered oil on sea urchins and mussels, and showed a progressive increase in oil toxicity with weathering over 80 days. Conversely, populations of invertebrates living within the sediments (e.g., polychaetes, nematodes, oligochaetes) have been shown to increase in areas where low concentrations of hydrocarbons are found (Blackburn et al., 2014; Jewett et al., 1999). Oil spills have been shown to result in a severe reduction or complete disappearance of amphipods and echinoderms, and the subsequent replacement by opportunistic polychaetes in oiled areas (Blackburn et al., 2014; Jewett et al., 1999). Hale et al. (2011) showed that deposit-feeding and burrowing benthic invertebrates are impacted by chronic exposure to hydrocarbons in polluted sediments and their populations can continue to fluctuate as they respond by building shallower burrows to avoid sediment-bound oil, leading to greater exposure on the surface, reduced mobility, and increased susceptibility to predation (Blackburn et al., 2014). The varying responses of benthic invertebrates to oil can lead to long-term alterations in the structure and biodiversity of benthic communities (Carls, Harris, and Rice, 2004; Jewett et al., 1999).

Blackburn et al. (2014) conducted a literature review of oil spill impacts to various invertebrates and reported the following findings:

- Echinoderms (e.g., sea urchins, sea stars, and sea cucumbers) can be particularly sensitive to oil with spills resulting in mass die-offs and strandings of adult sea urchins and sea stars. Early planktonic life stages exposed to oil may show impaired embryogenesis and larval growth.
- Mollusks (e.g., mussels, oysters, and snails) are highly sensitive to oil. Oil ingestion through filter-feeding results in bioaccumulation of hydrocarbons. The limited capacity of this group to metabolize oil leads to prolonged exposure and negatively affects feeding, growth, reproduction, embryo development, and immune response. Snails and limpets in intertidal rocky shores and estuaries have shown high levels of mortality after oil spills and reduced recruitment of juveniles for years afterwards, and sublethal concentrations impair their mobility, foraging behavior, and reproduction.
- Crustaceans (e.g., crabs, amphipods, lobsters, and shrimp) suffer substantially reduced populations and strandings after oil spills. Crustaceans can be exposed to oil that is buried in sediments for long periods of time, and chronic exposure can impair feeding, mobility, development, and reproduction.
- Polychaetes display complex and varied responses to oil pollution, including increases in abundance following the mortality of other invertebrates, rapid colonization of damaged habitat, and mortality resulting in reduced populations.

Summary and Conclusions for Small Spill Impacts

Overall, oil in open water can cause immediate mortality in zooplankton. In addition, because zooplankton includes immature stages of invertebrates that inhabit benthic habitats as adults, mortality may result in long-term decreases in abundance and changes in community composition. These early life stages are more sensitive to oil compared to adults, and thus zooplankton mortality has implications for recruitment of juveniles into existing adult populations. To compound the situation, benthic invertebrates also are affected adversely as adults by oil that is trapped and buried in sediments as well as mussel and oyster beds, where it can persist long-term.

Spills less than 1,000 bbl would still have some localized adverse effects to plankton and benthic organisms. Adverse effects to lower trophic species could be compounded for a spill 200 to 1,000 bbl (though only one spill 200 to 1,000 bbl is assumed for this analysis). Toxic effects on organisms (particularly early life stages) could occur in the immediate area of a spill. Even at low concentrations that are not directly lethal, some contaminants in oil can cause sublethal effects on sensory systems, growth, and behavior of invertebrates, or may be bioaccumulated.

For isolated small spills, which would be short-term and localized, minor impacts are expected to lower trophic organisms. Population-level effects would not likely be detectable for small, isolated accidental spills, especially if they are contained by the LDPI or ice and are cleaned up before they enter the water column. Chronic small spills that enter the water column may have a cumulative effect in the environment, which could lead to multi-generational, long-term effects on benthic communities. However, plankton is expected to repopulate the area via currents and no long-term impacts are expected. Over the life of the Proposed Action, the impacts from isolated small spills would be minor, but impacts from chronic small spills from the same location, such as the LDPI, could range up to moderate. The impacts from small spills could be minor to moderate. The disturbances and associated adverse impacts on lower trophic organisms from accidental spills may be reduced through the operating procedures required by regulatory agencies.

Large Oil Spills (Greater than or Equal to 1,000 bbl)

Although unlikely (Section 4.1.1.2; Appendix A, posted at www.boem.gov/liberty), for purposes of analysis, BOEM assumes that one large oil spill would occur during the life of the Proposed Action. A large oil spill can occur for many possible reasons, including equipment malfunction, pipeline breaks, or human error. Crude oil spills may occur directly from the proposed LDPI or a ruptured pipeline during development and production. Large oil spills could affect benthic and pelagic invertebrates depending on the location, volume, and trajectory of the spill and the time of year it occurs. Spilled oil would dilute slowly in ice-covered conditions, and more swiftly in open-water conditions. Local spill trajectory would depend on tide stage as well as wind and wave direction. In the unlikely event that a large oil spill occurred, the spill and the response would affect lower trophic organisms. The LDPI and pipeline are located within barrier islands, so even though large spills are unlikely, if they occur, the likelihood of contact with part of the shoreline is relatively high. Oil released from a wellhead or from a pipeline would affect plankton communities because they have no or limited ability to avoid contact with oil. Direct contact with oil would result in the uptake of toxic fractions, physical smothering, and possibly mortality (Blackburn et al., 2014). Results of post-spill studies of plankton communities following the DWH spill showed that oil and the biodegradation of oil can lead to indirect impacts such as inhibition of air-sea gas exchanges, reduced light penetration, and hypoxia resulting from accelerated hydrocarbon degradation (Abbrian et al., 2011; Ozhan, Parsons, Bargu, 2014).

A large spill (greater than or equal to 1,000 bbl), depending on the season and location, could be difficult to contain and could include lethal and sublethal effects on relatively large numbers of lower trophic level organisms. Lower trophic level organisms in Stefansson Sound and the surrounding region are represented in the OSRA model by ERAs that were identified as important habitat for lower trophic organisms (Appendix A posted at www.boem.gov/liberty, Table A-2-11); however, only ERAs 75 (Boulder Patch Area), 80 (Beaufort Outer Shelf 1), and 101 (Beaufort Outer Shelf 2) had any contact probabilities greater than or equal to 5 percent. All others had contact probabilities less than 5 percent and so will not be analyzed further. ERAs 80 and 101 have some instances where the probabilities of contact from a spill would be greater than or equal to 5 percent. Table 4-9 shows conditional probabilities of contact from a large spill in summer and winter, and the annual probability of contact. A summer spill (July 1 to September 30) has probabilities of 54 to greater than or equal to 99.5 percent of contacting ERA 75 based on the number of days spill constituents are permitted to persist in the environment and whether the spill originated at the LDPI (LI) or the offshore portion of the proposed pipeline (PL). Similarly, winter and annual probabilities for contacting ERA 75 were 55 to greater than or equal to 99.5 percent. Contact probabilities for ERAs 80 and 101 were generally less than 5 percent regardless of season, except after 90 and 360 days.

Table 4-9 Chance by Days of a Large Spill on LDPI or Pipeline Contacting a Given ERA*

ID	Environmental Resource Area Name	1 day		3 days		10 days		30 days		90 days		360 days	
		LI	PL	LI	PL	LI	PL	LI	PL	LI	PL	LI	PL
75	Boulder Patch Area (Annual)	>99.5	55	>99.5	57	>99.5	57	>99.5	57	>99.5	57	>99.5	57
75	Boulder Patch Area (Summer)	>99.5	54	>99.5	56	>99.5	56	>99.5	56	>99.5	56	>99.5	56
75	Boulder Patch Area (Winter)	>99.5	55	>99.5	57	>99.5	58	>99.5	58	>99.5	58	>99.5	58
80	Beaufort Outer Shelf 1 (Winter)	<0.5	<0.5	<0.5	<0.5	1	<0.5	3	2	5	3	5	3
101	Beaufort Outer Shelf 2 (Annual)	<0.5	<0.5	<0.5	<0.5	1	<0.5	3	2	6	3	6	3
101	Beaufort Outer Shelf 2 (Summer)	<0.5	<0.5	<0.5	<0.5	1	<0.5	4	3	6	4	6	4
101	Beaufort Outer Shelf 2 (Winter)	<0.5	<0.5	<0.5	<0.5	1	<0.5	3	2	5	3	5	3

Note: Chance of contact of a spill from LDPI (LI) or proposed pipeline (PL) is summarized by days elapsed since spill.

Effects of a large oil spill would be similar to those described for a small oil spill, but the area affected would be larger. The summer months are a period of peak primary productivity, and a large spill at the sea surface under the Proposed Action would result in mortality of plankton in the surface layer. However, the effects on plankton populations would not be measureable for long because of the rapid rate of production; phytoplankton and zooplankton populations are capable of doubling their biomasses within a few days and a couple of weeks, respectively. OSRA modeling indicates that a large oil spill originating from the LDPI would almost certainly impact the Boulder Patch. As with turbidity, limiting the amount of light available for primary production could have negative impacts on the Boulder Patch community, and recovery would be a long-term process. Compounding this with other effects of oil on lower trophic organisms could result in severe impacts to the Boulder Patch.

Large spills under the Proposed Action could affect the water column and benthic habitats offshore and along areas of coastline resulting in mortality of plankton and benthic communities. Depending on timing, duration, size, and location of a large spill, population-level impacts are not likely for plankton or benthic invertebrates, but a spill in the winter would result in a longer recovery period for plankton. Regardless of season, oil reaching the shoreline would result in long-term persistent impacts to benthic invertebrates in the oiled area. A large spill could affect large numbers of benthic invertebrates, and important habitat like the Boulder Patch. Heavy oiling through direct contact with a spill would likely result in mortality, while lightly oiled lower trophic level organisms may experience a variety of lethal or sublethal effects. Outside of the Boulder Patch, benthic and planktonic organisms live in an environment that is affected by ice scouring and changing salinity on an annual basis; a relatively quick recovery to benthic communities is expected. However, the impacts of a large spill would be widespread. Overall, impacts to lower trophic level organisms outside of the Boulder Patch from a large spill would be moderate and would depend on the timing, location, and environmental conditions affecting weathering of the oil. The Boulder Patch, given its long recovery time and the impacts of oil exposure on benthic organisms, would have major impacts if a large oil spill were to contact the area.

The Proposed Solid Ice Condition (Section 2.5.1) would shift much of the risks associated with a large oil spill from summer months to winter months. A large spill which occurred during the solid ice conditions of winter would likely have less impacts to lower trophics than a summer spill into open water, because a spill during solid ice conditions would disperse over a smaller area and be more easily cleaned up. Restricting reservoir drilling to winter months would also extend the time period required to complete the overall drilling program, but as drilling would be occurring when lower trophic productivity is lower, and when spills are more easily contained and cleaned up, the additional few months to couple of years of drilling activity would not meaningfully increase or decrease impacts from an oil spill to lower trophic organisms.

Spill Response Activities

Spill response activities could include mechanical recovery methods and in-situ burning of spilled materials. Increased vessel traffic, with corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations.

Planktonic organisms, such as zooplankton (including fish and invertebrate larvae) and phytoplankton, may be affected by mechanical recovery of spilled material, as they are located in the water column and are generally unable to move away from oil without a current, which would carry the spilled material with it. Physical damage from containment and collection procedures could also occur. Lethal impacts may occur to individuals, but would not be at the population level. These effects of mechanical recovery would be short-term and localized to the spill area. Benthic organisms would not likely be affected by mechanical recovery activities occurring at the surface. The effects of mechanical recovery on lower trophic organisms would be minor.

In-situ burning of spilled oil is used to remove oil from the surface and could impact lower trophic organisms in the immediate area due to residue from the burn sinking to the bottom. Death of planktonic organisms is expected in the area of the burn. At the seafloor, residue from a burn can sink and smother benthic organisms. These effects are expected to be short-term and localized to the immediate burn area, and would be considered minor.

Spill impacts and cleanup operations would be influenced by time of year. An oil spill occurring into ice may persist for a longer period of time than during ice-free conditions (Buist et al., 2008; Payne, McNabb, and Clayton, 1991). Should oil be trapped and persist in the environment, the effects on lower trophics would be expected to be greater than for summer response efforts. Natural processes would aid the degradation of the oil and gas released during a large spill, but at a slower rate than in warmer summer waters. Under calm conditions and cold temperatures in restricted waters, vertical mixing and dissolution would be reduced (Buist et al., 2008). A large spill occurring on or under ice would be trapped and persist until the ice melted, allowing the spill to disperse (Drozdowski et al., 2011), and trapped oil can be transported by currents to areas more distant from the site of the accidental spill. Volatile components of the spill would be more likely to freeze into the ice rather than evaporate. Response efforts would be hindered and aided by the presence of ice. Ice would contain a spill (reduce spreading), concentrate it, and may act as a barrier to shoreline oiling. However, ice may also make a spill difficult to detect, locate, and access. Oil trapped under the ice may persist longer in the environment than oil spilled in open water, and have a greater impact on lower trophic organisms.

These effects could be long-lasting and widespread for both the plankton and benthic communities if a large spill occurs, while impacts from a small spill would be localized. Effects are unlikely to be population-level, though, as planktonic communities can quickly recover, and benthic community impact would be limited spatially by the settling of oil.

4.3.1.2 Conclusion for the Proposed Action

None of the routine activities associated with the Proposed Action discussed previously, which includes isolated small spills, would have impacts that are long-term and widespread. These individual impacts would be isolated with little spatial or temporal overlap, therefore the additive impacts to lower trophic organisms from routine activities associated with the Proposed Action would be primarily short-term and localized, and thus minor. While the LDPI itself would be a long-term presence, impacts would have little to no impacts on benthic, epontic, and pelagic communities, and would eventually be eliminated. Impacts from isolated small oil spills on lower trophic organisms outside of the Boulder Patch are also expected to be minor. Impacts from chronic small spills, or in the event of a large spill, impacts could range up to moderate. Impacts to the Boulder Patch, considered as a subset of the lower trophic organisms, from routine activities are expected to be moderate because of long-term impacts to its community structure; recovery is expected to take at least a decade. Impacts from a small spill to the Boulder Patch would have moderate impacts, and large spills would have major impacts.

4.3.1.3 Alternative 2 (No Action)

Under Alternative 2, the Proposed Action would not occur, and the impacts to the Boulder Patch or lower trophic organisms in Stefansson Sound described above would not occur.

4.3.1.4 Alternative 3 (Alternate LDPI Locations)

4.3.1.4.1 Alternative 3A: Relocate LDPI Approximately One Mile to the East

Potential impacts on lower trophic communities under Alternative 3A would be similar to those described for the Proposed Action. The footprint of the proposed LDPI would increase and the pipeline would be longer, which would affect the area vulnerable to crushing and smothering, and could slightly increase the size of the sediment plume. This location would increase the distance between the LDPI and the Boulder Patch, likely resulting in a decrease in impacts to Boulder Patch resources from sedimentation and turbidity. In general, the types of impacts on lower trophic organisms would remain the same, and the increase in footprint size would not change the overall impact designation on invertebrates outside of the Boulder Patch from minor. Impacts to the Boulder Patch may decrease slightly, although the increase in sedimentation from the new proposed LDPI size could still allow sedimentation to reach the Boulder Patch. The overall impacts to the Boulder Patch under this alternative would depend on the extent of the sediment plume.

4.3.1.4.2 Alternative 3B: Relocate LDPI Approximately 1.5 Miles to the Southwest

Potential impacts under Alternative 3B would be similar to those described for the Proposed Action (Alternative 1). However, the footprint of the proposed LDPI would decrease and the pipeline would be shorter, which would affect the area vulnerable to crushing and smothering, and could slightly decrease the size of the sediment plume. Less gravel would be needed to construct the LDPI. This location would increase the distance between the LDPI and the Boulder Patch by 1.5 miles, resulting in a decrease in impacts to Boulder Patch resources from sedimentation and turbidity. In general, the types of impacts on lower trophic organisms would remain the same, and the decrease in footprint size would not change the overall impact designation on invertebrates outside of the Boulder Patch. Impacts to the Boulder Patch are likely to decrease, as the sediment plume would be smaller and originate farther away from the Boulder Patch area.

4.3.1.5 Conclusion for Alternatives 3A and 3B

Alternative 3A: Impacts of Alternative 3A on lower trophic organisms outside of the Boulder Patch would be essentially the same as those for the Proposed Action: minor for routine activities, minor to moderate for small spills, and moderate for a large spill. Impacts of Alternative 3A on the Boulder Patch may be less significant than the impacts for the Proposed Action: minor to moderate for routine activities, moderate for small spills, and major for a large spill.

Alternative 3B: Impacts of Alternative 3B on lower trophic organisms would be essentially the same as those for the Proposed Action: minor for routine activities, minor to moderate for small spills, and moderate for a large spill. Impacts of Alternative 3A on the Boulder Patch are likely to be less significant than the impacts for the Proposed Action: minor (potentially moderate) for routine activities, moderate for small spills, and major for a large spill.

4.3.1.6 Alternative 4 (Alternate Processing Locations)

4.3.1.6.1 Alternative 4A: Relocate Oil and Gas Processing to Endicott

Potential types of impacts on lower trophic organisms under Alternative 4A would be similar to those described for the Proposed Action. The pipeline would go to Endicott instead of the shore and would be in close proximity to the Boulder Patch (Figure 2-19). Sediment from pipeline trenching would be produced closer to, or even in, the Boulder Patch, which increases the amount of habitat disturbance to impact the resource. This may increase the amount of habitat disturbance to impact the resource, and would result in a more widespread effect than the Proposed Action. The footprint of the proposed LDPI would decrease, which would affect the area vulnerable to crushing and smothering, and could slightly decrease the size of the sediment plume from the LDPI. However, the size of the trench needed to contain a multi-phase pipeline could increase the impacts as compared to the Proposed Action. The types of impacts expected would remain the same, and the change in effects would not change the overall impact designation on lower trophic organisms outside of the Boulder Patch. However, the Boulder Patch impacts would likely be long-term and widespread.

4.3.1.6.2 Alternative 4B: Relocate Oil and Gas Processing to a New Onshore Facility

Potential impacts on lower trophic organisms and the Boulder Patch under Alternative 4B would be similar to those described for the Proposed Action. The footprint of the proposed LDPI would decrease, which would affect the area vulnerable to crushing and smothering, and could slightly decrease the size of the sediment plume. This onshore production facility would have negligible impact to marine, nearshore, and Boulder Patch resources as it would be located entirely on land. In general, the types of impacts on lower trophic organisms and the Boulder Patch would remain the same or be reduced slightly in magnitude. The overall impact designation would not change.

4.3.1.7 Conclusion for Alternatives 4A and 4B

Alternative 4A: Impacts of Alternative 4A on lower trophic organisms outside of the Boulder Patch would be essentially the same as those for the Proposed Action: minor for routine activities, minor to moderate for small spills, and moderate for a large spill. Impacts of Alternative 4A on the Boulder Patch would differ from impacts for the Proposed Action: major for routine activities, moderate for small spills, and major for a large spill.

Alternative 4B: Impacts of Alternative 4B on lower trophic organisms would be essentially the same as those for the Proposed Action: minor for routine activities, minor to moderate for small spills, and moderate for a large spill. Impacts of Alternative 3A on the Boulder Patch may be smaller than the impacts for the Proposed Action: minor to moderate for routine activities, moderate for small spills, and major for a large spill.

4.3.1.8 Alternative 5 (Alternate Gravel Sources)

Potential impacts on lower trophic organisms and the Boulder Patch under Alternative 5 would be similar to those described for the Proposed Action. Although the location of the gravel mine would change, the types of impacts would remain the same and would not change the overall impact designation on marine lower trophics organisms or the Boulder Patch community.

4.3.1.9 Conclusion for Alternative 5

Impacts of Alternative 5 on lower trophic organisms outside of the Boulder Patch would be essentially the same as those for the Proposed Action: minor for routine activities, minor to moderate for small spills, and moderate for a large spill. Impacts of Alternative 5 on the Boulder Patch would be essentially the same as those for the Proposed Action: moderate for routine activities, moderate for small spills, and major for a large spill.

4.3.2 Fish

4.3.2.1 The Proposed Action

4.3.2.1.1 Development

In the marine and estuarine environment, habitat alteration and seafloor disturbance would occur during development of the Proposed Action. Creation of the LDPI and pipeline trenching would affect benthic and pelagic fish species. Noise impacts are expected to occur during development of the LDPI as a result of proposed LDPI armoring activities, vessel traffic, gravel deposition, and pipeline laying. During construction at the LDPI, there would be no discharges of sanitary and domestic wastewater, potable water treatment reject wastewater, or STP wastewater. HAK anticipates discharging construction dewatering and secondary containment dewatering intermittently during construction activities. In the freshwater environment, anadromous fish present in the area of the gravel mine may be impacted by noise as a result of mining activities. Construction of ice roads may impact freshwater fish through water withdrawals from lakes, mines, or ponds.

4.3.2.1.2 Production

Production activities for the Proposed Action would take place on the LDPI, in the marine environment, and onshore. Habitat alteration is generally not expected to occur during production, as production activities are based on the proposed LDPI and do not require changes to the seafloor. Noise impacts would still be present from sources such as maintenance geohazard surveys of the pipeline, and vessel traffic. Physical presence of the LDPI may affect benthic and pelagic species present in the nearshore Beaufort Sea. Water intake structures could affect small marine pelagic fish, larvae, and eggs (impacts are discussed in Section 4.3.1.1.4). Freshwater fish may be impacted by water withdrawals for ice road construction. As discussed in Section 3.2.2, the current fish community may be altered by climate change processes, and though the impacts may intensify, they are not expected to differ from those described below.

4.3.2.1.3 Decommissioning

The removal of the LDPI would result in habitat alterations. The subsea pipeline would be flushed of all contaminants, ends cut and sealed, and abandoned in place, and decommissioning activities associated with it are not expected to impact fish. Onshore decommissioning activities may impact freshwater fish by creation of overwintering and freshwater habitat. Mine rehabilitation may provide habitat for freshwater and anadromous fish.

4.3.2.1.4 Habitat Alteration

Gravel deposition during LDPI creation would alter the seafloor habitat and could crush benthic fish species resulting in injury or mortality to individual fish present in the 24-acre footprint. Pipeline trenching and potential maintenance activities on the trenched backfill would also disturb the seafloor and would disturb habitat for benthic species. Fish are mobile animals and are expected to leave the area of disturbance, which would decrease the number of individuals that are affected by gravel placement and pipeline laying. Removal of the armor plating on the LDPI during decommissioning would result in complete removal of habitat for any species that had colonized the LDPI during the production life of the Proposed Action. As a result of gravel deposition, adult and juvenile fish are expected to exhibit avoidance behaviors in relation to construction activities, which would decrease the number of individuals that could be injured or killed by LDPI creation. Avoidance behavior would likely cease shortly after the disturbance was completed. The habitat available in the area of the LDPI would be different from the rest of Stefansson Sound, but may still be usable to some fish species. Fish eggs and larvae are generally unable to exhibit avoidance behaviors. Any fish eggs or larvae present during construction activities would likely be killed or injured. Gravel deposition is expected to be a short-term activity and limited to the footprint of the LDPI and pipeline, although the proposed LDPI can be considered a long-term alteration to the overall habitat to Stefansson Sound.

Gravel deposition and pipeline trenching is expected to increase turbidity temporarily as sediments on the seafloor are suspended in the water column. Localized increases in turbidity and a turbidity plume are expected around the proposed LDPI and pipeline path. The plume is expected to move offshore, away from the Sagavanirktok River (Figure 4-1); (Coastal Frontiers Corporation, 2014). This could affect marine benthic and pelagic species by decreasing visibility, which impacts both predator and prey interactions (De Robertis et. al., 2003), and also by potentially clogging gills. In the ice-covered season when construction activities are mostly occurring, the sediment plume is expected to be limited by the low currents and ice bonding of silt (Toimil and England, 1982; Newbury, 1983). Currents during the open-water season are higher due to greater impacts from winds (Trefry, et al., 2009), and so the area affected by elevated turbidity would increase. Monitoring of turbidity from previous gravel island constructions in the Beaufort Sea showed increased turbidity around installations during the summer, but detection of increased suspended sediments was unlikely beyond 1,640 feet from the site (Coastal Frontiers, 2014). Turbidity is likely to return to ambient levels once construction activities are completed; for the majority of the life of the project, local turbidity would not be increased. During the production phase, localized turbidity would likely be increased above ambient levels as a result of TSS concentrations in the ongoing STP discharge. However, any elevated TSS or turbidity is expected to quickly disperse to background levels by local currents and tides. Decommissioning activities are expected to increase the turbidity through resuspension of sediments as the proposed LDPI is worn away by currents. Impacts on fish from changes in turbidity are expected to be short-term and localized.

Ice habitat would be affected by cutting excisions in the ice to allow for gravel deposition. This could impact the feeding habitat of ice-associated fish species, such as Arctic cod (Lonne and Gullikson, 1989; Gradinger and Bluhm, 2004) by removing and eliminating ice ridges where these fish feed, though there is a large area of other available ice habitat.

Construction of ice roads may impact some freshwater fish habitat by altering the environment of the ponds, lakes, or abandoned gravel mines. Use of ice roads would take place outside of the aquatic environment, and would have a negligible impact on fish resources. Cott et al. (2008) analyzed the effects of water withdrawal from ice covered lakes on fish and found that impacts vary depending on the individual lake. However, some lakes showed decreases in overwintering habitat and oxygen levels. The impacts of water withdrawal as part of the Proposed Action may have localized adverse impacts to fish resources, should they be present in lakes used for this purpose, but the number of lakes or ponds impacted is relatively small compared to the amount of tundra lake habitat available in the region. Impacts in individual lakes may last longer than a year. Eventually, lakes would be expected to be recolonized by common fish species through flooding events. Reuse of the same pond for water each year would decrease the number of ponds affected for the life of the project. The effects of water withdrawal for ice road construction would be localized and less than severe.

The gravel mine, if located where fish are present in the surrounding waterbodies, may impact some overwintering freshwater and anadromous species, such as humpback and broad whitefish, ciscos, suckers, Dolly Varden, and sticklebacks through mining activities. Disturbances could include habitat degradation. If the mine site is rehabilitated in such a way that flooding could introduce fish species, these species may benefit from habitat expansion at this location.

Marine fish species (considering all life stages) that would be most affected by habitat alteration in the Proposed Action include capelin, Arctic cod, saffron cod, starry flounder, Alaska plaice, and Bering flounder, Arctic alligatorfish, and Pacific sand lance. Estuarine, migratory, and anadromous species (considering all life stages) that would be most affected nearshore and in tidal riverine areas include: capelin, least cisco, Bering cisco, broad whitefish, humpback whitefish, Arctic cod, saffron cod, Arctic char, Dolly Varden, pink salmon, chum salmon, and ninespine stickleback.

Overall, the initial construction of the LDPI would have the most adverse impact on fishes through habitat alteration. These impacts are not expected to have a population level effect, as adult and juvenile fish are mobile and expected to avoid the area during construction activities, thus decreasing the number of individuals that are impacted by crushing, smothering, or increased turbidity. Once the proposed LDPI is in place and construction activities are over, fish are expected to eventually return to normal use of the area. The proposed LDPI itself may mitigate adverse impacts by providing habitat for species that prefer hard-bottom substrates. Although the general habitat alteration impacts are expected to be relatively long-term, they would be less than severe and extremely localized to the proposed LDPI and gravel mine sites.

Noise

Fish rely heavily on sensory perceptions of sound and pressure for many activities vital for survival, such as feeding, navigation, spatial orientation, predator avoidance, and communication. Hearing loss can occur in fish from continuous (i.e., drilling) or impulsive sound (i.e., pile driving, seismic surveys) (Halvorsen et. al., 2012). Injury to the auditory nerve, hair cells, or swim bladder can be temporary or permanent. There could be chronic behavioral and physiological effects to fish at less intense sounds, and acute effects for individuals within a few yards of a sound source. If recovery from physical injury is slow or does not occur, fitness would be reduced and individuals would be more susceptible to physiological dysfunction, disease, and predation. Behavioral impacts may occur including balance disturbance; disoriented swimming behavior; increased swimming speed; disruption or tightening of schools; disruption of hearing; interruption of important biological behaviors (e.g., feeding, reproduction); shifts in the vertical distribution; and occurrence of alarm and startle behaviors (Dalen and Knutsen, 1987; McCauley, Fewtrell, and Popper, 2003; Pearson, Skalski, and Malme, 1992). Gravel mining and trucking of materials on ice produce enough sound to cause avoidance behaviors in sensitive-hearing fish species near ice roads and in Arctic lakes (Stewart, 2003; Mann, Cott, and Horne, 2009). Noise generated by geohazard seismic surveys could affect fish through several pathways, including interference with sensory orientation and navigation, decreased feeding efficiency, disorientation, scattering of fish away from a food source, and redistribution of fish schools and shoals (Purser and Radford, 2011; Slabbekoorn et al., 2010).

During construction and production, a potential stationary zone of displacement would likely be created around the LDPI by noise-related avoidance behaviors. In the short-term, these sounds may frighten, annoy, or distract a fish and lead to physiological and behavioral disturbances, which in turn can lead to reduced fitness of individual fish. Over the long-term, this impact could be naturally mitigated by habituation of fish to the noise produced by the drilling activity. Because drilling noises would be somewhat regular in type and source, it is possible that some fish species may become habituated to them and the zone of displacement may be reduced over time. Geohazard surveys to maintain the pipeline may cause damages to fish and fish larvae that are close to the noise source (Halvorsen et. al., 2012; Hawkins and Popper, 2012). However, it is expected that fish would exhibit immediate avoidance behaviors and these geohazard surveys would be infrequent, which would decrease the number of individuals affected. Mining activities, use of ice roads, and sea ice excision may elicit startle responses or avoidance behaviors in freshwater and estuarine fish. Vessel traffic may result in noise-related impacts, such as startle or avoidance behaviors, as described above.

The noises produced by the Proposed Action could affect fish, causing them to leave the source location or adjacent area. Some fishes are of greater concern due to their distribution, abundance, trophic relationships, or vulnerability in relation to noise and seismic emissions, including:

- migratory fishes that are abundant seasonally in the nearshore zone that could be deterred or obstructed in reaching their reproductive feeding grounds, especially Arctic char, least cisco, and broad whitefish;
- fishes known to be particularly important in the trophic food web, including Arctic cod; and
- Pacific salmon in their marine and estuarine migration and staging periods of life due to their broad distribution and exposure to sound over their entire life cycles.

Migratory species at risk of spawning delays or disruptions include Pacific salmon (mainly pink and chum salmon), cisco, and broad whitefish. Arctic cod and sculpins are hearing specialists and are some of the most acoustically sensitive species occurring in the area. They are, therefore, some of the most likely fishes to exhibit displacement and avoidance behaviors due to noise and seismic activities.

Estuarine and freshwater fish would be affected by vessel and construction noise, and could include species such as least cisco, Bering cisco, broad whitefish, humpback whitefish, Arctic cod, Arctic char, Dolly Varden, pink salmon, chum salmon, ninespine stickleback, Arctic flounder, and capelin.

Noise related impacts are expected to occur during development, production, and decommissioning phases. Physical and behavioral effects on fish and fish prey may occur as a result of construction, drilling, and ancillary activities, including geohazard seismic surveys. Construction activities and eventual removal of the armor plating of the LDPI would result in noise impacts. Vessel traffic, including use of ice roads, would produce noise that may affect fish in the area. These impacts are not expected to have a population level effect as adult and juvenile fish are mobile and are expected to avoid the louder, infrequent sounds, and to attenuate to the constant noises (i.e., drilling). However, noises present during spawning or migratory periods may have a greater impact on some fish species. In general, sound impacts are expected to be temporary and localized to the proposed LDPI and pipeline.

Physical Presence

Numerous vessel roundtrips would occur between the offshore facilities and the onshore facilities in open-water months during the life of the Proposed Action, especially during the development years (see Table 2-3). Fish species in the coastal and marine environments could be disturbed by the presence and passing of vessels during roundtrips from the proposed LDPI during the open-water season. Vessels cause a path of physical disturbance that could affect the behavior of fish species. Free-swimming fish in the immediate vicinity of such vessels are expected to avoid vessels. Pressure waves from vessel hulls could displace fish and cause injury or mortality to non-swimming and weak swimming fish life stages and fish prey (Hawkins and Popper, 2012). Additionally, one to two barge trips per year may transit through Dutch Harbor, and would occur in areas outside of the region described in Section 3.2.1. Impacts from these limited barge trips to the Beaufort Sea are the same as described in the BOEM Chukchi Sea Planning Area Lease Sale 193, Second SEIS (USDOI, BOEM, 2015).

The proposed LDPI, once constructed, could provide hard substrate habitat for some fish species. Existing information on fish attracting devices indicates that fish species are attracted to offshore structures (Fabi et al., 2004; Franks, 2000) because of the additional hard substrate habitat they provide for invertebrates, and protective habitat for finfish. The LDPI would occupy the entire water column, from the seafloor through the splash zone. The effects of the presence of the proposed LDPI may provide additional sheltering areas for fish or could attract predators (Fujii, 2015). Lights on the proposed LDPI during all phases may attract fish prey and predators (Shaw et al., 2002).

Many public comments raised the concern that the physical presence of the LDPI could also cause obstruction to movement for some fish species. A study on fish movement before and after Endicott showed that the construction of the island and causeways did not cause changes in fish movement (Craig and Griffiths, 1981; Schmidt et al., 1991). Arctic cisco young-of-the-year are carried into the

US Beaufort Sea from the Mackenzie River by winds and wind-driven currents (Schmidt et. al. 1991; Gallaway et al., 1983). The proposed LDPI is unlikely to interfere with these movements, as the waves and currents are expected to go around the proposed LDPI, and the proposed LDPI would not prevent movement to and from Stefansson Sound. The presence of the pipeline is expected to have little to no impact on fishes, as it would be buried (marine) and/or stationary (onshore). The impact from physical presence of the LDPI would gradually disappear during decommissioning as the gravel is carried away by currents, but that process would take many seasons. Although the proposed LDPI is a long-term addition to Stefansson Sound, fish are expected to habituate to it after initial construction has been completed.

EPA's NPDES permit requires HAK to develop and implement a BMP Plan to minimize the entrainment and impingement mortality of fish and shellfish. Specifically, the NDPES permit requires HAK to "select and implement seawater intake structure design and construction technologies or operational measures for minimizing entrainment and impingement mortality of fish and shellfish." This requirement is consistent with the Cooling Water Intake Regulations found at 40 CFR Part 125.84(c)(4), which regulates cooling water intake facilities with design flows greater than 2 MGD. Although the proposed STP facility would not be designed for cooling purposes, it would withdraw approximately 4.4 MGD, and, without proper design controls, could have the potential to cause entrainment and impingement mortalities. Compliance with these NPDES permitting requirements would minimize the effect of water intake structures on all life stages of fish and shellfish, and plankton.

The wastewater discharges associated with the LDPI consist of conventional pollutants, which are designated under Section 304(a)(4) of the CWA as BOD, TSS, pH, fecal coliform, and oil and grease. These conventional pollutants are not expected to bioaccumulate or persist in the environment. With the exception of the ongoing discharges from the STP during the life of the project, all other authorized discharges would be temporary, short-term, and would produce negligible impacts.

Pollutants not classified as conventional or toxic, such as temperature, are considered to be "nonconventional." The potable water treatment (Outfall 001B) and the STP (Outfall 002) processes may result in elevated temperatures in the effluent, as compared to the ambient receiving waterbody conditions. To ensure those discharges would not result in an unreasonable degradation of the marine environment, the NPDES permit requires weekly temperature monitoring of the influent and effluent for those systems.

Additionally, wastewater discharges from the potable water treatment system and the STP may contain trace amounts of chemicals. HAK has indicated that both systems may require the use of maintenance chemicals, such as biocides, clarifying agents, descalers, and/or chlorination/ dechlorination chemicals. The STP has been designed to minimize the release of these chemicals to the environment and the potable water treatment reject wastewater is expected to be disposed of through the disposal well. However, the NPDES permit requires whole effluent toxicity testing semi-annually and quarterly on effluent samples from the potable water treatment reject wastewater and the STP, respectively, during periods when chemicals are used and when the applicable waste streams are discharged to surface waters. It is expected that the discharged water would rapidly dilute, mixing to background levels. Effects of water intake and discharge would be localized to the LDPI and are not expected to have population-level impacts. Impacts to the Boulder Patch from water intake and discharges are expected to be negligible. Marine fish species (considering all life stages) that would be most affected by the physical presence of components of the Proposed Action offshore include capelin, least cisco, Bering cisco, broad whitefish, humpback whitefish, Arctic cod, saffron cod, Arctic char, Dolly Varden, pink salmon, chum salmon, ninespine stickleback, Arctic alligatorfish, and Pacific sand lance. Estuarine, migratory, and anadromous species (considering all life stages) that would be most affected nearshore and in tidal riverine areas include capelin, least cisco, Bering cisco, broad whitefish, humpback whitefish, Arctic cod, saffron cod, Arctic char, Dolly Varden, pink salmon, chum salmon, ninespine stickleback, starry flounder, Alaska plaice, and Bering flounder.

Fish would be affected by the physical presence of vessels, the LDPI, and pipelines in the marine and coastal environments. The LDPI may affect the movements of individual fish and larvae. The physical presence of ice roads used for winter construction activities is not expected to impact marine, estuarine, or freshwater fish resources, aside from noise, as fish would be located in overwintering locations and not on the direct path of the ice road. Habitat alteration impacts from the presence of the LDPI would span at least three decades, while habitat alteration from the pipeline would not last quite as long. Additionally, the NPDES-permitted waste streams are expected to result in negligible to minor impacts to fishes through habitat alteration. General impacts of the LDPI presence are expected to be temporary and localized.

Oil Spills

Accidental events could include small (less than 1,000 bbl) and large (greater than or equal to 1,000 bbl) spills stemming from the LDPI or the pipeline. Accidental discharge of oil can occur during development, production, or decommissioning. Small and large oil spills are considered accidental events, and the CWA and OPA 90 include regulatory and liability provisions designed to reduce damage to natural resources from oil spills. A Solid Ice Condition could reduce the risk of spills occurring in open-water conditions during the initial drilling phase of the project. A large spill during solid ice conditions would be easier to contain and clean up, and would reduce the impacts to fish.

Small Oil Spills (Less than 1,000 bbl)

Many factors determine the degree of damage from a spill on fish, including the size and duration of the spill, geographic location of the spill, and season. In whatever quantities, accidental oil spills can affect fish and their habitats. For much of the year, Stefansson Sound is covered in first year ice. Small spills are expected to be contained on either the LDPI or landfast ice. Clean up of oil spills before they enter the water column would mitigate the impacts of oil spills on fish. In open-water conditions, where the oil may reach the water column, small spills tend to evaporate and disperse within the first few days in the marine environment, although a small proportion of the heavier fuel components could adhere to particulate matter in the upper portion of the water column and sink. Spills less than 1,000 bbl could still have some localized adverse effects to fish. Adverse effects to fish species could be compounded for a spill 200 to 1,000 bbl (though only one spill 200 to 1,000 bbl is assumed for this analysis). Toxic effects on fish (particularly early life stages) could occur in the immediate area of a spill. Even at low concentrations that are not directly lethal, some contaminants in oil can cause sublethal effects on sensory systems, growth, and behavior of fish, or may be bioaccumulated. A pipeline rupture over land could impact freshwater and anadromous fish resources, depending on where the rupture occurred.

Small spills may adversely affect individual fish prey organisms. It is likely that individuals (e.g., prey organisms, eggs, larvae) encountering oil, even at low concentrations, could suffer deformities or mortality. Arctic cod, an important keystone fish species in the Arctic, has been shown to have especially high sensitivity to oil pollution when exposed as eggs (Nahrgang et al., 2016). These effects on the food chain could have indirect effects on larger predatory fish by reducing the available prey base and foraging opportunities for predators.

Chronic small oil spills could have an adverse effect on fish because residual oil can build up in sediments and affect living marine resources. Low levels of PAHs from chronic pollution can accumulate in salmon tissues and cause lethal and sublethal effects, particularly at the embryo stage. Effects on fish from low-level chronic exposure may increase embryo mortality, reduce marine growth (Heintz et al., 2000), or increase straying away from natal streams by returning adults (Wertheimer et al., 2000).

For isolated small spills, which would be short-term and localized, minor impacts are expected to pelagic and demersal fish. Although impacts to individual organisms could be lethal, population-level effects would likely not occur for small, isolated accidental spills, especially if they are contained by the LDPI or ice and are cleaned up before they enter the water column. Chronic small spills that enter the water column may have a cumulative effect in the environment, which could lead to multi-generational, long-term effects on fish communities. Over the life of the Proposed Action, the impacts from small spills on fish resources could be moderate. The disturbances and associated adverse impacts on fish from accidental spills may be reduced through the operating procedures required by regulatory agencies. Potential spill impacts would be reduced by incorporation of a Spill Prevention, Control, and Countermeasure Plan into LDPI operations.

Large Oil Spills (Greater than or Equal to 1,000 bbl)

Although unlikely, for purposes of analysis, BOEM assumes that one large spill would occur during the life of the Proposed Action. A large oil spill can occur from many possible sources including equipment malfunction, pipeline breaks, or human error. Crude oil spills may occur directly from the low density polyethylene or a ruptured pipeline during development and production. A pipeline rupture over land could impact freshwater and anadromous fish resources, depending on where the rupture occurred. Large oil spills could affect marine, estuarine, and tidal riverine fish species depending on the location, volume, and trajectory of the spill and the time of year it occurs. Spilled oil would dilute slowly in ice-covered conditions, and more swiftly in open-water conditions. Local spill trajectory would depend on tide stage as well as wind and wave direction. In the unlikely event that a large oil spill occurred, the spill and the response would affect fish populations.

Although oil is toxic to fish at high concentrations, certain species are more sensitive than others, and oil can have toxic effects even in low concentrations. Pelagic and demersal fish adults, juveniles, eggs, and larvae would be exposed, and there could be acute effects on these various life stages for the fish species in the area. In general, the early life stages of fish (eggs and larvae) are most sensitive, juveniles are less sensitive, and adults least so (Rice et al., 2000). Accidental spills into the water column could cause a direct adverse impact on water quality as well as adverse impacts on pelagic fish and larvae. Strong-swimming demersal and pelagic fish that are exposed to oil spills in the upper water column may be capable of swimming away from oil slicks. Eggs, larvae, and juvenile stages of fish in the water column would have continued exposure to oil due to their inability or limited ability for motility.

Migratory fish, such as whitefish and Pacific salmon, could be affected adversely by a large oil spill in spawning and rearing habitats. Other biologically important fish in the area that could be impacted by oil spills include Arctic cod, capelin, sculpins, sticklebacks, and snailfish (Morrow, 1980; Jarvela and Thorsteinson, 1999; Craig, 1984). Effects of oil spills in nearshore intertidal areas could persist for generations and might have multiple effects by affecting more than one life stage. The overall effects of individual spills on fish would be somewhat contained within Foggy Island Bay because of the barrier islands.

The LDPI and pipeline are located within barrier islands, so even though large spills are unlikely, if they occur, the likelihood of contact with part of the shoreline is relatively high. The effects of oil spills, as described previously, could include the mortality of adult and juvenile fish as well as lethal and sublethal effects to eggs and the juvenile stages of fish.

Table 4-10 Chance of a Large Spill on LDPI or Pipeline Contacting a Given ERA or LS (Conditional)

ID	Environmental Resource Area or Land Segment Name	1 day		3 days		10 days		30 days		90 days		360 days	
		LI	PL	LI	PL	LI	PL	LI	PL	LI	PL	LI	PL
ERA 85	Sagavanirktok River Delta (Annual)	38	39	55	49	61	54	62	54	63	54	63	54
ERA 85	Sagavanirktok River Delta (Winter)	37	38	53	47	59	52	61	53	61	53	61	53
ERA 88	Simpson Lagoon (Annual)	<0.5	<0.5	<0.5	<0.5	3	1	5	2	6	3	6	3
ERA 88	Simpson Lagoon (Winter)	<0.5	<0.5	<0.5	<0.5	4	1	5	2	6	2	6	2
LS 104	Prudhoe Bay, Heald Pt. (Annual)	1	<0.5	3	1	4	2	5	2	5	2	5	2
LS 104	Prudhoe Bay, Heald Pt. (Summer)	1	<0.5	3	1	5	2	5	2	5	2	5	2
LS 105	Point Brower, Sagavanirktok River, Duck I. (Annual)	14	13	24	19	28	21	29	21	29	22	29	22
LS 105	Point Brower, Sagavanirktok River, Duck I. (Summer)	17	15	27	21	32	24	33	24	33	24	33	24
LS 105	Point Brower, Sagavanirktok River, Duck I. (Winter)	14	13	23	18	27	20	28	21	28	21	28	21
LS 106	Foggy Island Bay, Kadleroshilik River (Annual)	6	37	17	47	21	50	21	50	21	50	21	50
LS 106	Foggy Island Bay, Kadleroshilik River (Summer)	6	37	17	48	20	49	20	49	20	49	20	49
LS 106	Foggy Island Bay, Kadleroshilik River (Winter)	6	36	17	47	21	50	22	50	22	50	22	50
LS 107	Tigvariak Island, Shaviovik River (Annual)	1	1	5	4	7	5	7	6	7	6	7	6
LS 107	Tigvariak Island, Shaviovik River (Summer)	1	1	4	3	5	4	5	4	5	4	5	4
LS 107	Tigvariak Island, Shaviovik River (Winter)	1	1	5	4	7	6	8	6	8	6	8	6

Marine and anadromous fish in Stefansson Sound and the surrounding region are represented in the OSRA model by ERAs and LSs that were identified as important habitat (Appendix A, Table A-2-12); however, only ERA 85 (Sagavanirktok River Delta), ERA 88 (Simpson Lagoon), LS 104 (Prudhoe Bay, Heald Point), LS 105 (Point Brower, Sagavanirktok River., Duck Island), LS 106 (Foggy Island Bay, Kadleroshilik River), and LS 107 (Tigvariak Island, Shaviovik River) had any contact probabilities greater than or equal to 5 percent. All others had contact probabilities less than 5 percent and so would not be analyzed further. ERA 88, LS 104, LS 107, and LS 101 have some instances where the probabilities of contact from a spill would be greater than or equal to 5 percent. Table 4-10 shows conditional probabilities of contact from a large spill in summer and winter, and the annual probability of contact. The Sagavanirktok River (ERA 85) has the highest chance of being contacted by a large spill that occurs during summer and winter months, with contact probabilities ranging from 37 to 63 percent based on the number of days spill constituents are permitted to persist in the environment and whether the spill originated at the LDPI (LI) or the offshore portion of the proposed pipeline (PL). Contact probabilities ranged up to 33 percent for LS 105 and 50 percent for LS 106, with the highest probabilities occurring after more time had lapsed. Contact probabilities for ERA 88, LS 104, and LS 107 were generally less than 10 percent regardless of season.

Large oil spills would be expected to persist on the water long enough (30 days) for a trajectory analysis to predict the fate and distribution of oil. Some of the spilled oil would degrade and weather naturally, but much of it could contact sensitive biological areas. A large oil spill in Stefansson Sound would adversely affect fish resources, and associated habitat by causing lethal and sublethal effects. Intertidal habitats are most likely to suffer long-term impacts if a large oil spill were to occur. Oiled intertidal areas could lead to considerable mortality of eggs and juvenile stages in the affected areas. Elevated levels of developmental malformations and physiological aberrations in eggs and juvenile stages can cause reduced survival to adulthood, thereby delaying recovery of subpopulations affected by an oil spill. Organisms that rely most heavily on these environments would be most affected. In intertidal areas, some of the species and life stages that might be most affected include capelin eggs and adults, sculpins, salmonids, and sticklebacks. A large spill would primarily affect beach and intertidal habitat because it would persist in those areas, possibly for more than a decade.

Depending on the timing of the spill, Arctic cod and whitefish species could be the most impacted, although any marine or estuarine fish species present in the spill region could be affected. A large oil spill during a spawning run could interrupt some spawners, or even substantially reduce a cohort. A large spill during the wind-driven migration of whitefish larvae could greatly reduce recruitment for that year. Recovery of specific cohorts could take years, but is unlikely to cause population-level change in the Beaufort Sea. Depending on the location of the spill, adverse effects on fish resources from oil spills would possibly be of long duration, but likely be less than severe in magnitude because Stefansson Sound fish communities are similar to what is found throughout the nearshore Beaufort Sea, and severe population effects are not expected.

The Proposed Solid Ice Condition (Section 2.5.1) would shift much of the risks associated with a large oil spill from summer months to winter months. A large spill which occurred during the solid ice conditions of winter would likely have less impacts to fish than a summer spill into open water, because a spill during solid ice conditions would disperse over a smaller area and be more easily cleaned up. Restricting reservoir drilling to winter months would also extend the time period required to complete the overall drilling program, but as drilling would not be occurring when fish are spawning, and when spills are more easily contained and cleaned up, the additional few months to couple of years of drilling activity would not meaningfully increase or decrease impacts from an oil spill to fish.

Spill Response Activities

Spill response activities could include mechanical recovery methods and in-situ burning of spilled materials. Increased vessel traffic and corresponding increases in vessel discharges and noise would also be associated with spill cleanup operations. If cleanup operations include sections of the beach, or intertidal zones, access to spawning or overwintering habitat for some species may be restricted.

Pelagic fishes may be affected by mechanical recovery of spilled material, but are expected to avoid an oiled area and to move away from vessels and booms or skimmers. However, these avoidance impacts would be short-term and localized to the spill area. Benthic fishes and shellfish would not likely be affected by mechanical recovery activities occurring at the surface. The effects of mechanical recovery on fish resources would be negligible.

In-situ burning of spilled oil is used to remove oil from the surface and may impact fish in the immediate burn area during the burn. As with lower trophic organisms, residue from a burn can sink and smother benthic fish. These effects are expected to be short-term and localized to the immediate burn area.

Spill impacts and cleanup operations would be influenced by time of year. An oil spill occurring into ice may persist for a longer period of time than during ice-free conditions (Buist et al., 2008; Payne, McNabb, and Clayton, 1991). Under calm conditions and cold temperatures in restricted waters, vertical mixing and dissolution would be reduced (Buist et al., 2008). A large spill occurring on or under ice would be trapped and persist until the ice melted, allowing the spill to disperse (Drozdowski et al., 2011), and trapped oil can be transported by currents to areas more distant from the site of the accidental spill. Volatile components of the spill would be more likely to freeze into the ice rather than evaporate. Response efforts would be hindered and aided by the presence of ice. Ice would contain a spill (reduce spreading), concentrate it, and may act as a barrier to shoreline oiling. However, ice also would make a spill difficult to detect, locate, and access. Natural processes would aid the degradation of the oil and gas released during a large spill, but at a slower rate than in warmer waters. Increased vessel traffic would add noise to the environment, and would increase the chance of small discharges from response vessels. Effects to fish from small spill cleanup would be short-term.

Cleanup for a large spill could result in long-lasting and widespread impacts for fish. Effects are unlikely to be population-level though, as fish can avoid areas of spilled oil. Depending on the size of the spill and the time of year, oil spills and spill response activities could have minor (small spill) to moderate (large spill) effects on fish.

4.3.2.2 Conclusion for the Proposed Action

None of the routine activities associated with the Proposed Action discussed previously, which includes isolated small spills, would have impacts that are long-term and widespread. These individual impacts would be isolated with little spatial or temporal overlap, therefore the additive impacts to fish from routine activities associated with the Proposed Action would be short-term and localized, and thus minor. While the presence of the LDPI itself would be long-term, impacts would have little to no negative impacts on fish, and would eventually be eliminated. Impacts from small isolated spills would also be minor but could range up to moderate for chronic small spills originating from the LDPI. In the event of a large spill, impacts to fish are expected to be moderate.

4.3.2.3 Alternative 2 (No Action)

Under Alternative 2, the Proposed Action would not occur, and the impacts to fish in Stefansson Sound described above would not occur.

4.3.2.4 Alternative 3 (Alternate LDPI Locations)

4.3.2.4.1 Alternative 3A: Relocate LDPI Approximately One Mile to the East

Potential impacts on fish under Alternative 3A would be similar to those described for the Proposed Action. The footprint of the proposed LDPI would increase and the pipeline would be longer, which would affect the area vulnerable to crushing and smothering, and could slightly increase the size of the sediment plume. More gravel would be needed to construct the LDPI, which could increase impacts on freshwater fish. However, the types of impacts would remain the same, and the increase in effects would not change the overall impact designation on fish.

4.3.2.4.2 Alternative 3B: Relocate LDPI Approximately 1.5 Miles to the Southwest

Potential impacts under Alternative 3B would be similar to those described for the Proposed Action. However, the footprint of the proposed LDPI would decrease and the pipeline would be shorter, which would affect the area vulnerable to crushing and smothering, and could slightly decrease the size of the sediment plume. The marine and nearshore fish species impacted would remain the same. The general types of impacts would also remain the same, and the decrease in effects would not change the overall impact designation on fish.

4.3.2.5 Conclusion for Alternatives 3A and 3B

<u>Alternative 3A</u>: Impacts of Alternative 3A on fish would be essentially the same as those for the Proposed Action: minor for routine activities, minor to moderate for small spills, and moderate for a large spill.

<u>Alternative 3B</u>: Impacts of Alternative 3B on fish would be essentially the same as those for the Proposed Action: minor for routine activities, minor to moderate for small spills, and moderate for a large spill.

4.3.2.6 Alternative 4 (Alternate Processing Locations)

4.3.2.6.1 Alternative 4A: Relocate Oil and Gas Processing to Endicott

Potential impacts on fish under Alternative 4A would be similar to those described for the Proposed Action. The pipeline would go to Endicott SDI instead of the shore, and would be in close proximity to the Boulder Patch. Sediment from pipeline trenching would be produced closer to, or even in, the

Boulder Patch. This may increase the amount of habitat disturbance impact to fish that use the resource. Impacts to nearshore fish may be decreased if the pipeline is not routed through the nearshore environment. The footprint of the proposed LDPI would decrease and less gravel would be required, which would affect the area vulnerable to crushing and smothering, and could slightly decrease the size of the sediment plume. However, the types of impacts expected would remain the same, and the change in effects would not change the overall impact designation on fish.

4.3.2.6.2 Alternative 4B: Relocate Oil and Gas Processing to a New Onshore Facility

Potential impacts to fish under Alternative 4B would be similar to those described for the Proposed Action. The footprint of the proposed LDPI would decrease, which would affect the area vulnerable to crushing and smothering, and could slightly decrease the size of the sediment plume. Less gravel would be needed to construct the LDPI, but additional gravel would be required for construction of the production pad onshore. This onshore production facility could affect nearshore and freshwater fish during construction activities, if any streams or lakes were located in close proximity to the pad. In general, the types of impacts on marine, anadromous, and freshwater fish species would remain the same, and the change in effects would not change the overall impact designation.

4.3.2.7 Conclusion for Alternatives 4A and 4B

Alternative 4A: Impacts of Alternative 4A on fish would be essentially the same as those for the Proposed Action: minor for routine activities, minor to moderate for small spills, and moderate for a large spill.

Alternative 4B: Impacts of Alternative 4B on fish would be essentially the same as those for the Proposed Action: minor for routine activities, minor to moderate for small spills, and moderate for a large spill.

4.3.2.8 Alternative 5 (Alternate Gravel Sources)

4.3.2.8.1 Alternative 5A and 5B

Potential impacts on fish under Alternative 5A and 5B would be similar to those described for the Proposed Action. Changes in gravel mine location could affect different streams, but the general species affected would be the same. Although the location of the gravel mine would change, the types of impacts would remain the same and would not change the overall impact designation on fish.

4.3.2.9 Conclusion for Alternatives 5A and 5B

Impacts of Alternative 5 on fish would be essentially the same as those for the Proposed Action: minor for routine activities, minor to moderate for small spills, and moderate for a large spill.

4.3.3 Birds

This section analyzes the potential effects of the Proposed Action and alternatives on birds in marine, coastal/intertidal, and terrestrial environments including those species listed as threatened or endangered under the ESA. Effects to birds that are expected to occur within the specific context of the Proposed Action and alternatives are analyzed, without and with proposed mitigation, so that potential levels of impact can be determined.

4.3.3.1 The Proposed Action

Potential impacts to birds from the Proposed Action are detailed below. Impacts are described in terms of a relative impact along a continuum. Localized impacts are less than those that are widespread. Temporary impacts are less than those that last for several seasons or decades, depending on species context. Activities that result in mortalities may affect relatively few individuals of a population (less than severe) or could affect so many that the population would take many years to recover (severe). Effects with no detectable mortality, are localized, or temporary, are generally negligible to minor. Widespread, long-term (decades) effects resulting in mortality that would not be recovered for an extended period are considered major impacts.

Bird species most likely to be affected by the Proposed Action include species that are chronically susceptible to collisions during migration, vulnerable to increased predation levels in nesting areas, and/or repeated disturbance in foraging, nesting, and molting areas (e.g., some sea duck, loon, passerine, and shorebird species), particularly those with small and/or potentially vulnerable populations (e.g., eiders, brant, red-throated loon, buff-breasted sandpiper dunlin, phalaropes, and other shorebirds).

4.3.3.1.1 Disturbance and Displacement

Vessel, air, and vehicle traffic can disturb and displace birds. Besides behavioral effects, this can have energetic and productivity consequences. Traffic can also have direct mortality effects on birds. Many of these potential effects are especially pronounced during sensitive stages of birds' annual cycles. This section analyzes potential impacts to birds resulting from Proposed Action aircraft, vessel, and vehicle traffic. Sources of impacts (i.e., traffic sources) are examined separately for all birds in the Proposed Action Area, then for listed species. This is followed by a conclusion of the overall expected level of disturbance impact for the Proposed Action.

Vessel Traffic

Many marine and coastal birds avoid close contact with vessels while swimming in coastal or pelagic waters, or even nesting onshore, and can be temporarily displaced from localized areas when support vessels approach or transit through the area (Burke et al., 2005). Birds may be especially sensitive to vessel disturbance when undergoing flightless molt in sheltered marine waters, or staging, and foraging pre-migration. Besides disturbance and displacement, birds can collide with lighted vessels under certain environmental conditions, an effect that is discussed separately below (Light Attraction and Collisions).

As described in Chapter 2 (Table 2-1) and the Liberty DPP (Table 5-3), barges, hovercraft, and other vessels would be used to transport equipment, personnel, and supplies to the LDPI during the open-water season. About 20 vessel trips per day, including shoulder season hovercraft use, would occur for the years of construction and drilling, and generally fewer than 2 or 3 trips per day otherwise. Vessels would transit along a marine access route between the LDPI, Endicott SDI, and West Dock (Figure 2-2), with some deviation occasionally expected by hovercraft "during shoulder seasons when… open-water vessel support (is) not available" (Hilcorp, 2015, Section 5.1.3).

Foraging, resting and molting birds in the water could be disturbed by vessel traffic and noise, particularly in the proposed routes between the proposed LDPI and Endicott SDI and between Endicott SDI and West Dock. Bird species resting in surface waters and foraging in surface waters, the water column, and seafloor of the Proposed Action Area could be the most impacted. Long-tailed ducks, common and king eiders, Pacific and red-throated loons, and glaucous gulls are among the most common birds using these waters, and vessels would also regularly encounter others such as scoters (*Melanitta* spp.), mergansers, phalaropes, arctic tern, black-legged kittiwake, and black guillemot. Most birds paddle away from slow-moving vessels or take flight. Birds undergoing flightless molt in marine waters of the Proposed Action Area, such as long-tailed duck, would remain capable of slowly moving away from slow-moving vessels via paddling or diving. Many birds, including flight-capable long-tailed ducks, common eiders, and scoters, typically take flight to avoid a fast-approaching vessel; the larger the flock, the greater the distance at which they flush on vessel approach (Kahlert, 2006; Madsen, 1985; Schwemmer, et al., 2011). Regular vessel disturbance of flocks of sea ducks and seabirds is expected. Vessel disturbances and speeds at which species are disturbed would vary, and many birds would return quickly. Some birds, including scoters, king eider, and Kittlitz's murrelet, however, could be displaced from preferred foraging habitats for 6 to 8 hours or more (Agness et al., 2008; Gall, 2013; Lacroix et al., 2003; Merkle et al. 2009; Frimer, 1994; Schwemmer, et al., 2011). Aside from temporary disturbance, loons (*Gavia* spp.) may alter their distribution pattern for the season to avoid high intensity vessel traffic areas (Schwemmer et al., 2011).

Vessel disturbance during brood rearing would have a possible negative impact on chick-provisioning rates of individual Pacific and red-throated loons and other piscivorous waterbirds that breed in or near the Proposed Action Area, based on studies of piscivorous murrelets in southeast Alaska (Hentze et al., 2006 ; Schoen et al., 2013). Because loons and other piscivores do not forage locally in high density flocks they are unlikely to be disturbed in large numbers, however.

The largest concentrations of molting waterfowl along the central Beaufort Sea coast occur on the lagoon side of barrier islands, but this is variable according to species and time of day. Brood-rearing waterfowl including brant also use nearshore waters inside the lagoons. Project vessels would regularly transit through nearshore waters inside of the outermost barrier islands (e.g., Cross Island, Narwhal Island), but not generally within narrow lagoon habitat or immediately adjacent to barrier islands. From July through September, which is most of the vessel-use period, open water should be extensive enough that birds and vessels are not restricted to narrow leads and relatively few birds should be disturbed along the proposed vessel routes. The probability of disturbance and displacement of birds by marine traffic could increase during break-up and freeze-up if open-water availability is restricted because potential spatial overlap of birds with marine transit routes is greater.

Vessel disturbances would persist over the life of the Proposed Action across the entire 18.6 miles of nearshore habitat across the Sagavanirktok River Delta. Given the high levels of site fidelity for some species, it is possible that some of the same individuals would experience repeated vessel disturbance within and between years. Impacts to birds from routine vessel traffic would be limited when the traffic follows the planned route because it is distant from onshore habitat (Hilcorp, 2015, Figure 5-3) where wake-swamping of nests could occur or disturbance of staging shorebirds is most likely. When ice or weather conditions cause vessel routing to deviate, a greater level of impact could result if vessels approach close to important onshore habitat when large flocks are using the habitat, or should flocks of shorebirds of any one or more particular species be repeatedly displaced during the peak of a migration stopover period. Conditions that would bring vessels in close proximity to deltas, lagoons, saltmarshes, or other important littoral habitats when birds are present would be infrequent, so disturbance and displacement impacts to birds from vessel traffic would be primarily in open-water areas.

Aircraft Traffic

Some marine and coastal birds can be disturbed and/or temporarily displaced from local areas when aircraft transit across coastal and pelagic areas. Disturbance levels often increase with larger flock size, and flights are more likely to affect species that are sensitive to noise and aircraft presence or are in a particular area because they are molting, brood-rearing, resting, or staging. Brant feeding and resting in coastal salt marshes, and molting and post-breeding king eiders and long-tailed ducks have been impacted by local aircraft transits (Mosbech and Boertmann, 1999; Frimer, 1994; Ward and Sharp, 1974). Breeding birds can also be disturbed by aircraft, including eiders by low-level (e.g., less than 656 feet) flights, and gulls and jaegers at potentially higher altitudes (Maftei et al., 2015).

Helicopter traffic (no fixed-wing aircraft use is planned) associated with the Proposed Action would occur year-round (Table 2-1). To assure a conservative analysis, BOEM assumes that most of the time 2 flights per day would support the project, with 4 flights per day during the few years of overlapped construction and drilling activities (Table 2-1, Figure 2-1). Flights are expected to occur among multiple Proposed Action-related sites, including the proposed LDPI, Endicott SDI, West

Dock, Deadhorse, and along the proposed onshore and offshore pipeline route. The DPP (Hilcorp, 2015, Section 5.1.4) states that "(t)ypically… routing is direct as possible." Because it also notes that "routes and altitude (will be) adjusted to accommodate weather, other air traffic, and subsistence activities," and because of the number and variety of Proposed Action destinations and routes, most flights would route over river deltas and associated barrier island habitat (e.g., Sagavanirktok River Delta).

Aircraft traffic could disturb and displace birds during important life history stages, including breeding, nesting, and pre-migration staging. Most impacts would occur during the open-water season, when birds are most abundant in the area. During the winter months, when ice and snow covers available open-water and terrestrial habitat, most birds are absent. Only raven, ptarmigan, raptors, and owls would occur, in very low abundances (Hilcorp, 2015, Appendix A, p. 2-49).

Birds that potentially would be impacted by air traffic associated with the Proposed Action are primarily those at breeding colonies or other concentration areas, including flocks of staging and migrating shorebirds and waterfowl. Air traffic over the Sagavanirktok River and Kadleroshilik River Deltas could impact birds, depending on flight frequency, environmental conditions, seasonal bird abundance, and flock size. If several overflights occurred when large flocks of peak numbers of fall staging shorebirds are present on one of these deltas, hundreds or thousands could potentially experience reduced foraging or resting times leading to reduced fitness for some. Four overflights occurring at the same tidal phase daily for a week and coinciding with flock presence could lead to such effects, but this scenario is unlikely to occur often even during the few years of overlapped construction and drilling activities. Resulting impacts could be fairly widespread (given the number of shorebirds and their migratory nature), although most large healthy populations would be expected to quickly rebound.

Nesting snow geese at the Howe Island colony and brant on the Sagavanirktok River Delta are sensitive to disturbance by aircraft from May to August (Noel, Johnson, Butcher, 2004; Ward et al., 1999), and common eider and some seabirds are particularly sensitive when using barrier island nesting habitat between May and July (Carney and Sydeman, 1999). The Howe Island colony has been recognized as a sensitive biological resource, as noted by Hilcorp (2015, Appendix A, Section 3.13). Over half of the breeding Sabine's gulls recorded during Arctic Coastal Plain (ACP) surveys were located in the Proposed Action Area (Dau and Bollinger, 2009, 2012).The local breeding density of most other sensitive waterbirds are not highly concentrated or large relative to overall ACP populations (Dau and Bollinger, 2009, 2012).

Some raptor species have been reported to habituate to low-altitude helicopter flights and negligible levels of effect on the reproductive success of raptors or passerines from aircraft disturbance is expected (Andersen, Rongstead, and Mytton, 1989; Delaney et al., 1999).

Overall, most aircraft disturbances would be brief. With few great concentrations of nesting birds expected in the Proposed Action Area, few breeding individuals would be subject to repeated disturbance. Exceptions may be the snow goose/brant and Sabine's gull colonies, which host important portions of the Beaufort Sea populations and therefore disturbance, particularly from low-level flights, could cause more long-lasting and widespread effects. Low-level flights over large flocks of staging shorebirds could have a greater level of impact if the same shorebirds are displaced repeatedly. The Liberty DPP (Section 5.1.4) indicates that flight altitude may be adjusted for operations (i.e., not including mitigation) reasons under certain conditions (see above), but low-level flights that typically cause flock displacement (e.g., less than 600 feet [Mosbech and Boertmann 1999]) are expected to occur no more than a few times under such conditions during the few years of most frequent (i.e., 4 per day) flights. While routes over some of these important nesting and staging habitats are expected, low altitude flights would be irregular and few. In conclusion, given the expected flight rates and availability of open-water habitat for pelagic foraging birds, and infrequent necessity for low-level flights, disturbance and displacement from aircraft traffic would have short-term impacts on most birds. Under particular conditions, there could potentially be more long-term effects that could have an impact on a few populations of waterbirds and gulls. However, a typical mitigation measure is applied by NMFS and USFWS for aircraft, including helicopters, to fly at 1,500 feet AGL when within 100 feet of whales or seals, or within 0.5 miles of walrus or polar bears (Appendix C, Section C-3). Imposing a stricter 1,500-foot AGL minimum flight altitude requirement (Appendix C, Section C-4) would further reduce impacts from aircraft on birds.

Vehicle Traffic

Vehicle traffic and heavy equipment operations in terrestrial environments can impact birds with associated noise, human activity, and physical alteration of the environment. Similar to vessel and aircraft traffic effects, vehicle traffic can disturb nesting birds or cause birds using an area for foraging or rest during migration to avoid the area and be displaced to areas of less favorable food resources. The majority of vehicle and heavy equipment operations associated with Proposed Action construction would occur during the winter season and on ice roads when and where most birds are not present, so impacts to birds would be minimized. Construction of the pads and pipeline, and vehicle traffic in winter mainly would displace a few individual adult ptarmigan from the immediate work area or route of ice roads.

Vehicle traffic and heavy equipment operations that continue until areas of surrounding tundra become snow-free or birds arrive on tundra or adjacent intertidal areas could potentially impact birds, particularly early-nesting birds. Tundra ice road footprints can experience delayed ice and snowmelt, and use may be expected until April (Table 2-1). Birds using the areas during courtship may avoid the area or be displaced to less favorable nesting territories. After construction is complete, ice road vehicle traffic disturbance during the operations phase is expected to be negligible relative to the large amount of surrounding adjacent habitat and low densities of breeding birds in the early spring.

Increased ground traffic is expected year-round on the nearby gravel road from Deadhorse to Endicott SDI. Traffic would be higher during construction, but remain elevated above current levels through the life of the Proposed Action. Any tundra-travel vehicle usage in summer has the potential to disturb nesting birds or destroy flightless chicks. Increased traffic on the tundra during the spring and summer on Proposed Action Area access roads could impact natural movement patterns of some tundra-nesting birds and their broods. Broods may avoid crossing a road on their way to the safety of aquatic habitat, for example, and experience increased predation when they remain exposed. A vehicle collision that causes the loss of an incubating parent would guarantee the death of an entire brood, or entire broods (including shorebirds and waterfowl such as snow geese and brant) could be struck by one vehicle. Most tundra-nesting birds in this area, however, are not colonial breeders and therefore do not occur in any large concentrations that would put them at more than minor risk of occasional collisions. Exceptions could be black brant and snow geese, which breed in their highest ACP concentrations between the Colville River Delta and the Sagavanirktok River Delta (Larned, Stehn, and Platte, 2010; Stickney and Ritchie, 1996).

A maximum of single-digit vehicle collision numbers have been reported for any bird species in the BPXA North Slope oil fields between 2010-2014 (Bishop and Streever, eds., 2016; Streever and Bishop, eds., 2014 and 2013). These collisions have likely been mitigated by speed restrictions and personnel training. Speed restrictions, on the Deadhorse-Endicott gravel road at least, are considered part of the Proposed Action activities since the road is a shared facility already in use. Given the combined length of gravel roads in BPXA’s North Slope oil fields is at a minimum 10 times that of Endicott Road (see Bishop and Streever, 2016, Figure 5-3); and assuming that the BPXA records reflect the results of mitigating personnel training, but also potential incomplete record keeping, BOEM estimates that unmitigated vehicle collision numbers per year could conservatively be from zero to tens, including primarily hens and non-breeding chicks, for the most abundant species. Only the local breeding population is in danger of being struck by vehicles on land. Because these numbers are low relative to overall ACP breeding populations of waterfowl and shorebird species that would produce tens of thousands in the same time frame, they would have no more than local and short-term impacts to tundra-nesting birds.

General Disturbance

Disturbance can also displace birds from areas around facilities. With no long-term human presence expected at terrestrial facilities, however, no other relevant disturbance effects to birds are expected for the Proposed Action other than those associated with traffic, construction, and marine facilities.

ESA-Listed Species

ESA-listed spectacled eiders could be disturbed and displaced by aircraft and vehicle traffic on the freshwater and terrestrial nesting grounds. Some foraging and migrating spectacled eiders and, rarely, Steller's eiders, could also be disturbed and displaced by vessel or helicopter traffic in nearshore waters.

Disturbance during the spectacled eider nesting and brood-rearing period (approximately June 5 through August 15) could adversely affect individuals by: 1) displacing adults and or broods from preferred habitats during pre-nesting, nesting, and brood rearing, causing reduced foraging efficiency and higher energetic costs, and 2) flushing females from nests or shelter in brood-rearing habitats, exposing eggs or ducklings to inclement weather, damage, abandonment, and predators (Götmark and Ählund, 1984; Livezy, 1980; Major, 1989). The behavioral response of nesting listed eiders to low-level aircraft flights is variable; some spectacled eiders nest and rear broods near the Deadhorse airport, indicating that some individuals tolerate or habituate to frequent, but regular, aircraft noise (Johnson et al., 2006). Flights associated with the Proposed Action that occur irregularly or in undeveloped areas (relative to an airport) over nesting or brood-rearing eiders, may cause spectacled eider to relocate to less favorable habitat. Eiders that abandon a nest probably will not nest again that year. An increase in vehicle traffic during the breeding season could cause direct mortality (through collisions); it may also disturb brood access to preferred habitats and waterways which could increase predation risk.

The Sagavanirktok to Shaviovik rivers breeding habitat in the Proposed Action Area is at the eastern edge of spectacled eider ACP breeding range and is a negligible, relatively low density fraction of the total (Larned, Stehn, and Platte, 2006). Because there would be only low numbers of breeding eiders, gravel road miles (i.e., single road from Deadhorse to Endicott Island with speed limits), and expected low-level flights in the terrestrial habitat of the Proposed Action Area, traffic impacts (air and vehicle) to breeding spectacled eiders would be considered localized and would not likely exceed habitat alteration impacts. This potential nest impact rate is also similar to that calculated for Alpine Satellites Development Project sites on the nearby Colville River Delta (Seiser and Johnson, 2012). If the species continues to recover as expected, population impacts from the loss of on the order of 3 or 4 broods over the life of the Proposed Action would also likely be short-term.

A few male spectacled eiders and early-departing females use early ice-free areas off river mouths and deltas— including the Sagavanirktok River Delta— in the summer, and the birds use coastal migration routes as the water opens up. A few spectacled eiders would likely encounter Proposed Action-related disturbances in these nearshore areas, first from hovercraft and helicopters during break-up, and then potentially helicopters and other vessels in more open water (Day et al., 2005; Troy, 2003). Eiders disturbed while in nearshore waters should react to the disturbances similarly to other sea ducks (described above), by diving, flushing, or avoiding the area. If eiders relocate to other areas, competition for food available following migration may result in lowered fitness. Summer flights to the proposed LDPI, particularly 2 to 4 a day, may displace some eiders from preferred marine foraging areas or coastal habitats occupied after young have fledged. However, few low-level flights are anticipated as part of the Proposed Action so displacement should be minimal. These flights are not likely to directly cause bird mortality, and as noted in Section 3.2.3, the nearshore Beaufort Sea waters are not habitat for large numbers of foraging spectacled eiders. Marine-area traffic (including both vessel and air) impacts to relatively few spectacled eiders will be short-term and localized.

Available data on Steller's eider indicates that they are unlikely to nest near or migrate through the Proposed Action Area. Air and vehicle traffic impacts associated with the Proposed Action that occur over and on terrestrial areas likely would have greater temporary effects on nesting Steller's eiders than would marine disturbances, though impacts are still expected to be negligible for Steller's eider (even terrestrially, because of the low likelihood of the intersection of the few low-level flights with the occurrence of this species in the Proposed Action Area). Most onshore activities in the Proposed Action Area are likely to affect at most only one or two individuals.

Impacts of vessel, aircraft, and vehicle traffic associated with the Proposed Action are not likely to be widespread or long-term on most non-listed and listed species. The exception to this is more densely occurring populations such as nesting snow geese, black brant, and Sabine's gulls, which could experience effects to a greater proportion of their populations. From November to early April, most birds are absent from the Beaufort Sea coastal areas (onshore and marine) and would not be affected by traffic. While certain types of transit conducted during periods and in locations of high bird density or sensitivity (e.g., repeated low-level flights over/nearshore fast vessel trips near staging shorebirds or barrier island breeding birds) could potentially have measurable impacts, these types of transit are not routine activities associated with the Proposed Action.

Mitigation

BOEM's conclusions regarding impacts assume implementation of, and compliance with, the mitigation measures described in Sections C-1 through C-3 of Appendix C.

Proposed mitigation measures that would reduce impacts to birds are described below and in Appendix C, Section C-4.

Proposed Mitigation Measures

- Aircraft shall maintain a minimum altitude of 1,500 AGL (where safety allows).
- Vehicles shall adhere to a speed limit of 25 mph on all road to minimize collisions and other impacts to waterfowl and shorebird broods.
- Personnel shall be trained to watch for and stop for adult birds with broods attempting to cross roads.
- All avian mortalities and collisions (including vehicle collisions) and their circumstances shall be reported to BOEM and USFWS. These data would help verify the assumption that collision mortality is low and negative effects are small.

4.3.3.1.2 Habitat Loss and Alteration

Habitat loss and alteration can affect nesting, brooding, prey abundance, and foraging. Construction activities and structure emplacement can also affect behavior and destroy nests.

Terrestrial and marine habitat impacts are considered separately for all birds in the Proposed Action Area, and then for listed species in particular.

Terrestrial Construction/Habitat Alteration

Alteration of terrestrial and coastal habitats, including Arctic tundra and barrier island areas, can impact nesting, migrating, and foraging birds. It can cause reduction of available nesting and foraging sites for shorebirds, waterbirds, and passerines, and changes in overall bird species composition, within the footprint of the alteration (Meehan, 1986). It is possible that birds could be displaced to lower quality habitats, which can affect fitness and reproductive potential.

Beyond habitat loss in the directly altered footprint, other impacts may also be expected to occur for avian species, especially nesting passerines and nesting and migrating waterbirds. For example, nesting or foraging areas could be lost due to habitat fragmentation from a road project (Barrows, Fleming, and Allen, 2011). Construction activities in intertidal and other coastal areas in the spring and fall can displace migrating birds from feeding areas during limited stopover and staging times, causing them physiological stress. Construction activities in wetland and upland habitats during the spring and summer breeding season would be expected to displace birds from nesting sites, or directly destroy eggs and flightless chicks of numerous nests.

Proposed Action activities that would affect terrestrial bird habitat (primarily wetland habitat as described in Section 4.3.7) include construction of pads (Badami tie-in pad, ice road crossing, and pipeline landfall), the VSMs, and the proposed gravel mine (approximately 25 acres) west of the Kadleroshilik River. Altogether, these sites would result in permanent habitat loss on the order of 30 acres. Proposed reclamation of the gravel mine site would ultimately convert naturally vegetated tundra habitat into a lake.

The Wetland Delineation Report for the Proposed Project (Hilcorp, 2015, 2016), including the proposed gravel mine site and most or all of the tundra ice road routes, has identified the land as entirely wetlands, primarily a patterned ground complex of emergent wetlands, both seasonally and permanently flooded, and ponds. It was found to be “not rare for the North Slope, and similar habitats are found over millions of acres in the same Alaskan North Slope wetland complex,” and “(t)he wetland functions provided by these wetlands are not unique.” While not unique, the wetlands proposed for gravel extraction and pad development (i.e., permanent habitat alteration) currently provide habitat for migrating and nesting birds, including waterfowl, shorebird, and landbird species (Section 3.2.3).

Additional habitat acreage could be subject to seasonal and temporary impacts during the first years of the Proposed Action. Delayed melt in ice road footprints and associated snowdrifts could leave the following areas unavailable for early nesting, and vegetation under the ice would not be available for foraging until after the ice and snow melted by mid-summer:

- An ice pad constructed for overwinter overburden storage would temporarily restrict access to an estimated 28 acres of tundra habitat around the perimeter of the mine site during spring and early summer for one year.
- Ice roads (Ice Road #4, or the Badami Ice Road) to access the gravel mine would temporarily reduce access to approximately 70 acres of tundra habitat during spring and early summer for up to 4 years.
- The onshore portion of the ice road constructed in support of pipeline construction in the pipeline corridor to LDPI would temporarily reduce access to an estimated 9 acres of tundra habitat during spring and early summer for up to 4years.

In the above areas, early-nesting species, including greater white-fronted goose, long-tailed duck, Lapland longspur, semipalmated sandpiper, buff-breasted sandpiper, and red-necked phalarope could temporarily experience loss of breeding and foraging habitat.

In the case of delayed melt, other non-listed species, including king eider, American golden-plover, dunlin, long-billed dowitcher, pectoral sandpiper, stilt sandpiper, red phalarope, Arctic tern, Pacific loon, and rock ptarmigan (Bishop and Streever, 2016; Lanctot and Laredo, 1994; Saalfeld et al., 2013), could lose access to some breeding habitat. Most of these species are territorial breeders, with no colonies or unusually high density (relative to their overall ACP ranges) breeding areas present in the Proposed Action Area. It is possible that some of these birds, for example semipalmated sandpipers which appear to use a range of breeding habitat types (Hicklin and Gratto-Trevor, 2010; Smith et al 2012), may also find alternative suitable nesting habitat.

In general there is currently little evidence that displaced birds do find alternative breeding habitat, however. For purposes of conservative analysis, therefore, BOEM assumes permanent habitat loss within the Proposed Action Area of approximately 30 acres, plus 4 years' temporary habitat loss of approximately 125 acres. Of the colonial-nesting species, greater white-fronted goose and Arctic tern may nest within the footprint of the gravel pit or ice road or pads but in low numbers (Streever and Bishop, 2014). Territorial-breeding birds directly impacted by an approximately 150-acre loss could number in the single digits to tens per species, annually. Lapland longspur, and semipalmated and pectoral sandpipers would likely lose the most nesting sites, based on their highest relative densities in the vicinity (Section 3.2.3.2), but these species also have high overall abundances and they would not experience measurable impacts relative to overall Beaufort Sea Coast breeding populations. Less common birds such as American golden-plover or buff-breasted sandpiper may lose up to one or two territories annually (Streever and Bishop, 2014).

Clearing and excavation of the proposed mine site would occur between January and April (DPP Section 3.2), so no direct impacts to active bird nests are expected. Similarly, disturbance impacts from onshore construction activities confined primarily to the non-breeding season, would be localized, short-term, and temporary, and are planned to be confined to disturbance footprints that would be largely unsuitable for nesting.

Other aspects of the ice road construction would potentially alter local nesting distributions and habitat usage. For example, the proposed ice road north of the Badami pipeline crosses along the inland area of early-spring foraging habitats and summer brood-rearing habitats used by snow geese, tundra swan and brant. It would run closely parallel to the existing annual Badami ice road which is used for other projects. Delayed melt-out of the ice road would temporarily fragment adjacent habitat, which may lower habitat quality south of an important and relatively large fraction (i.e., half of the greater Sagavanirktok River Delta area) of their ACP brood-rearing habitat. The Badami ice road would only be used during initial construction however, and not be present during brood-rearing season in the late summer.

ESA-Listed Species

Nesting spectacled eiders occur commonly at relatively low densities on mainland tundra in the Proposed Action Area during summer. Over the life of the Proposed Action a few of these individuals could experience loss of tundra-nesting habitat as a result of gravel mine construction and/or the presence of ice roads. Because tundra would not be excavated after May, it is not expected that disturbance from gravel mine development would directly impact breeding, nesting, or brood-rearing spectacled eiders. Construction activities still occurring when spectacled eiders arrive, however, could potentially prevent them from initiating nests or displace them from preferred nesting habitat (Anderson et al. 2007; USDOI, FWS, 2015b).

FWS recently estimated a potential loss of 4.88 spectacled eider nests for a 30-year gravel mine project at the nearby Kuparuk River oilfield. They assumed that for 300 acres, (including a 656-foot buffer disturbance zone), 0.161 nests would be lost annually, and that 30 years x 0.161 nests = 4.88 nests lost over the life of the project (USDOI, USFWS, 2015b). BOEM estimates that for the Proposed Action, approximately 30 acres would be considered a life-of-the-project loss; the 25-acre mine site area plus pads, landfall and VSMs. Using the FWS (2015b) methodology and adding a few additional acres for buffers, and with 125 additional acres of 4 years' temporary loss assumed for ice road impacts, the total area would still be less than the 300 acres of Kuparuk loss and disturbance estimates. The Proposed Action would therefore affect less spectacled eider breeding habitat than the Kuparuk gravel mine and fewer than 4.88 nests would be lost over its 25-year lifetime. With a total spectacled eider population on the ACP in the low tens of thousands and recovering (Section 3.2.3), a loss of that level would result in only short-term impacts. Furthermore, pendant grass (*Arctophila fulva*), known to be a preferred habitat substrate for spectacled eider foraging and brood-rearing, was not found at the wetland mapping site investigated as the gravel pit location (ASRC, 2015). In summary, gravel mine construction would not result in the loss of relatively high density or valuable spectacled eider breeding habitat.

After gravel extraction, the proposed mine site would be rehabilitated over one summer season. A pond would remain, with part of its shore likely graded to a shallow slope and revegetated to provide enhanced waterfowl habitat. Without continuous (i.e., multi-year) restoration work, which itself can cause disturbance, the site is not expected to remain as a shallow pond and this site rehabilitation would be of negligible benefit to spectacled eiders and could have localized adverse effects if rehabilitation activities disturbed any eiders nesting in adjacent wet tundra areas.

Regarding Steller's eider, because its low breeding population is clearly centered in the Utqiaġvik area, (Section 3.2.3) and nests are unlikely to occur in the Proposed Action area, this species is not expected to be impacted by Proposed Action-related terrestrial habitat alteration.

Summary

The Proposed Action would result in the loss of nesting habitat for some Arctic avian species but the area affected would constitute an insignificant fraction of ACP nesting habitat relative to species' populations. Temporary and permanent habitat alteration areas are not known to be densely occupied during breeding or heavily used for migration staging or foraging, or other life history purposes, by any particular avian species. Disturbance impacts from onshore construction activities are expected to be minor as they are confined primarily to the non-breeding season and would be localized, short-term, and temporary. Some habitat fragmentation or degradation may occur from delayed melt-out of an ice road across the Sagavanirktok River Delta, but these effects are expected to be temporary. Altogether, terrestrial habitat impacts would be localized and primarily short-term, affecting birds at the individual rather than population level.

Impacts to Steller's eider are not anticipated because they nest in a relatively small area around Utqiaġvik and nests in the Proposed Action Area are considered extremely rare.

Marine Habitat Loss and Alteration (Seafloor Disturbance)

Loss or alteration of benthic or pelagic habitats, potentially affecting prey abundance or availability by placement of fill, seafloor disturbance, or increased water turbidity, can impact foraging marine birds. Construction of the proposed LDPI would result in the permanent loss of about 24 acres of benthic avian foraging habitats. As described in Section 4.3.1, this marine habitat loss is not expected to have more than a minor level of effect on invertebrate prey communities relative to the overall thousands of acres of benthic invertebrate habitat available in Stefansson Sound and Foggy Island Bay, and relative to the short invertebrate community recovery time expected. Construction of the LDPI and an offshore pipeline could have additional effects on marine and coastal birds by temporarily altering additional benthic and pelagic foraging habitat via increased water turbidity from an increase in suspended sediments. Because most construction would occur during winter, much of the increase in turbidity should not affect foraging waterbirds. However, some increase in turbidity during spring and summer would result from the winter proposed LDPI construction, SDI hovercraft landing area modification, and pipeline construction. Increased water turbidity probably would decrease foraging efficiency for benthic- and pelagic-feeding waterfowl and pelagic-feeding loons. Displacement due to water turbidity would be temporary, localized, and short-term.

ESA-Listed Species

Offshore construction would bury about 24 acres of potential sea duck bottom-foraging area, representing, as noted in the previous paragraph for non-listed species, a very small portion of the thousands of acres of available habitat. The construction of the LDPI and offshore pipeline would increase the amount of habitat disturbance or modification in the marine and terrestrial environments. Installation of the undersea pipeline would involve seafloor excavation which could disturb and/or degrade seafloor habitats and suspend fine materials in the water column. Nearshore foraging habitats also would be altered temporarily by increased turbidity from an increase in suspended sediments around the proposed LDPI and along the subsea pipeline route. See Section 4.3.1 for more information on impacts to benthic habitats.

Construction of the proposed LDPI and offshore pipeline would cause localized, temporary increases in water turbidity. Long-term sedimentation effects to some benthic organisms and permanent marine habitat loss from the LDPI seabed footprint are expected to result in no more than a slight reduction of the amount of available marine bird foraging habitat. All marine construction and habitat alteration activities combined are expected to have at most short-term and localized impact effects on birds, including listed species.

Mitigation

BOEM's conclusions regarding impacts, as noted under Disturbance and Displacement above, assume compliance with the mitigation measures described in Appendix C, Sections C-1 through C-3. Habitat loss and alteration and construction impacts are expected to be no more than minor. The scale of impact level, however, is in reality a continuum, and mitigation as described in Appendix C can help keep these impacts at the lower end of minor, and potentially reduced to negligible for some species. One important measure, abandonment and rehabilitation of the gravel mine site, is regulated by ADNR and the USACE (see Sections C-2 and C-3), and BOEM assumes that HAK will submit a reclamation plan to ADNR and USACE for their approval. Implementation of the proposed mitigation measure below can further reduce impacts.

Proposed Mitigation Measures

- Equipment shall be staged in winter or as early in the spring season as possible to deter birds from nesting in areas planned for construction or gravel extraction.

4.3.3.1.3 Light Attraction and Collisions

The physical presence of facilities has the ability to impact birds, including listed species, in several ways. Disturbance, displacement, and habitat loss impacts anticipated for the Proposed Action are analyzed elsewhere; this section analyzes the potential for impacts to birds caused by in-flight collisions, including collisions caused by attraction to artificial light and gas flaring (vehicle collisions are analyzed in Section 4.3.3.1.1, Disturbance and Displacement). First, the primary sources of these collision impacts are examined in regard to birds in general, and then listed species in particular. This is followed by conclusions of overall expected level of collision impacts for the Proposed Action.

The presence of new structures, including associated light sources, in the environment, can potentially result in energetic costs and mortality effects via attraction and collision. Structures in otherwise open areas can present a collision hazard to flying birds. ("Collision" is used herein to refer generally to a bird/structure encounter in which a bird does not independently and immediately depart. For example, exhausted or disoriented birds may alight on a vessel but not ultimately survive. To support a conservative analysis, all collisions are considered fatal.) Structure and vessel lighting is widely understood to exacerbate this hazard for many species, especially during migration and when conditions are stormy or foggy, or during certain lunar phases, via attraction, disorientation, exhaustion, and ultimately injury and mortality from collisions (Crawford, 1981; Day et al., 2015; Day, Prichard, and Rose, 2005; Ronconi, Allard, and Taylor, 2015; Montevecchi et al., 1999; Verheijen, 1981; Wiese et al., 2001). Both interior and exterior lighting, as long as it is visible to migrating flocks of birds under these environmental conditions, has the potential to disorient and attract; just as structures that are relatively new impediments in what for evolutionary time were unobstructed flyways have the potential to cause collisions. The two in combination can be particularly hazardous.

The physical presence of Proposed Action facilities—including the proposed LDPI, crane booms, onshore pipeline, and associated vessels—are expected to create collision hazards for birds. Occasional gas flaring from the LDPI is a potential incineration hazard as well. These hazards would be increased by light attraction at night under certain environmental conditions, and could draw in additional birds from surrounding airspace towards structures, including the LDPI, crane booms, drill rigs, vessels, and gas flare boom.

Some birds may be more prone to collisions with structures and vessels than others because of their typical flight pattern or attraction to artificial light. Bird species such as eiders that fly low over water have a greater potential to collide with offshore structures and ships, especially under conditions of poor visibility such as fog, precipitation, and darkness (e.g., Erickson et al., 2001). Strong headwinds can also increase collision risk by influencing migrating birds to fly lower (Richardson, 2000). Certain species, including common raven and raptor species, can also be attracted to stationary heavy equipment or vehicle storage areas for perching or nest sites. Many of these birds are predators on passerine and waterbird species (see Increased Predator Abundance, below).

Numerous avian species and species groups occurring in the marine and/or terrestrial Proposed Action Area are at particular risk of in-flight collisions. These include long-tailed ducks and eiders that migrate in large numbers along the coast and have histories of platform strikes, and other waterfowl species with similar habits of flying fast and low above the water are (Bruinzeel, van Belle, and Davids, 2009; Merkel, 2010; USDOI, BOEM, 2015). Many passerines, shorebird species, and seabird species also appear to be attracted to vessels and offshore oil facilities, often due to light attraction at night (Black, 2005; Montevecchi, 2006; Montevecchi et al., 1999; Ronconi, Allard, and Taylor, 2015; Wiese et al., 2001). The year-round resident common raven and the locally common glaucous gull are among at-risk species with a history of oil and gas facility collisions. Passerines, which are typically nocturnal migrants, have demonstrated high relative rates of light attraction and strikes in Alaskan waters and elsewhere (USDOI, BOEM, 2015e; Shell Gulf of Mexico Inc., 2012, 2015; Bruinzeel, van Belle, and Davids, 2009).

Offshore, many species of birds would collide with any portion of the LDPI, especially vertically-walled tanks and edifices, crane booms, drill rigs, and gas flare booms. Birds would collide with some Proposed Action-associated vessels, particularly larger, well-lit vessels that may remain offshore in marine waters for extended periods (e.g., assist tug). Reports of annual bird mortality rates at oil and gas facilities from collisions, nocturnal circulations, and incineration vary based on avian group, location (especially in relation to migratory pathways), and survey methodology (Ronconi et al., 2015). Some information on waterfowl collisions during fall migration has been collected from Northstar and Endicott SDI. A minimum average of 5 common and king eiders and 4 long-tailed duck strikes were reported over 4 partial fall migration seasons at Northstar (Day, Prichard, and Rose, 2005). Aside from an unidentified swan and goose, these 3 were the only waterfowl species recorded in strikes at BPXA North Slope oil field facilities (including Northstar) between 2010 and 2014 (Bishop and Streever, 2016; Streever and Bishop, 2014, 2013). At least 16 common and king eiders were reported together at Endicott SDI, between Northstar and the Proposed Action site, in October of 2001 (USFWS, 2010 unpublished data). Long-tailed duck and raven have also been reported downed at Endicott SDI (Streever and Bishop, 2014).

Systematically-collected bird collision survey data is available for offshore oil and gas exploratory drilling units and associated vessel support in the neighboring Chukchi Sea. Many of the same species at risk of collision in the Beaufort Sea are also at risk in the Chukchi Sea, as the facilities themselves are similar (from the perspective of migrating bird flocks) in vertical elevation profile and relative light output. BOEM estimates an average rate of 28 reported strikes per platform per year and 7 strikes per support vessel per year from data collected over 2 recent open-water exploration drilling seasons in the Chukchi Sea at sites ranging out as far as approximately 60 miles from shore and 150 feet in water depth (USDOI, BOEM, 2015; Shell Gulf of Mexico Inc., 2015, 2012). Strikes included approximately 30 species of passerines, seabirds, shorebirds, sea ducks, and a short-eared owl. These species are known or assumed to migrate or occur over the offshore Proposed Action Area as well, and based on these similarities and adjacencies with gravel islands, platforms, and support vessels, are expected to be among future collisions resulting from the Proposed Action.

Besides individual strikes, strike events of flocks (i.e., multiple individuals of one or more of many species), are also expected to occur. Several such events were reported in the 2 years of Chukchi Sea drilling, often involving 2 or 3 but up to 10 long-tailed ducks, 11 king eiders, and 12 passerines each. For the Proposed Action, these are expected minimum rates because while some birds found aboard platforms from strikes actually recover many more are believed to strike and fall unnoticed into the sea (Ronconi, Allard, and Taylor, 2015). For species with large stable populations these losses, although chronic, would not have long-lasting population effects.

Over the life of the Proposed Action, as the environmental baseline changes with a changing climate, environmental circumstances could align with migration timing for a species with a relatively low or declining population and a large circulation or flock collision or collisions may be possible. Rusty blackbird, a sharply declining neotropical migrant, for example, was recorded among the offshore collisions in the Chukchi Sea in both 2012 and 2015. With the relatively inshore location of the Proposed Project and no prior evidence of strike events of this order in 15 years of data collection at similar gravel islands, however, strike impacts to even vulnerable species are not expected to be long-lasting or widespread (e.g., a loss on the order of 100 or more breeding-age rusty blackbirds or buff-breasted sandpipers, particularly more than once).

Onshore Pipeline and Equipment

Birds in flight, particularly waterfowl during migration, are at risk of collision with terrestrial facilities, e.g., the onshore pipeline, and large stored heavy equipment such as cranes or drill rigging. Both spring and fall migration of most species of arctic-nesting sea ducks involves overland routes (Peterson and Savard, 2015). Day et al., 2005, found that eiders in September flew at a mean altitude of 19.7 feet, and as low as 3.3 feet, and long-tailed ducks flew at a mean altitude of 6.6 feet. They found that in the Point Barrow and Prudhoe Bay areas, as elsewhere, collisions of migrating waterfowl, especially eiders, with wires and other infrastructure are common, particularly so during periods of heavy fog (USFWS, unpublished data, as reported in Miller et al., 2016; Stout and Cornwell, 1976; Drewitt and Langston, 2008; MacKinnon and Kennedy, 2011). Because the pipeline would not be lit, and therefore attract additional birds in to face collision hazards, fewer annual collisions with the pipeline should occur than with the lighted LDPI and vessels. As with marine infrastructure collisions, the potential of collisions with the onshore pipeline and any large stored heavy equipment is expected to be greatest during periods of fog and low visibility during migration.

Non-listed species carcasses (possible strikes) at BPXA-operated onshore Beaufort Sea coastal area oil field facilities between 2010 and 2014 include king eider, common eider, a ptarmigan, glaucous gull, rough-legged hawk, raven, American robin, Lapland longspur, snow bunting, and dark-eyed junco (Bishop and Streever, 2016; Streever and Bishop, 2014, 2013). These species are therefore among those considered at risk of collision with onshore Proposed Action facilities. Strike numbers would not be comparable to or include those potentially caused by light attraction, and would be expected to remain in single or double digits or less per year, below population level effects.

Gas Releases

Gas flaring produces extremely bright ambient light at night, and can attract a variety of bird species including long-tailed ducks, glaucous gulls, and passerine species (Day et al., 2015; Wallis, 1981; Wiese, et. al., 2001). Gas flare events have had extreme consequences for birds, especially passerines, as with the Canaport LNG gas flare on September 14-15, 2013, in New Brunswick, Canada that killed 7,500 songbirds during migration (CBC News, 2015). Some species become entrapped in nocturnal circulations around artificial lights, and may eventually die from collision, exhaustion, or overexposure to heat or incineration by flares (Ellis et al., 2013; Hope-Jones, 1980; Montevecchi, 2006; Ronconi, Allard, and Taylor, 2015; Russell, 2005; USDOI, BOEM, 2015a).

The Proposed Action would include a flare system for burning off excess natural gas that may, over its 25-year life, be expected to flare off excess natural gas at such a rate and time that an intense bright light is created. This light may occur on a night during the aviation migration period, impacting birds. Although the flare is planned “not to exceed 4.0 million standard cubic feet per day (MMscfd)” (Hilcorp, 2015, Section 9.4.3), unplanned gas flaring incidents do occur. Furthermore, although there may be daylight during most nights in the Arctic migration seasons, low visibility nights do occur when there is enough differential in light intensity between the ambient sky and a gas flare event to attract birds. A gas-flaring event at Northstar Island on a September night during fall migration was clearly shown by radar to attract large numbers of night-migrating birds, in spite of a repelling effect noted for some species for the anti-collision light system. Besides being attracted to the gas flare, bird flocks exhibited erratic flight behaviors, circling Northstar Island repeatedly. Long-tailed ducks and, to a lesser extent, glaucous gulls, were the primary species affected, and 22 flocks of long-tailed ducks appeared to be attracted and disoriented, with four flocks almost hitting island buildings before making extreme changes in both flight direction and altitude to avoid imminent collision (Day et al., 2015). Such flare induced events, if repeated in future years with changing environmental baselines, could cause long-lasting impacts to certain vulnerable species.

ESA-Listed Species

Migrating spectacled and Steller’s eiders, which typically fly at low altitudes (average = 20 feet) along the coast, and have high flight speeds (average = 50 mph) and low maneuverability (Day et al., 2005) appear to be particularly susceptible to collision-caused mortality. The collisions, often as flocks, of similar species, e.g., common eider and king eider, and long-tailed duck, with offshore oil infrastructure and vessels elsewhere in northern waters are well-documented (Merkel, 2010; USDOI, BOEM, 2015e; Bruinzeel, van Belle, and Davids, 2009). Spectacled and Steller’s eiders have also been reported to collide with powerlines and other infrastructure on the ACP. One strike of a spectacled eider was reported on a vessel associated with the Chukchi Sea oil and gas exploration activities in 2015, several king eider and long-tailed ducks, including flocks, have struck Northstar Island, oil and gas facilities on the ACP, and Chukchi Sea exploration platforms (Shell, 2012, 2015). Strike reports are considered minimum measures of mortality as some birds are believed to strike and fall into the sea or be scavenged unnoticed. The only difference in susceptibility to collisions is likely to be that king eider and long-tailed duck are much more abundant locally than either spectacled or, especially, Steller’s eider. Given the similarities in behavior it is possible that collisions involving flocks of listed spectacled eiders could occur, and given their relatively low population and the potential movement of birds from other areas, this could result in impacts that are relatively more widespread than those to other sea ducks.

The following is from USFWS (2013b) regarding the susceptibility of spectacled eiders to collisions with non-lighted onshore facilities (i.e., the onshore gas pipeline and large equipment) extending in to the average elevation of central Beaufort Sea coast eider migratory flight routes:

> Eiders migrating east during spring and west during summer/fall would be at risk of colliding with [onshore] structures. These structures include the light poles, buildings,

> drill rig, communication tower, overhead powerlines, and guyed power poles. However, we expect most eiders to remain offshore during spring migration because they are thought to follow open-water leads in pack ice during their spring migration to breeding grounds (Woodby and Divoky, 1982; Johnson and Richardson, 1982; Oppel et al., 2009; M. Sexson, USGS, pers. comm.). During post-breeding migration in summer and fall, we anticipate that male eiders would have the greatest collision risk in the action area. However, we anticipate spectacled eider collision risk with [onshore] structures from mid-May through late July would be greatly reduced by the visibility of structures during 24 hours of daylight in the Action area. When females and juveniles migrate during late summer/fall, decreasing daylight and frequent foggy weather conditions could increase collision risk. Longer nights increase the duration that eiders are vulnerable to collisions with unseen structures, and may compound susceptibility to attraction and disorientation from Action lighting. However, we anticipate sea ducks, including spectacled eiders, would be more likely to migrate over open water in the Beaufort Sea (Petersen et al. 1999, TERA, 2002), thereby avoiding inland… structures…
>
> Overall, we anticipate risk of spectacled eider mortality from collisions with Action infrastructure would be low [however]… an unknown level of collision risk remains, and this risk will persist over the estimated 30-year Action life.
>
> …We acknowledge the proposed [onshore structures] constitute a long-term, if not permanent, collision risk to migratory birds in the Action area, including listed spectacled eiders. …we speculate… that 5 or fewer spectacled eiders would collide with wires over the life of the Action. … Given that the North Slope-breeding population of spectacled eiders is estimated to be 11,254 (8,338–14,167, 95 percent CI), and authorized take equates to 1 adult bird every six years, this impact would be so minor that population level effects from [onshore] collisions are not expected. (USFWS, 2013b)

The onshore pipeline planned as part of the current Proposed Action is, at 1.5 miles, shorter, and would be expected to be more noticeable to birds during good visibility conditions than the narrow, 2.2-mile power line in the project referenced above. The onshore pipeline would, however, be oriented approximately perpendicular to the coastal migratory pathway of spectacled eiders and is, at 7 feet, within their observed average flight height above the tundra. The FWS also partly based the spectacled eider risk of collision for the above-referenced onshore power line project on mitigations (lighting, design features) applied to that Proposed Action. The likelihood of collisions with onshore structures would therefore be low but not negligible.

Summary

The presence of the LDPI and other Proposed Action facilities would be on-going hazards as obstructions to individual flying birds. The greatest hazard would be during construction and decommissioning years with both the assist tug and drill rigs present, (i.e., multiple sources of attraction and collision) but as long as the LDPI remains lighted in the intervening years, the risk level would remain almost as high due to attraction. Based on best available information from local and other relevant sources, a minimum of tens to hundreds of flying birds would collide annually with the LDPI and associated vessels. Many of these would be the result of night time light attraction. Flock collision events of multiple individuals, including passerines and waterfowl, would occur regularly. Irregular gas flare events, should they occur during certain low visibility conditions during peak migration periods, also have the potential of causing occasional attraction and flock collision events. All collisions are assumed to cause direct mortality. A few additional collisions, in the singles or possibly low tens per several species in occasional years, would occur at onshore facilities or equipment.

Species with stable populations of thousands or more would be able to withstand these chronic mortalities with no population level or long-lasting impacts. The actual impacts on non-listed bird populations from the physical presence of platforms (and associated vessel traffic), including lights and gas flaring, are expected to range from negligible to minor, because of their generally short-term and localized effects, depending on species.

The same anticipated amount of direct mortality years would be relatively greater in proportion to, and therefore be expected to potentially have a greater level of effect on, species with declining or otherwise vulnerable populations. In particular, certain species that migrate through the Beaufort Sea coastal areas with documented high collision risks, and are known to be facing population declines or be limited in number (e.g., listed spectacled eider), could face more long-lasting impacts from light attraction and strikes. Based on the anticipated risk and the observed history of eider collisions offshore, spectacled eiders in the single digits in any one year would be expected to collide with Proposed Action facilities. At this level, it is possible that the effects over the life of the Proposed Action would be potentially more widespread or long-lasting than other birds. The level of collision impacts on listed spectacled eider would therefore be considered minor to moderate.

Mitigation

BOEM's conclusions regarding impacts, as noted under Disturbance and Displacement above, assume compliance with the mitigation measures described in Appendix C, Sections C-1 through C-3. Adherence to the additional mitigation measures proposed below would be expected to further reduce the number of bird strikes, and monitoring would allow for adaptive management (such as revised lighting operations during certain weather patterns or seasons) that would be expected to also reduce bird strikes.

Because lights and physical presence of facilities, at some level, are an integral part and unavoidable impact of the Proposed Action, mitigation may not achieve an overall negligible level of impacts for all species, and would remain minor for some birds.

Proposed Mitigation Measures

- The lighting plan shall include details on design, installation, and day-to-day operation of lighting on the LDPI and large vessels (e.g., assist tug and similar length or larger which may be offshore overnight or longer). Plan will be developed in cooperation with the USCG, BOEM, FWS, and FAA, and will include a contractor/staff education component to increase efficacy of Lighting Plan operations and ensure minimization of potential for bird strikes.
- The LDPI shall be designed such that all exterior lights are reduced and down-shielded (as safety and Action Plan operations allow). The FWS has recently published recommended guidelines for reducing bird collisions with buildings and building glass. While these are not specific to oil and gas facilities, the lighting design and operations recommendations have general applicability (USFWS, 2016). Recommendations include 1) avoid unnecessary lighting; 2) install motion sensors on all lights; 3) ensure exterior lighting is "fully shielded" so that light is prevented from being directed outward, except as necessary for safety, and skyward; and 4) minimize light operation during bird migration periods. Black-out curtains should be used to reduce attraction to interior lights.
- Shorter wavelength lights shall be used for proposed LDPI exterior lighting. Recent research suggests that birds are less attracted to shorter wavelength light and that installing green and blue artificial lights at structures as an additional mitigation strategy will decrease the number of mortalities among nocturnally migrating birds (Marquenie et al., 2014; Poot et al., 2008). In the North Sea, studies indicated that different colored lights cause different responses. White lights caused attraction and red caused disorientation, while green and blue caused a weak response. White lights were replaced with lights that appeared green, and this resulted in 2 to 10 times

fewer birds circling the offshore platforms. (Verheijen, 1985; Montevecchi, 2006; Gauthreaux and Belser, 2006).

- A strobe-based light-repellant system, similar to Northstar, shall be designed and implemented. Such a system apparently has had some success in minimizing collisions of some species (Day et al., 2005; Greer et al., 2010).
- To reduce the attractiveness of the LDPI to migrating birds, buildings shall be painted light tan, rather than white or very dark colors (Day et al., 2015).
- Crane booms shall be lowered and removed whenever possible when not in use (Day, Prichard, and Rose, 2005). Unused cranes or other large heavy equipment shall not be stored on-site.
- A Gas Flare Plan shall be developed and implemented. The potential impacts of gas flares will be reduced by employing the following measures:
  - Ensure that the height of the end of the flaring boom is higher than the mean flight altitude of low-flying at-risk species (if safety considerations allow), such as has been suggested to be beneficial in the case of the flaring boom at Northstar Island (Day et. al, 2015), The gas flare boom(s) should be at least 215 feet high, or as high as human safety considerations allow.
  - Include operations planning and education to minimize unnecessary gas flaring during low visibility nights in the height of spring and fall passerine migration season (April 20 through May 30, and July 20 through September 20).
- The onshore portion of the pipeline shall be removed after the Proposed Action is complete.
- A monitoring plan shall be developed and implemented that, at minimum, provides for daily (or first light) surveys of the LDPI for the presence of birds, alive or dead. Basic monitoring and mitigation protocols are commonly recognized as appropriate strategies for tracking and reducing collision mortalities at artificial structures, including oil and gas platforms. One potential component of a mitigation strategy is monitoring in the form of comprehensive tracking, following pre-determined and scientifically approved protocols, of attractions, collisions, and ultimate fate of grounded birds, to obtain improved and more comprehensive assessments of the impacts associated with platform and associated vessel attraction (Wiese, et al., 2001; Hatch Associates Limited and Griffiths Muecke Associates, 2000; Baillie et. al., 2005; Ellis et al., 2013). Monitoring also can result in site or condition-specific data that can allow for adaptive management in lighting operations and other potential mitigation strategies. Records shall be kept according to protocols developed in cooperation with BOEM and the FWS, and reports will be annually submitted to both. The Monitoring Plan shall include an Adaptive Management component, and complement the Gas Flare and Lighting Plans.

4.3.3.1.4 Increased Predator Abundance

The physical presence of new facilities associated with the Proposed Action are expected to increase the number of potential nesting and perching sites for avian nest predators and increase availability of anthropogenic food and nesting/denning resources for predators. These factors can lead to locally increased abundance of certain Arctic fauna that prey on eggs and chicks. Some that are found in the Proposed Action Area and are sometimes referred to as the “subsidized” predators, benefiting from proximity to humans on the ACP, include common raven, Arctic fox, red fox, and gulls (Liebezeit et al., 2009, Liebezeit and Zack, 2008 and 2010; Bishop and Streever, 2016; Streever and Bishop, 2014, 2013). Some level of nest predation is part of the natural tundra ecology of the ACP. Jaegers are common nest predators, but they are a “non-subsidized predator” (Liebezeit et al., 2009) and their abundance is not demonstrated to be related to human development. Nest predation has been observed to be the most common cause of nest failure in general (Liebezeit et al., 2009). A “subsidized,” or artificial, increase in predator abundance may not be able to be withstood without impact to productivity by a vulnerable local breeding population (Liebezeit et al., 2009). Passerine nestling survival has been sharply reduced by predation within 3.1 miles of oil and gas infrastructure on the ACP.

Activities associated with the Proposed Action that would likely lead to increased predator abundance include construction of year-round facilities, long-term storage of heavy equipment such as cranes, and increased human presence (and associated increase of food and trash).

Permanent structures that would be potential nest and perching sites include cranes, the onshore pipeline, support pads, and LDPI. Temporary structures that would provide nesting and perching sites would include drill rigs during the initial and decommissioning Action years. No new gravel roads or permanent onshore buildings or other structures are planned, which would help to minimize fox denning and the perching and nesting of avian predators on land. Glaucous gull will be absent in winter, but the common raven is likely to occur regularly near the Proposed Action in the winter. Overwintering survival of ravens could be positively affected through access to waste heat from buildings, cover, and potential increased access to food.

Without effective dissuasion of nesting, the LDPI would be expected to support the same number of ravens as the similar Northstar drilling island where a clutch of common ravens appears to have been produced annually for most years since its construction (BPXA, 2013, 2014, 2015; Hilcorp, 2015b; USFWS, 2010 unpublished data). Increases in the number of nesting ravens in the vicinity of the LDPI could lead to decreased productivity of other tundra-nesting birds through increased rate of nest depredation. Furthermore, as the numbers of nest predators could continue to increase, the overall impacts to tundra nesting birds could continue to accelerate with time. This increasing pressure could impact population growth or decline of a vulnerable, finite, or limited range avian population.

ESA-Listed Species

Productivity of spectacled eiders nesting near any of the Proposed Action facilities could be reduced through artificial increases in the abundance of common ravens or foxes attracted to the facility. Ravens are highly efficient egg predators (Day, 1998), and have predated on Steller’s eider nests near Utqiaġvik (Quakenbush et al., 2004). Studies of Steller’s eiders near Utqiaġvik suggest a relationship between predation rates and breeding success (Quakenbush et al., 1995; Obritschkewitsch et al., 2001; Rojek, 2008; Safine, 2011) and a similar relationship for spectacled eider may be expected. Therefore, as the number of structures and anthropogenic attractants associated with the Proposed Action increases, listed eider reproductive success may decline.

Because Steller’s eiders are unlikely to nest in the Proposed Action Area, they would not be immediately affected by any artificial increase in predator abundance that might occur, although it is possible that the spread of ravens could eventually contribute to predator impacts.

Summary

Because of the physical presence of new infrastructure and increased human presence, an increase in nest predators—specifically ravens and glaucous gulls—and potentially Arctic and red foxes, is expected to accompany new infrastructure and increased human presence. Permanent (i.e., life-of-the-Proposed Action) structures including the LDPI and support pads and pipelines would provide long-term habitat enhancements for nest predators. Temporary presence of cranes and drill rigs would provide additional temporary perch, and possibly nest, sites. Unmanaged predator levels would be expected to influence local population levels. Predation levels are unlikely to be reduced to pre-construction levels, and increases may have long-lasting effects on local populations of nesting shorebirds, waterfowl, loons, and passerines.

Mitigation

BOEM’s conclusion regarding impacts assumes implementation of, and compliance with, the mitigation measures described in Appendix C (Sections C-1 through C-3). Appendix C also contains additional potential mitigation measures recommended in recent peer-reviewed literature and developed by subject matter experts (Section C-4). Implementing the additional proposed mitigation measures successfully would keep increased predation impacts on birds, including listed species, from the Proposed Action from exceeding minor levels. These proposed additional mitigation measures, as relevant to increased predation, are described below.

Proposed Mitigation Measures

- A Wildlife Interaction Plan Work shall be developed, in coordination with BOEM and USFWS staff, that includes the following:
  - Contractor/employee education on problems associated with feeding wildlife and prohibitions against feeding or encouraging wildlife, reporting all wildlife encounters, and training on waste management and use of animal-proof dumpsters.
  - Monitoring for detection of nest building by predatory birds on towers or other structures, and fox denning on or near any of the Proposed Action facilities.
  - Discouragement of nest building and denning activities.
  - A procedure for reporting all evidence of predator attractions to the facilities, including nesting or denning; anthropogenic feeding, food caching, or stealing; persistent perching; etc., for the purpose of adaptive management.
  - Removal of (i.e., to include egg treatment or other methods as appropriate for prevention of successful nesting and re-nesting) any found nests or dens as appropriate under all applicable legal requirements including State and Federal laws and permits.
  - All potential necessary permits for nest and den removal or other wildlife interactions, as discussed/approved/permitted in advance as necessary with appropriate SOA and federal regulators prior to initiating construction.

4.3.3.1.5 Oil Spills

Oil spills have a high potential to affect birds. The magnitude and extent of impacts is a function of the time of year the spill occurs, the volume and product type, the environmental conditions at time of the spill, the species and/or habitats and habitat quality exposed, and results— beneficial and/or negative—from any cleanup activities. Timing (i.e., if peak periods in bird density overlap temporally with the spill), location (high- versus low-density areas), and environmental conditions (wind conditions, wave action) may have a greater overall effect on avian mortality than the spill size and fluid type (Byrd, Reynolds, and Flint, 2009; Castège et al., 2007; Fraser, Russell, and Von Zharen, 2006; Wilhelm et al., 2007). Presence of sea ice can affect oil spills and OSR in a number of ways such as trapping oil for various periods of time and otherwise impacting extent of oiling, rate of oil migration, dispersion, and weathering, and in turn largely affecting response strategies and timeline (Arctic Council, EPPR, 2015).

Certain species of birds may be more susceptible to contact with spilled oil than others: seabirds and sea ducks are initially most vulnerable to offshore oil spills because they spend the majority of their time in marine waters and often aggregate in dense flocks. Diving birds and underwater swimmers are susceptible to spilled oil because of their relatively long exposure time within the water and at the sea surface (Camphuysen, 2007). Birds in shoreline and wetland habitats may be susceptible to direct oiling if, for example, a spill were to reach the beach intertidal zone where shorebirds and other species forage, or inshore wetland habitats where waterfowl, shorebirds, and other species nest and raise young. The exposure to marine and coastal birds could range from acute (birds may be covered by lethal amounts of oil) to chronic (birds are exposed to smaller amounts of oil over a longer period of time). Effects of chronic exposure can range from lethal to sub-lethal.

Common routes of exposure to oil include covering skin or feathers, inhalation of vapors, and ingesting oil or contaminated prey. Chronic exposure can lead to reproductive effects and reduced food sources and fitness. Oil spills have the greatest potential for affecting large numbers of birds in part due to toxicity to individuals and their prey and the difficulties involved in cleaning up spills in remote areas, and with the wide variety of possible ice conditions.

Direct contact with oil can irritate or inflame sensitive tissues (e.g., skin, eyes) and foul plumage, which is the primary cause of stress and mortality in oiled birds (Balseiro et al., 2005; Burger and Fry, 1993). Oil causes marked loss of insulation, waterproofing, and buoyancy in the plumage, causing hypothermia, exhaustion, starvation, or drowning deaths (Balseiro et al., 2005; Wiese et al., 2001). Even small volumes of oil (i.e., oil sheens) are a concern for diving birds because of the potential to compromise thermoregulatory capabilities (Fraser, Russell, and Von Zharen, 2006; Jenssen, 1994; Wiese and Ryan, 2003). O'Hara and Morandin (2010) documented measurable oil transfer to feathers with small quantities of oil absorption. Even a light coating of hydrocarbons can negatively affect feather microstructure, potentially compromising buoyancy, insulation, and flight characteristics.

Oil ingested and inhaled during feeding, grooming, and preening can lead to tissue and organ damage, interfere with food detection, predator avoidance, homing of migratory species, disease resistance, growth rates, reproduction, and respiration (Balseiro et al., 2005). Ingested oil causes short- and long-term reproductive failure in birds, including delayed maturation of ovaries, altered hormone levels, thinning of eggshells, reduced egg productivity, reduced survival of embryos and chicks, reduced chick growth, and abandonment of nests by adults (Burger and Fry, 1993; Golet et al., 2002; Piatt and Andersen, 1996). Additionally, lightly oiled birds could bring oil contamination or contaminated food to a nest while heavily oiled birds would be unable to return to the nest, resulting in abandonment and starvation of the young. Impacts of lost reproduction from mortality of breeding-age adults must also be accounted for (Deepwater Horizon NRDA Trustees, 2016). For purposes of this analysis, all birds contacted by oil are assumed to die.

Prey items and other food resources used by birds may also be reduced in quantity (e.g., fish or invertebrate prey may experience mortality as a result of a spill, or there may be effects to primary producers that carry up through the food web (Golet et al., 2002). Habitat fouling that reduces habitat quality can also lead to displacement of affected birds to secondary locations (Day et al., 1997; Esler et al., 2002; Golet et al., 2002; Lance et al., 2001; Wiens et al., 1996). Chapman (1981, 1984) conducted a study of the impact of the 1979 Ixtoc exploration well oil spill on shorebirds, and found that oil on the beach caused birds to shift their habitat selection to less productive areas. Displacement of bird species from a portion of preferred feeding grounds can result in additional energetic requirements and increased foraging time for parents feeding chicks and for migrating birds, potentially affecting productivity (Golet et al., 2002) or making them unable to complete their migration.

Details of impacts to birds as a result of spills associated with the Proposed Action are described below.

Small Oil Spills (Less than 1,000 bbl)

The majority of small accidental spills would be less than 10 bbl, so those that do enter the water column would quickly dissipate, and would be unlikely to affect habitat or individual birds. Small spills less than or equal to 10 bbl but less than 200 bbl may affect small areas of habitat and few individuals but would be similarly relatively easy to contain.

Should a fuel spill occur during refueling and escape containment, a small number of birds in the immediate vicinity of the vessel could be affected, depending on current and wind patterns. Few birds, however, are likely to be in the area during refueling and in the unlikely occurrence of a fuel spill, a limited number of individual bird mortalities could occur. These spills may be easier to contain and clean up, or may occur in seasons when birds are unlikely to be present. The potential difference in impacts to birds from small spills that could result from such a measure is not likely to be measurable, however, because there is still a risk of small spills from vessels supporting other Proposed Action operations during open-water conditions.

Most small spills, with or without solid ice conditions, would be expected to result in no more than short-term impacts to small habitat areas (see Sections 4.2.1.1 and 4.3.7.1). For isolated small spills, negligible to minor impacts are expected to birds. Population-level effects would not occur for small accidental spills. Widespread annual or chronic disturbances or habitat effects are not anticipated to accumulate across one year, and localized effects are not anticipated to persist for more than one year.

Large Oil Spills (Greater than or Equal to 1,000 bbl)

As with small spills, the magnitude and severity of impacts would depend on the spill location and size, type of product spilled, environmental conditions, and presence of birds.

A large crude oil spill may be difficult to contain and could result in lethal and sublethal effects on relatively large numbers of birds, depending on the season and location. The Beaufort Sea and ACP bird community is complex and includes many species, a number of which occur in great abundance and a variety of life stages and habitat usages that differ with location and time of year. There are varying degrees of vulnerability to exposure to an oil spill, depending on season, location, and duration of spill. Impacts could include oiling of plumage, ingestion of oil from preening, oiling of foraging habitats, and displacement to secondary locations. Landbirds, shorebirds, seabirds, or waterfowl, including listed spectacled eiders, could be impacted depending whether the spill occurred on land, in nearshore or coastal waters or in the presence of birds offshore.

Vulnerability may vary slightly for different age classes of certain species, such as juvenile versus adult phalaropes (Taylor et al, 2010). Certain exposures are of particular concern for birds in the Beaufort Sea Proposed Action Area. For example, concentrations of birds at certain times of year put large numbers of birds at risk from a single accidental event, as with the waves of hundreds and thousands of shorebirds that move through the local river deltas and coastal mudflats foraging as they stage for fall migration. Reproductive impacts are also of significance given the short summer period at high northern latitudes and the high energetic investment in egg laying.

Because the proposed LDPI is relatively nearshore (i.e., approximately 5 mi, and well within the outer barrier islands), the season (e.g., late spring, fall) of a large spill is likely to have a greater effect on birds than the point of origin (i.e., whether a spill originates at the LDPI or offshore pipeline), or spill volume. Once breeding birds begin arriving in spring, abundances grow sharply within weeks. The earliest birds (e.g., snow bunting, tundra swan) begin arriving on the tundra in April, and thousands of birds, including greater white-fronted goose, black brant, phalaropes, long-tailed duck, king eider, and Lapland longspur) may be present in coastal waters and onshore tundra of the Proposed Action Area by mid- to late-May (Ward et. al., 2015; Cotter and Andres, 2000).

Populations of different species will variously grow and shrink over the spring, summer, and fall as they breed, molt, stage, and then migrate. Birds will remain present in the area and vulnerable to spills in substantial numbers, until most migrants depart from the Proposed Action Area and the Arctic by freeze-up (though a few seabirds use distant areas of open water even in winter). Numerous non-listed species that could be directly contacted by a large spill occurring in the marine environment in either spring, summer, or fall months (i.e., May through October) include those listed in the preceding paragraph, plus king and common eiders; surf, white-winged, and black scoters; long-tailed ducks; red-breasted and common mergansers; red-necked and red phalarope; jaegers; black guillemot; black-legged kittiwake; glaucous and Sabine's gulls, Arctic tern; Pacific, red-throated, and yellow-billed loons; and short-tailed shearwater. The largest concentrations or abundances of species in local marine waters typically include breeding and post-breeding long-tailed ducks, king and common eiders, post-breeding rafts of scoters, glaucous gulls and phalaropes (Stehn and Platte, 2002), and these species would likely be those that would experience the highest numbers of direct mortality via contact with a large spill.

If a large spill reaches coastal waters without containment, it is also likely to impact tundra swans, geese (e.g., lesser snow geese, brant), and dabbling ducks such as northern pintail and American wigeon that are commonly found along Beaufort Sea barrier islands and mainland shores. Should a spill reach coastal mudflats, saltmarshes or river delta habitat, large numbers of staging shorebirds, including sandpiper species like pectoral, semipalmated, and buff-breasted, and brood-rearing geese and other waterfowl could also be impacted. BOEM conducted an OSRA for a large spill, detailed below, that lists areas estimated to be contacted and the percent chance of contact to these areas.

A large spill that originated from the onshore pipeline and occurred on terrestrial habitat during the spring or summer would not spread as far in surface habitat as an uncontained marine spill, but could potentially impact brooding lesser snow geese and brant, pectoral and semipalmated sandpipers, and Lapland longspur. It may also affect lower density but still common breeders like loons.

Birds that are not directly oiled could be affected by impacts to nearshore and intertidal invertebrate or fish food resources, which would be expected to incur moderate to major impacts (Sections 4.3.1 and 4.3.2). Most of these birds would be additional numbers of the same species, but would also include a few scavengers and predators such as ravens and raptors who attempt to feed on contaminated bird carcasses or other food sources. Contamination of food sources is assumed to cause direct mortality. Benthic habitats of marine invertebrate prey items of sea ducks may experience relatively moderate to major effects following a large oil spill. Reduction of food sources could also reduce survival or reproductive success of birds foraging or nesting in the impact area. Lowered food intake may slow the completion of growth in young birds, the replacement of female energy reserves used during nesting, and energy storage for migration of all individuals.

Impacts to most locally breeding marine and coastal bird populations from a large spill of up to 5,100 bbl would be somewhat limited and localized because most of these species have widely dispersed breeding distributions. As to other birds using the area at different life history stages, contamination of one or two local marine or shoreline staging, molting, resting, foraging, or other habitat areas would have more widespread impacts because of the migratory nature of birds. The impacts would be considered less than severe, however, for many populations, with some important exceptions, because most populations are widely dispersed in similar habitat with similar prey organisms widely distributed in the region. Impacts could be more serious, however, if the few local high density breeding populations are affected, bird populations are already in decline, or an affected foraging site is important to a significant proportion of a population (e.g., Beaufort Sea coastal river delta habitat complex for staging shorebirds). If a spill reaches shoreline areas such as river deltas and/or saltmarsh, habitat effects could persist for several years, affecting additional birds. Contamination of nearshore marine waters when large numbers of staging king eiders or molting long-tailed ducks are present would be expected to potentially kill thousands of birds, which could be considered a major impact, as could impacts to colonial nesting common eider or certain shorebird populations. A large spill impacting subtidal and intertidal habitats when large numbers of any one or several species of birds are present feeding, staging or molting, would result in lethal and sublethal effects that could be widespread due to the birds' migratory nature, and severe.

The Proposed Solid Ice Condition described in Section 2.5.1 would be unlikely to measurably minimize disturbance impacts to birds over the life of the project. It would shift much of the risks associated with a large oil spill from summer months to winter months, and potentially make cleanup easier, but other activities that impact birds would still occur year-round, including drilling into non-hydrocarbon bearing zones. The measure would potentially increase the overall drilling time an additional 3 to 5 months, so this would mean a slight increase in impacts, or risk of impacts, to birds.

Oil Spill Risk Analysis

Bird habitat resources in the Beaufort Sea and the surrounding region are represented in the OSRA model by ERAs, LSs, and GLSs as listed in Appendix A (posted at www.boem.gov/liberty), Table A-1-9 and A-1-10. A summary of the highest percent chance that a large oil spill would contact bird resources within 1, 3 and 30 days during summer and winter is provided in Table 4-11.

Table 4-11 Bird Resource Areas with Highest Percent Chances of Contact by a Large Oil Spill[1]

OSRA Feature Type	Highest Percent Chance Contact	Summer			Winter		
		1 day	3 days	30 days	1 day	3 days	30 days
Environmental Resource Area (ERA)	1-5%	78	8,72,73,96	2,5,8,65,68,69,73	78	9,72,78	8,9,68,69,71,72,73,78,96
ERA	6-19%		9,78	9,71,72,78,96	77	77	
ERA	20-<50%	77					77
ERA	≥50%		77	77			
Grouped Land Segment (GLS)	1-5%			171,182			170
GLS	6-19%			170			

Notes: [1] Highest percent chance from any launch area at LDPI (LI) or pipeline area (PL) during summer or winter. Note that only ERAs, and GLSs with percent chances of contact ≥1 are shown.

Source: Appendix A (Tables A-2-1 through A-2-11). Maps of ERAs, LSs, and GLSs are provided in Appendix A, Maps A-2a-1 through A-4c.

Should a large spill occur in either summer or winter, the Sagavanirktok River Delta and Foggy Island Bay is the ERA (No.77 in Table 4-11 and Appendix A posted at www.boem.gov/liberty) with by far the greatest vulnerability (i.e., highest percent chance of contact from a large spill, should one occur at a location at the LDPI or offshore pipeline). No other bird resource area ever experiences a greater than 14 percent chance (experienced by No. 72 according to the OSRA: Gwyder Bay, West Dock, Cottle and Return Islands 30 days after a summer launch, see Table A.2-4) of large oil spill contact at any time. The Sagavanirktok River Delta and Foggy Island Bay ERA experiences up to a 43 percent chance of contact within a day should a large spill occur in the summer, up to a 60 percent chance within 3 days, leveling out at a 68 percent chance within 90 days in the summer. “Summer” for the OSRA is defined as July 1 through September 30, and therefore includes the majority of the peak period of shorebird migration staging on the Sagavanirktok River Delta (Kendall et al., 2011; Taylor et al., 2010). Species at risk of impacts from a large oil spill at that time would include, but not be limited to, dunlin, American golden-plover, black-bellied plover, long-billed dowitcher, pectoral sandpiper, ruddy turnstone, semipalmated plover, stilt sandpiper. As the percent chance of contact rises slightly to areas along the Beaufort Sea coast to the west and barrier islands out to the north, northwest, and slightly east, vulnerability to contact may increase for some species such as Baird’s and buff-breasted sandpipers and sanderling (Taylor et al., 2010).

The chance that a large spill would extend west of Point Barrow is limited. There is only up to a 2 percent chance that contact with the eastern boundary of GLS No. 124 (the Chukchi Sea Nearshore important bird area [IBA]), where it extends east of Point Barrow parallel with Barrow Canyon (Table A.2-4 and Map A-2f) could occur within 90 days, should a large spill occur in summer. Even after 360 days, no further west progression is estimated to occur with a greater than 1 percent chance. Large spills are not estimated to travel eastward in summer or winter far beyond Stockton Islands or Mikkelsen Bay with a greater than 1 percent chance.

Spill Preparedness and Response Activities

Spill cleanup operations can also impact birds. Birds present in or near oil-affected habitats may be disturbed or displaced during spill cleanup operations (Andres, 1997; Harwell and Gentile, 2006; Jenssen, 1994). For example, mechanical recovery, in-situ burning, or other spill response activities that take place in nearshore, intertidal, or coastal environments may displace birds from important habitats in the immediate or adjacent area. This could result in reduced reproductive success or survival, depending on the nature of those habitats (e.g., nesting, molting, and staging) and time of year. Other impacts may be physical or physiological in nature. One recent study has demonstrated that burn residue in water from in-situ burning of an oil spill can foul feathers equally or worse than oil (Fritt-Rasmussen, 2016). None of the conditional or combined probabilities factor in the effectiveness of OSR activities to large spills, which may range from highly effective under ideal conditions to less effective during unfavorable or broken-ice conditions.

In marine waters, birds are likely to move away from mechanical recovery and in-situ burning operations, similar to moving away from other vessels, though in offshore waters this is not likely to result in measurable effects. It is possible that an exception to this may occur in heavy ice conditions if birds were sheltering in an open-water lead of limited area where response activities were occurring, although impacts to bird populations from such response efforts would still be expected to be short-term and localized. Spill drills conducted by the government (GIUE) would be infrequent and localized and are expected to contribute negligible impacts to birds.

Spill cleanup in coastal areas or on barrier islands may cause disturbance effects if it occurs while waterbirds are nesting, brood-rearing, molting, or staging for migration, or juveniles are occupying coastal habitats. Predators may take some eggs or young while adults are displaced off their nests, and birds disturbed often during this activity may have lowered reproductive success or survival. Camouflaged nests in coastal habitats could be inadvertently crushed by cleanup workers. Few high density nesting areas occur in the Proposed Action Area, but a few locally important breeding populations such as common eider (increasingly susceptible to rising sea levels and storms) may be disproportionately susceptible to nest disturbance or destruction. The duration of cleanup activities may preclude birds from using an area for an entire season. Displacement or nest destruction could disrupt a year’s productivity, although some breeding birds have been shown to recover quickly in subsequent seasons (Andres, 1993). Mechanical and physical means of OSR are expected to contribute minor to moderate impacts to invertebrates and fish (Sections 4.3.1 and 4.3.2). Some of these prey populations may be locally important bird food resources for a few bird species but may take a few years to completely recover.

In summary, OSR activities that include in-situ burning, mechanical recovery and other physical presence and occur in the nearshore, intertidal, or coastal environments, would be expected to have minor impacts, and slightly increase the moderate and major impacts expected from an oil spill. The highest impacts (i.e., a major level of impact for large spill and spill response activity combined) would be expected to occur to those birds such as common eider that may survive initial spill impacts but have nesting efforts impacted in a subsequent cleanup season. Such impacts could be long-lasting for Central Beaufort Sea populations that may be heavily impacted in successive breeding seasons.

ESA-Listed Species

Spectacled eiders commonly forage off the Sagavanirktok River Delta and in Foggy Bay. This listed species also nests on the Proposed Action Area tundra in low densities. A large spill from the LDPI or the offshore pipeline would have the highest probability of contacting nearshore and offshore areas of Foggy Island Bay and the Sagavanirktok River Delta, where spectacled eiders may be staging in open waters in spring following migration, or foraging throughout the area post-breeding prior to fall migration. Oil could contact these eiders from early June to September. Stehn and Platte (2002) found that a very low number and percentage of the total ACP spectacled eider population would be exposed to a large spill originating in this area. While the modelling, spill trajectories, and exact spill volumes differ from the current OSRA, a low level of impact on spectacled eider is still expected. This is because the earlier finding was based primarily on the low abundance of the species on the central Beaufort Sea coast, and the species’ generally widespread distribution, which would prevent a large percentage of the population from being contacted by the spill. These factors remain true for the species.

One oil spill of 5,100 bbl could cause a few deaths among nesting, brood-rearing, or staging spectacled eiders. Depending on location, benthic resources may incur moderate or major impacts (with Boulder Patch resources among the latter) (Section 4.3.1). Reduction of prey populations from a spill could have a negative effect on the foraging success of breeding or staging spectacled eiders, especially in spring when there is limited open water. Spectacled eiders do not occur in high densities in the vicinity of the Proposed Action Area but numbers up to the low tens could be directly impacted by a large spill. Spill cleanup activities may disturb brood-rearing or staging eiders occupying coastal habitats, resulting in decreased survival. Because eiders tend to be somewhat dispersed with limited flock size and, because of the area in which oil from a large spill is most likely to stay somewhat confined, impacts over 2 years' cleanup season may impact tens of eiders or more. Impacts of this size from a large spill and spill cleanup efforts on spectacled eider could be considered widespread and long lasting, and therefore moderate, particularly if Canadian breeders were affected while staging in the area.

Regarding Steller's eider, with its limited abundance and low chance of contact to either individuals or their marine use areas, this species is expected to incur negligible impacts from small and large oil spills associated with the Proposed Action.

Overall Impacts of Oil Spills

While spills can occur on land, spills in the marine environment have the greatest potential to affect large numbers of birds, including listed birds, because of their ability to spread and persist in aquatic (including shoreline) environments. Exposure of listed spectacled eiders and other marine and coastal birds is expected to result in the general effects summarized below. This analysis assumes that all birds contacted by oil would not survive and that secondary effects may cause impaired physiological function and production of fewer young.

If a large spill were to occur, it would have the highest percent chance of contacting nearshore and offshore areas of Foggy Island Bay and the Sagavanirktok River Delta, where, depending on spill timing, waterfowl and other aquatic birds may be molting, staging before migration, or pausing during migration. The number of birds that could be lost depends considerably on the timing. Birds are absent from the marine environment in winter, and largely from the terrestrial environment as well. A spill in July or August, however, could impact hundreds or thousands of long-tailed ducks and king eiders, hundreds of glaucous gulls, common eiders, and scoters, and a number of loons and other waterbirds.

Perhaps at greatest risk in terms of numbers of birds directly contacted would be several thousand shorebirds comprised of several species on the Sagavanirktok River Delta or other coastal mudflats during peak fall migration staging, and the rapid turnover of migrants during this period suggests that many more could be exposed. This could result in population-level or major effects to one or two species. Some of the several hundred brood-rearing, molting, or staging brant and snow geese could contact oil in coastal habitats. A large onshore pipeline spill in summer, however, would be unlikely to affect more than a few nests of any one species, because there are no known breeding colonies or particularly high density nesting areas in the onshore Proposed Action Area and onshore spills have a relatively lower chance of spreading. For most bird species, the relatively small losses likely to result from a spill may be difficult to separate from the natural variation in population numbers, but their populations are not expected to require lengthy recovery periods. If the reduction or contamination of food sources persists long after the spill has dispersed or been cleaned up, impacts to local populations of birds also could persist.

If a large oil spill contacted the listed population of spectacled eider or affected its benthic food source, it would be expected to have widespread and long lasting, and therefore moderate impacts, depending on number of individuals impacted, how far their breeding range spanned, or temporal and areal extent of impact to food resources, due to the population's limited population size.

Based on the large number of birds that occur in the area during the summer months and the likelihood of important bird habitats being contacted, thousands of birds could be impacted as a result of the large oil spill assumed under the Proposed Action, resulting in a moderate to potentially major level of impact to some non-listed species, and a moderate level of impact to listed spectacled eider. The level of impact from spills could be increased temporarily by spill clean-up efforts, but would still remain moderate for spectacled eiders and moderate to major for non-listed species. The Proposed Solid Ice Condition described in Section 2.5.1 would be expected to reduce the frequency of spills occurring during the seasons when most birds are present or in open-water conditions when spills may spread further and more rapidly than spills in winter. There are assumed to be other potential sources of a large spill, however (e.g., the pipeline or the LDPI during the years of production, see Table 4-3) that would be unaffected by this Condition. Marine prey (Sections 4.3.1.1 and 4.3.2.1) is also assumed to still incur moderate to major (Boulder Patch) level of impacts even with the Solid Ice Condition. Therefore, while it may be slightly reduced by a seasonal restriction, there will still be potential for a moderate to major level of impact from a large oil spill to some bird species.

4.3.3.2 Conclusion for the Proposed Action

The greatest levels of direct impact from routine operations associated with the Proposed Action are expected to come from increased predator levels; traffic disturbances; and the collision hazards associated with the physical presence of new facilities, including the proposed LDPI, onshore pipeline, and associated vessels. Collision hazards are particularly exacerbated by light attraction: the bright artificial lighting of the LDPI (i.e., ambient and occasional gas flaring) and some vessels (e.g., assist tug) would cause attractions and disorientations of additional vulnerable migrants from beyond the random expected collisions in the flightpath, and therefore measurably increase levels of collisions when certain environmental conditions are present during migration. Potential increased predation and terrestrial habitat alteration could have long-term impacts on vulnerable birds on the ACP breeding grounds, while collisions would particularly affect some birds migrating from widespread areas beyond the Proposed Action Area, and traffic would potentially affect birds in several life stages and many populations. Therefore, while many bird populations using the Proposed Action Area are expected to incur short-term or negligible impacts, the overall potential impact to avian resources would collectively range up to widespread and long-term, or moderate. Details are summarized below.

Increases in nest predator numbers would be long-term so the potential effects, originally somewhat localized, on some vulnerable nesting populations would therefore also continue into the long-term and spread farther through ACP breeding populations as predators disperse. Separately, pre- and post-breeding, tens of thousands or more primarily different birds are likely to stream in flight along the Beaufort Sea coastline in the vicinity of the Proposed Action Area. Many of these migrants from breeding grounds in adjacent or distant circumpolar Arctic coastal habitats could be exposed to Proposed Action impacts too. Besides these spring and fall migrations, disparate breeding populations densely move through, or sometimes gather in, the Proposed Action Area for migration staging, molt migration, or molting itself. Because these are migrant populations, impacts they potentially incur including chronic or increased collision hazards and vessel or aircraft disturbance of flocks of molting or staging waterbirds, could be considered widespread. Certain declining or limited-population species, including buff-breasted sandpiper, are among those of the many species at risk of collision. The long-term presence (i.e., life of the Proposed Action) of these facilities and vessels such as the assist tug means that these collision hazards would be on-going, although are not expected to cause impacts substantial enough, relative to most species' abundances, to be considered more than minor. Collision hazards would potentially reach a moderate level of impact, however, for listed spectacled eider, due to the high susceptibility of eiders to chronic collisions and flock events, and vulnerability of the low-population "non-recovered" listed species. It is conceivable that listed spectacled eider could be impacted by both increases in predator abundance and collision risk, as this population likely both breeds and migrates through the area.

The bright artificial lighting of the LDPI (i.e., ambient and occasional gas flaring) and some vessels (e.g., assist tug) would cause attractions, disorientations, and indirect effects via exhaustion and increased levels of collisions when certain environmental conditions are present during migration. Certain declining or limited-population species, including buff-breasted sandpiper, are among those of the many species at risk of collision. The long-term presence (i.e., life of the Proposed Action) of these facilities and vessels such as the assist tug means that these collision hazards would be on-going, although are not expected to cause impacts substantial enough, relative to most species' abundances, to be considered more than minor. Collision hazards would potentially reach a moderate level of impact, however, for listed spectacled eider, due to the high susceptibility of eiders to chronic and flock collisions and vulnerability of the species because of its low population.

Minor levels of impact are expected from most traffic disturbances. Aircraft traffic, given that low-level flights are only infrequently part of the Proposed Action, may also have a minor level of disturbance impact except for current direct routing that could take them across sensitive areas like nesting colonies. Such routing is expected to mean a moderate level of impact without mitigation. Birds generally move away from localized sources of disturbance. Other sources of disturbance are not anticipated to occur in areas uniquely important to birds (e.g., vessel disturbance of barrier-island nesters).

The impacts of terrestrial habitat alteration are expected to range up to minor. The permanent loss of habitat and displacement from habitats would persist across seasons. However, gravel extraction and pipeline construction activities are not anticipated to occur in areas uniquely important to birds, including listed species. Acreage of breeding habitat loss and fragmentation is small relative to tens of thousands of acres of available habitat. Marine habitat effects are expected to be negligible to minor as turbidity would be short-term, and benthic prey would recover in most areas from sedimentation, and the amount of foraging habitat affected is negligible relative to that available.

Effects from the physical presence of vessels, aircraft, vehicle traffic, or drilling facilities, including disturbance and mortality from birds encountering vessels and structures, and small spills, would not persist from season to season except for potentially a few vulnerable populations. Habitat alteration impacts, occurring primarily in the marine environment and not to nesting birds, would be localized and small scale. Decreased levels of productivity from higher predator abundance associated with increased human and infrastructure presence could result in more widespread and long-lasting impacts for a few vulnerable species. The levels of effect of the Proposed Action would be minor for most avian species. Some vulnerable (i.e., declining and limited) populations and listed spectacled eiders would be particularly susceptible to the additive effects of several impact-producing factors such as collisions, disturbance, and increased predation on the local nesting ground, however, and could incur more long-lasting and widespread, therefore moderate, levels of impact.

GIUEs (spill drills) would be infrequent and localized and are expected to contribute negligible impacts to birds. Impacts to birds as a result of NPDES-permitted discharges are expected to be negligible, with any potential impacts being intermittent, localized, and short-term in nature.

Alaska-breeding Steller's eiders breed almost exclusively on the ACP, but nesting is concentrated in tundra wetlands near Utqiaġvik, Alaska. The probability of Alaska breeding Steller's eiders occurring in the Proposed Action Area is so low as to be discountable. Thus, the Proposed Action is likely to have a negligible (to potentially eventually minor in the case of increased predation) level of effect on Steller's eider.

Appendix C describes mitigation measures derived from lease stipulations, design features and BMPs the operator committed to, and requirements and BMPs that other agencies typically require (Sections

C-1 to C-3). BOEM's conclusion above of overall impacts to birds assumes implementation of, and compliance with, the mitigation measures described in Sections C-1 through C-3.

The effects of the Proposed Action on birds may be reduced by implementing the proposed mitigation measures as described in this section and listed in Appendix C (Section C-4).

4.3.3.3 Alternative 2 (No Action)

Under this Alternative, the Proposed Action would not be approved and the actions described in the Liberty DPP would not take place. Impacts from the Proposed Action on birds, including listed species, from traffic or equipment operations disturbances, habitat alterations, collisions, increased predator abundance, oil spills, or spill response associated with the development of the Liberty DPP would not occur. Consequently, selection of Alternative 2 would result in no impact to birds, including listed species.

4.3.3.4 Alternative 3 (Alternate LDPI Locations)

4.3.3.4.1 Alternative 3A: Relocate LDPI Approximately One Mile to the East

This alternative would require (relative to the Proposed Action and impacts to birds) longer drilling time, a small amount more gravel mined, a negligible increase in seabed footprint, longer ice road, and more vehicle travel time, including potentially summer travel. Taken together, these aspects would be expected to increase effects to birds, primarily through disturbances and potentially increased number of small spills associated with lengthened drilling and travel time. These additional disturbance and small spill impacts would be localized and temporary, and therefore the increase would be expected to be relatively small. Nesting and brooding listed spectacled eider would be among those tundra-nesting birds affected. Spectacled eider local nesting density is relatively low, however, so increase in impacts should be minimal. In summary, the combined impact of routine activities associated with Alternative 3A on listed and non-listed birds would be moderate, although slightly increased above that of the Proposed Action. The moderate level of impact is primarily due to increased predator abundance that remains as described for the Proposed Action. While the discharge location would change (see Section 2.2.4.1), the overall impacts to birds as a result of NPDES-permitted discharges under Alternative 3A would be the same as the Proposed Action, which is negligible.

4.3.3.4.2 Alternative 3B: Relocate LDPI Approximately 1.5 Miles to the Southwest

This alternative substantially increases the drilling time (between 2 and 3 times longer), and requires a larger drill rig, less gravel, and a slightly smaller seabed footprint. A slight increase in the effects to birds, including both listed and non-listed species, may be expected, primarily because of a temporary increase in collision risk from the larger drill rig and increased length of drill rig presence. Unless the increased drilling time results in the drill rig being physically present as a collision hazard for a season or more, including months of low visibility during migration, that it would be under normal operations planned for the Proposed Action, the increase may be negligible. This Alternative is expected to result in a somewhat lowered level of effect on Boulder Patch organisms, which can be prey sources for marine birds. These differing levels for lower trophic resources are not substantial, however, especially given the relative alternative availability of benthic forage habitat for birds. The level of impact for routine activities associated with Alternative 3B, overall, is expected to be similar to that of the Proposed Action, i.e., moderate. While the discharge location and permitting jurisdiction would change (see Section 2.2.4.1), the overall impacts to birds as a result of NPDES-permitted discharges under Alternative 3B would be the same as the Proposed Action, which is negligible.

4.3.3.5 Alternative 4 (Alternate Processing Locations)

For both options of Alternative 4, the small differences in habitat alteration (i.e., less gravel mined and used for the LDPI) as compared to the Proposed Action would result in a negligible difference in impacts to birds. Other differences, however, have more significance and are explained below. Impacts to birds as a result of NPDES-permitted discharges under Alternatives 4A and 4B are the same as those for the Proposed Action, which is negligible.

4.3.3.5.1 Alternative 4A: Relocate Oil and Gas Processing to Endicott

This alternative would potentially cause less vessel and air traffic disturbance, because less vessel and air traffic may be needed between Endicott and the proposed LDPI, although the difference in traffic is not clear and the differences in disturbance, both temporary (i.e., during construction) and long-term, may be slight. More vehicle travel and usage of gravel roads in all seasons and for the life of the Proposed Action may also be expected, which could increase vehicle traffic effects on both listed and non-listed species. Overall, routine activities associated with Alternative 4A may have a similar impact level to that of the Proposed Action, i.e., minor to moderate.

4.3.3.5.2 Alternative 4B: Relocate Oil and Gas Processing to a New Onshore Facility

This alternative would be expected to have increased levels of impact on birds, because one of the greatest expected sources of impact, a large new lighted facility that is an attraction and collision hazard in an otherwise dark landscape where tens of thousands birds migrate, would be doubled with the addition of another new processing facility (plus the new LDPI). The additional few acres of terrestrial habitat loss and disturbance for the new onshore facility would affect numerous species of breeding birds, but the numbers of breeding territories lost would be small relative to overall population numbers breeding across thousands of adjacent acres. Permanent fragmentation of coastal habitat, while fairly localized, may occur however, and this may become more pronounced over the life of the Proposed Action as coastal erosion is also expected to occur (see Section 3.1.6). Increased chronic disturbance and long-lasting effects of predator abundance would also be expected from increased onshore human presence and the presence of a new onshore pad and facilities. Collectively, the potential impacts of routine activities associated with Alternative 4B would be numerous, substantial, and long-lasting. While none of the avian populations at risk of impact are currently critically imperiled, it is possible that over the life of the Proposed Action a changing environmental baseline would result in further declines to already declining vulnerable populations (e.g., listed spectacled eiders, non-listed shorebirds). While the impacts would not be expected to become large or widescale enough to be severe, because the avian populations are not expected to depend entirely on the Proposed Action Area for any life phase, the expected moderate level of impact would be distinctly greater than that of the Proposed Action.

4.3.3.6 Alternative 5 (Alternate Gravel Sources)

4.3.3.6.1 Alternative 5A: East Kadleroshilik River Mine Site #2

This site would require a 40 percent longer roundtrip gravel haul by truck, including a Kadleroshilik River crossing. Thousands of gravel truck hauls are required for the construction of the pads and LDPI, and most occur in the winter or spring when flightless birds are not present. Nonetheless, many may still occur after some birds have arrived in the spring, and the increased trip length also means increased areas for small spills to potentially occur, and, potentially, more small spills. The site is located about 0.5 miles from a previously identified Kadleroshilik River buff-breasted sandpiper lek, an important breeding feature and a bird of limited population size. This species' leks, however, are likely to be highly transitory in location (R. Lanctot, pers. comm., 2016), are not closely adjacent to nests, and the Alternative 5A mine site is primarily different habitat types than the previous lek site on the river's gravel bars. Increased impacts to birds and their habitats may be expected, primarily from the increased trip lengths, but routine activities associated with Alternative 5A would be expected to remain within moderate levels.

4.3.3.6.2 Alternative 5B: East Kadleroshilik River Mine Site #3

This site would require a 50 percent longer roundtrip gravel haul by truck, including a Kadleroshilik River crossing. Thousands of gravel truck hauls are required for pad and LDPI construction, and most would occur in the winter or spring when flightless birds are not present. Nonetheless, many may still occur after some birds have arrived in the spring, and the increased trip length also means increased areas for small spills to potentially occur, and, potentially, more small spills. These disturbance impacts would be limited to one year, however, and therefore routine activities associated with Alternative 5B would be expected to remain within moderate levels.

4.3.4 Marine Mammals

Section 4.3.4.2 explains the regulatory framework for underwater noise impacts assessments, noise thresholds for differing groups of marine mammals (Section 4.3.4.1), potential impacts from discharges (Section 4.3.4.2.10), and the potential impacts from decommissioning activities. The effects described in this section are the potential impacts of proposed activities on marine mammals in general. Section 4.3.4.3 analyzes and summarizes the potential species-specific direct and indirect effects of the Proposed Action. The Impacts Scale applied to determine level of impacts of the Proposed Action and all Action Alternatives is described in Section 4.1.2.2. For biological resources, including marine mammals, impacts were determined based on changes to the population rather than at the individual level.

4.3.4.1 Marine Mammals and Noise

Marine mammals use sound, sight, smell (olfaction), and somatic (orientation of the body) senses to interact with their environment. Some of the ways anthropogenic (human made) sound can affect marine mammals include:

- Behavior disruption
- Sound masking
- Hearing loss
- Physiological stress or injury
- Ecosystem changes

The frequency bands and source levels of industry-related sounds and the hearing frequencies of Arctic marine mammal groups are depicted in Figure 4-21. In some instances, the hearing frequency of a particular species may not have much overlap with noise frequencies associated with certain industry activities.

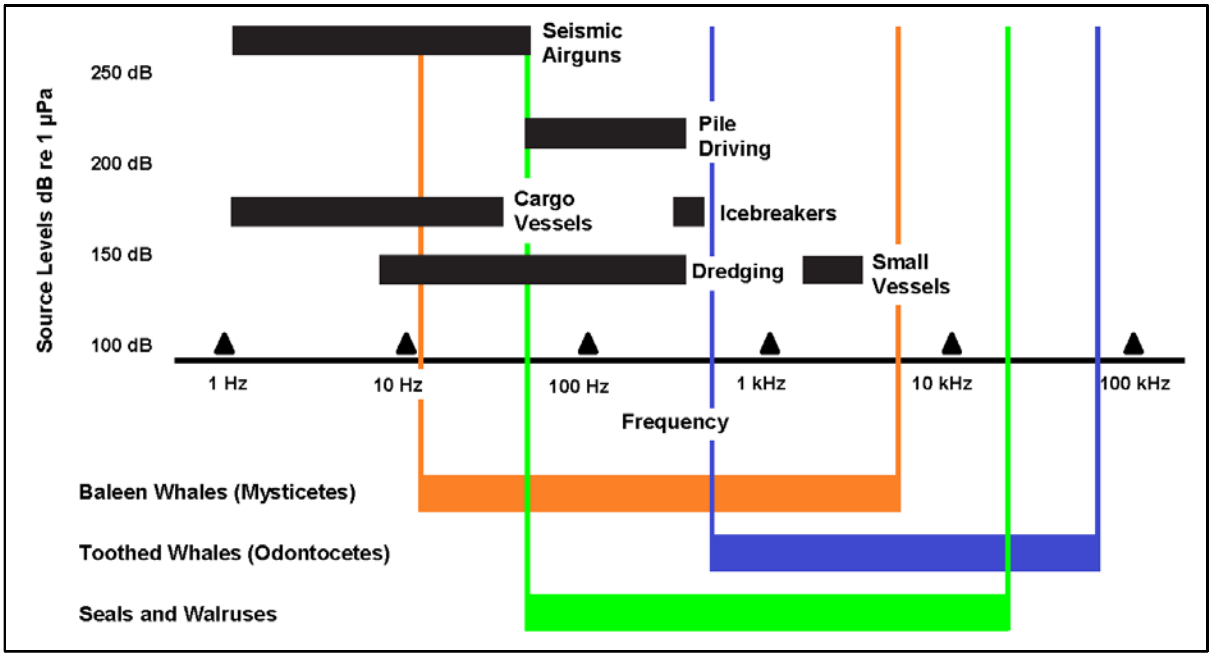

Figure 4-21 Frequency Bands and Source Levels for Common Arctic Offshore Activities
Source: Moore et al., 2012; Greene, 1995.

Different marine mammal species would be affected to varying degrees by the noise associated with the Proposed Action. Table 4-12 summarizes the upper and lower hearing ranges (called boxcar ranges) of several marine mammal species.

Table 4-12 Boxcar Frequency Range for Marine Mammal Hearing Groups

Species Group	Lower Limit (Hz)	Upper Limit (Hz)
Low Freq. (LF) Cetaceans (Bowhead and Gray Whales)	7	35,000
Medium Freq. (MF) Cetaceans (Beluga Whales)	150	160,000
Walruses, Polar Bears (in water)	60	39,000
Bearded, Ringed, and Spotted Seals (in water)	50	86,000

Note: [1] Frequency ranges follow that identified in NMFS (2016b).

Marine mammals have varying hearing capabilities with respect to hearing sensitivity and frequency (NMFS, 2016a). The NMFS (2016a) uses Sound Exposure Levels (SEL) over a 24-hour period as the preferred assessment tool for injury to marine mammals from impulsive and non-impulsive noise (Table 4-13 and Table 4-14), and gives direction on interim behavioral harassment thresholds (Table 4-15). BOEM's analyses are based on these NMFS thresholds.

Acoustic exposures can result in three main forms of noise-induced losses in hearing sensitivity:

- **Permanent Threshold Shifts (PTS).** A permanent, irreversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level. The amount of permanent threshold shift is customarily expressed in decibels. PTS is caused by physical damage to the sound receptors (hair cells) in the ear. Such damage produces permanent partial to total deafness within a range of audible noise frequencies.
- **Temporary Threshold Shifts (TTS).** A temporary, reversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level. The amount of temporary threshold shift is customarily expressed in decibels. Based on data from cetacean TTS measurements, a TTS of 6 dB is considered the minimum threshold shift clearly larger than any day-to-day or session-to-session variation in a

subject's normal hearing ability. TTS has been studied by determining the impact on sound receptors (hair cell damage). Because hair cell damage does not occur in a TTS, hearing losses are temporary, with recovery periods that can last minutes, days, or weeks.

- **Compound Threshold Shift (CTS).** CTS occurs when some loss in hearing sensitivity is permanent and some is temporary. For example, there might be a permanent loss of hearing sensitivity at some frequencies and a temporary loss at other frequencies or a loss of hearing sensitivity followed by partial recovery.

Table 4-13 and Table 4-14 illustrate NMFS' (2016a) new thresholds for continuous and impulse noise that can lead to either permanent or temporary threshold shifts (see definitions below the table) in hearing.

Table 4-13 Non-Impulsive Level A Harassment (Injury) Thresholds for Beaufort Sea Marine Mammals

Group	Species	PTS Onset	TTS Onset
LF Cetaceans	Bowhead, Gray,	199 dB SEL (Type II weighted)	179 dB SEL (Type II weighted
MF Cetaceans	Beluga Whales	198 dB SEL (Type II weighted)	178 dB SEL (Type II weighted
Phocidae (in water)	Bearded, Spotted, and Ringed Seals	201 dB SEL (Type I weighted)	181 dB SEL (Type I weighted)
Odobenidae (in water)	Pacific Walrus	219 dB SEL (Type I weighted)	199 dB SEL (Type I weighted)
Ursidae (in water)	Polar Bear	219 dB SEL (Type I weighted)	199 dB SEL (Type I weighted)

Note: Type I weighting is a baseline, while Type II weighting modifies Type I to account for new data showing increased susceptibility to noise at higher frequencies.
Source: NMFS, 2016b.

Table 4-14 Impulse Noise Level A Harassment (Injury) Thresholds for Marine Mammals

Group	Species	Onset PTS	Onset TTS
LF Cetaceans	Bowhead, Gray Whales	183 dB SEL or 219 dB Peak SPL	168 dB SEL or 213 dB Peak SPL
MF Cetaceans	Beluga	185 dB SEL or 230 dB Peak SPL	170 dB SEL or 224 dB peak SPL
Phocidae (in water)	Bearded, Spotted, Ringed Seals	185 dB SEL or 218 dB Peak SPL	170 dB SEL or 212 dB Peak SPL
Obodenidae Water	Pacific Walruses	203dB SEL or 232 dB Peak SPL	188 dB SEL or 226 dB Peak SPL
Ursidae Water	Polar Bears	203 dB SEL or 232 dB Peak SPL	188 dB SEL or 226 dB Peak SPL

Notes: The USFWS identifies 180 dB as the MMPA Level B harassment threshold.
Source: NMFS, 2016b.

NMFS uses interim behavioral harassment thresholds of 160 and 120 decibels, root mean square (dB_{RMS}) for impulsive and non-impulsed noises, respectively (Table 4-15). Noises are louder at the source and may propagate and attenuate out for several miles depending upon the activity and source levels (NMFS, 2013b, p. 197-198; 2016a). These behavioral thresholds serve as NMFS' criteria for Level B Harassment. Table 4-13 and Table 4-14 reflect the injury thresholds that serve as NMFS' criteria for Level A Harassment. The USFWS uses different injury and behavioral ($180dB_{RMS}$) thresholds (not shown in Table 4-13 and Table 4-14) for polar bears and walrus, respectively (Table 4-15). The USFWS has not yet defined new criteria for Level A or Level B harassment (pers. Comm. with C. Putnam, USFWS, February 2016).

Table 4-15 NOAA/FWS Current In-Water Behavioral Disturbance Thresholds, and FWS Injury Thresholds

Criterion	Criterion Definition	Threshold
Level A	PTS (injury) conservatively based on TTS	190 dB_{RMS} Polar Bears 180 dB_{RMS} Pacific Walrus
Level B	Behavioral disruption for impulsive noise (e.g., impact pile driving)	160 dB_{RMS} All Marine Mammals
Level B	Behavioral disruption for non-pulse noise (e.g., vibratory pile driving, drilling)	120* dB_{RMS}[1] All Marine Mammals

Notes: Thresholds exclude tactical sonar and explosives. All decibels referenced to 1 micro Pascal (re: 1µPa). All thresholds are based off root mean square (RMS) levels.
*The 120 dB threshold may be slightly adjusted if background noise levels are at or above this level.
[1] At present, the USFWS has focused on thresholds for impulsive noise and has not evaluated polar bear and whale Level B thresholds for continuous noise (pers. comm. with Christopher Putnam, USFWS, February 2016).
Sources: NOAA Fisheries, West Coast Region Interim Sound Threshold Guidance (NMFS, 2016b); USDOI, USFWS, 2013a. NMFS, 2016a.

Table 4-16 shows the distances from noise sources to the onset of behavioral responses expected for marine mammals. These noise thresholds are used to represent the onset of Level B Harassment under the MMPA.

Table 4-16 A Compilation of Distances from Noise Sources to Behavioral Thresholds for Continuous (120 dB_{RMS}) and Impulsive Noise (160 dB_{RMS})

Low-Frequency Noise Source	Median Distance to Behavioral Thresholds
LDPI Drilling	0.055 km / 0.05 mi
Production	0.045km / 0.28 mi
Gravel Trucks	3.26 km/2.03 mi
Vibratory Sheet Pile Driving	14.8 km / 9.2 mi
Impact Sheet Pile Driving	2.05 km/1.3 mi
Impact Pipe Driving	0.315 km/0.2 mi
Support Vessel (barge)	1.85 km / 1.15 mi
Support Vessel (tug)	0.8 km / 0.5 mi
Support Vessel (crew)	0.26 km / 0.16 mi
Hovercraft	0.07 km / 0.04 mi
General Slope Shaping, Armament Installation	1.16 km / 0.72 mi
*Bulldozer	1.16 km/0.72 mi/
*Augering	1.7 km/1.06 mi
*Pumping	1.83km/1.14 mi
*Backhoe	3.28 km/2.04 mi
*Ditch Witch	7.29 km/4.53 mi

Note: Distance from Low-frequency Noise Sources to 120 dB (ambient) Noise Levels Data.
* Represents under ice noise propagation.

Source: Funk et al., 2008; Blackwell, 2005; Richardson, Würsig, and Greene, 1990; Greene et al., 2008; Richardson, 1995a; Aerts et al., 2008; SLR, 2017.

Ambient sound levels near the Liberty site occurred at frequencies between 10 and 450 Hz with 95 percent of noises occurring between 70 and 100 dB_{RMS} (Greene 1998, Aerts et al., 2008). These results are consistent with similar sound measurements recorded near Northstar Island, between 2001 and 2003 (Blackwell and Greene 2006).

The proposed LDPI would be located in shallow water, approximately 19 feet deep. Noises below 160 Hz at this site have been found (Urick, 1983, p. 175; Katlai et al., 2009) to attenuate and the attenuation increases as the water becomes shallower. Consequently, noises below 160 Hz at this location should attenuate in the shallow water and seabed.

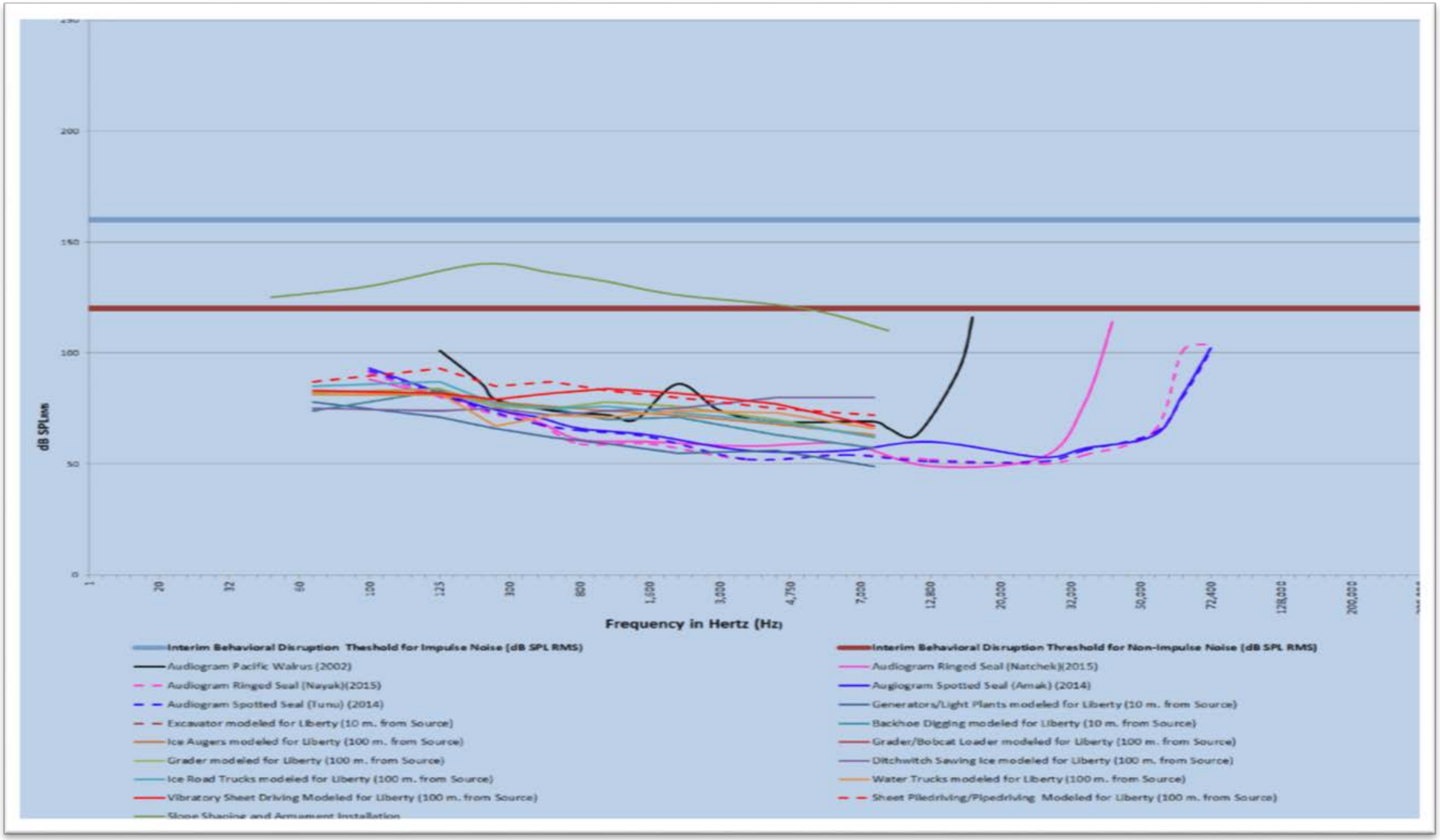

Figure 4-22 Ice Road and LDPI Construction Noise, Pinniped Audiograms, and the NMFS Interim Behavioral Disturbance Thresholds for Noise (Level B Harassment)

Audiograms compared to the sounds emitted by proposed construction equipment on ice road and proposed LDPI construction; includes NMFS and FWS harassment criteria thresholds.

Source: Sills et al. 2014; Sills et al. 2015; Kastelein et al. 2002; Greene et al. 2008; USFWS; NMRS, 2016a; SLR, 2017.

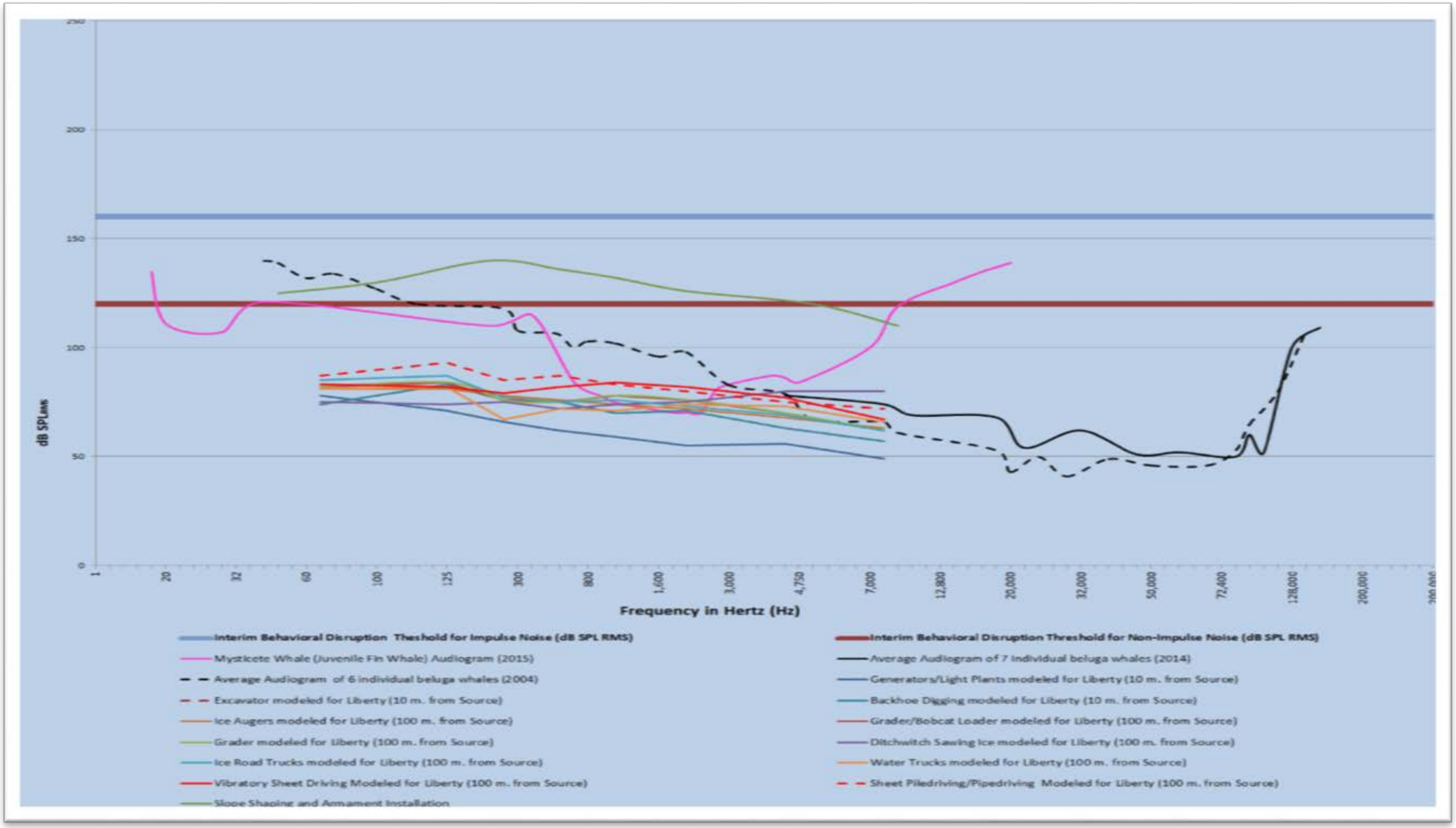

Figure 4-23 Ice Road and LDPI Construction Noise, Beluga and Mysticete Whale Audiograms, and the NMFS Interim Behavioral Disturbance Thresholds for Noise (Level B Harassment)

Audiograms of beluga whales compared to the sounds emitted by proposed construction equipment on ice road and proposed LDPI construction; includes NMFS harassment criteria thresholds.

Source: Awbrey, Thomas and Kastelein, 1988; Castellote et al, 2014; Greene et al. 2008; Johnson, McManus, and Skaar, 1989; Nedwell et al. 2004; White, et al. 1978, SLR 2014; NMRS, 2016a; SLR, 2017.

4.3.4.2 Impacts Common to all Species

4.3.4.2.1 Ice Road Construction and Heavy Equipment Operations

Ringed seals and polar bears are the only marine mammal species that would occur in the vicinity of ice road construction. Some bearded seals overwinter in the Beaufort Sea using lead systems and polynyas north of the LDPI site. Noise from ice road use could disturb some ringed seals in their dens.

During construction of the ice roads leading to the Northstar project, several bulldozers were in use simultaneously. Greene et al. (2008) determined ice road construction was one of the quieter activities occurring during the construction of the Northstar Project (Table 4-17). Construction methods for the Liberty project ice roads should be similar to those used at Northstar where heavy equipment, including bobcats (small bulldozers) and graders were used.

Table 4-17 Northstar Project Ice Road and Island Construction Heavy Equipment Noise

Sound Source	Broadband SPL at 100 m (dB_{RMS})	Frequency Bandwidth of Produced Noise ≥100 m (dB_{RMS})
Bulldozer	114.2	31.5 Hz–125 Hz
Augering	103.3	None
Pumping	108.1	500 Hz–1 kHz
Ditch Witch	122	<5 Hz - 3.15 kHz
Trucks	123.2	<5 Hz–500 Hz
Backhoe	124.8	<5 Hz–1.2 kHz
Vibrahammer, sheet-driving	142.9	23 Hz–25 Hz
Sheet Pile-driving	148	5 Hz–55 Hz
*Background Noise	78–110	20 Hz–5 kHz

Notes: * Highly variable due to environmental variables.
Source: Greene et al., 2008; Blackwell, Lawson, and Williams 2004.

4.3.4.2.2 Vehicles

Vehicle noise would have limited effects on marine mammals in the Beaufort Sea since vehicle use relevant to marine mammals would occur on ice roads. Greene et al. (2008) measured noises from gravel trucks at Northstar (123.2 dB_{RMS}) using hydrophones; SLR (2017) modeled the noise for vehicle use at LDPI and found it was much lower (Figure 4-22).

4.3.4.2.3 LDPI Construction

During Northstar construction in 2000, the underwater noise field was dominated by noises below 500 hertz (Hz), and exceeded ambient noise levels by about 45 dB. At about 0.6 miles from Northstar, the produced frequencies occurred below 100 Hz, while at 1.2 miles frequencies below 7 Hz and a few tones around 23 Hz were detectable above ambient levels (Shepard et al., 2001). Collectively, noises produced during Northstar construction in 2000 mostly remained under 300 Hz (Greene et al. 2008).

4.3.4.2.4 Gravel Mining

Gravel mining would not affect marine mammals other than polar bears and those effects will be analyzed in Section 4.3.4.3.3.

4.3.4.2.5 Vibratory and Impact Sheet, Pile-, and Pipe-Driving

Vibrahammers were initially used to drive sheet pilings during the construction of the Northstar facility (Shepard et al., 2001). A Vibrahammer is a heavy device attached to a standing sheet pile which vibrates vertically, driving the sheet into the ground. These vibrations are believed to mostly travel through soft substrate into the lower areas in the water column (Shepard et al., 2001), with greater transmission loss in shallow water. Noise transmission frequencies occurred at 24 to 25 Hz at

Northstar, and less than 50 Hz at two islands in Prudhoe Bay (Greene, Blackwell, and McLennan 2008; Shepard et al., 2001). The noise levels from vibratory sheet piling reached 143 dB_{RMS} at 328 feet from the noise source (Greene, Blackwell, and McLennan 2008). The collective broadband sounds from pile driving diminished to median background noise levels at 0.6 to 3.1 miles from the noise source. Of those noises, about 35 percent attenuated out within 0.6 miles from the source, while 55 percent of the noise dropped to ambient levels within 1.2 miles of Northstar (Greene, Blackwell, and McLennan, 2008; Blackwell, Lawson, and Williams, 2004). Impact pile driving was used to further set the piles deeper into substrate after sheet pilings were firmly planted. The noises produced by the impact pile driving mostly occurred at frequencies below 55 Hz and at levels up to 148 dB_{RMS} at 328 feet from the island (Greene, Blackwell, and McLennan 2008, Blackwell, Lawson, and Williams 2004).

SLR (2017) modeled vibratory sheet piling, impact pile driving, and pipe driving noise production for the LDPI (Table 4-18 and Table 4-19). They found noises from vibratory sheet, pipe, and pile driving could occur at levels having potential to cause injury within 0.5 miles of the LDPI (Table 4-18). Only vibratory sheet pile driving could impact marine mammal behavior beyond the McClure Islands but only during the open-water season (SLR 2017). Impact pile and pipe driving produce smaller zones of influence where behavioral disturbances (Table 4-19) could occur; all within Foggy Island Bay. It is anticipated that the longest duration of work would occur in the early open-water season and would last up to 15 days (see Chapter 2). The majority of pile driving (vibratory or impact) would occur during the ice-covered season, but some pile driving could occur during the open-water season (HAK has estimated that approximately 15 days of pile driving could occur in the open-water season). Thus, pile driving could be finished before cetaceans reoccupy the Beaufort Sea, but if not, some cetaceans could be exposed to noise. BOEM has proposed a mitigation measure (Appendix C, Section C-4) that would not allow pipe-/pile-driving to be conducted after August 1, which encompasses the initiation of the subsistence whale hunt (generally considered to begin about August 26), and provides for a quiet time prior to the beginning of the hunt. Adherence to this mitigation measure would reduce the potential for whales to be exposed to noise from pile-/pipe-driving.

Table 4-18 Modeled Distances from Impact Pipe Driving, Pile Driving, and Vibratory Sheet Driving at the Proposed LDPI to Onset of Permanent Threshold Shifts among Marine Mammals

Marine Mammal Functional Hearing Group	PTS Threshold for Impact Sheet Pile Driving	PTS Threshold for Impact Pipe Driving	PTS Threshold for Vibratory Sheet Driving
Low Frequency Cetaceans – bowhead and gray whales	2,526 feet (10 min.) – 6,365 feet (40 min.)	1,132 feet (30 min.) – 2,854 feet (2 hrs)	164 feet (2.5 hrs)
Mid Frequency Cetaceans – beluga whales	82 feet (10 min.) – 197 feet (40 min.)	32.8 feet (30 min.) – 88.5 feet (2 hrs)	<32.8 feet (2.5 hrs)
Phocid Seals – bearded, ringed, and spotted seals	689 feet (10 min.) – 1,725 feet (40 min.)	312 feet (30 min.) – 787 feet (2 hrs)	65.6 feet (2.5 hrs)

Source: SLR (2017).

Table 4-19 Modeled Distances from Impact Pipe-Driving, Pile Driving, and Vibratory Sheet Driving at the Proposed LDPI to Onset of Behavioral Threshold Shifts among Marine Mammals

Pile Driving Activity	Open Water		Under Ice Distance to Behavioral Thresholds
	Impulse Noise Behavioral (160 dB_{RMS}) Threshold Distance	Continuous Noise Behavioral (120 dB_{RMS}) Threshold Distance	
Vibratory Sheet Driving	---	10.9 miles	1,280 feet
Impact Sheet Driving	1.4 miles	---	295 feet
Impact Pipe Driving	0.25 miles	---	36 feet

Source: SLR (2017).

4.3.4.2.6 Other Construction Noises

Richardson (1995) concluded marine mammals generally do not avoid equipment operating on small islands. Under certain conditions some species may become curious and investigate such activities.

SLR (2017) found island construction activity noise would occur below the behavioral effects thresholds for all marine mammal species. Based on existing audiogram data, most construction noises would occur near the minimum hearing thresholds of seals, walruses (Figure 4-24), and whales (Figure 4-25). For these reasons, construction noises other than vibratory sheet, impact pile/pipe driving, should not adversely affect marine mammals.

4.3.4.2.7 Drilling

Underwater sound associated with drilling from an artificial gravel island is generally weak and inaudible beyond a few miles (Richardson et al., 1995). Most sound energy from drilling occurs at low frequencies with a peak below 250Hz and another around 1,000 Hz (NMFS, 2012a). These frequency ranges are audible to marine mammals (Table 4-12 and Table 4-13; and Figure 4-24 through Figure 4-25). Blackwell et al. (2004) found underwater drilling noises from Northstar occurred across the 10 Hz to 10 kHz broadband spectrum, mainly within the 700 Hz to 1.4 kHz bandwidth and at maximum levels of 124 dB_{RMS} at 0.6 miles, and attenuated to background levels within 5.8 miles from the source. Richardson et al. (1995) suggests drilling noise on man-made islands during normal ambient conditions would attenuate below audibility within 1.2 miles. However, it could be detectable up to 6.2 miles from the source during unusually calm periods (Greene and Moore, 1995).

Direct measurements of under ice drilling noise at Tern Island Shoal (the remnants of a man-made drilling island in Stefansson Sound) were made in 1997. Acoustic transmission loss occurred at ranges between 0.12 and 1.2+ miles and frequencies below 150 Hz (Greene 1997). Noise was undetectable beyond 1.2 miles, and below the low ambient noise levels in that area (Greene 1997). Greene (1997) noted the strongest components of drilling noise occurred at frequencies below 170 Hz. Even in close proximity (656 feet) from Tern Island, the highest detectable drilling sound occurred at 400 Hz. This was a high rate of attenuation, as expected for waters 19.6 to 23 feet deep, similar to those at the proposed LDPI.

SLR (2017) modeled noise for drilling at the Proposed LDPI (Figure 4-24 through Figure 4-25), however the model did not account for the shielding effects of the island itself (SLR, 2017; p. 16). Data in Appendix B (SLR, 2017) indicated drilling noise should occur at noise levels below marine mammal audibility, consistent with similar results measured at Sandpiper Island. Furthermore, drilling would occur within LDPI and inside of a building, which would reduce noise propagation. For these reasons, drilling noise should not exceed any behavioral (Figure 4-25) or injury thresholds (NMFS, 2016b).

If the mitigation described in Section 2.5.1 is implemented, the duration of the drilling period could be extended. Noise impacts to marine mammals resulting from an extended drilling period would be minimal due to the low numbers of marine mammals that should be present in the Proposed Action Area during the ice-covered or early open-water seasons.

4.3.4.2.8 Aircraft Noise

Aircraft associated with the Proposed Action would transit between the proposed LDPI and Deadhorse and/or the Endicott SDI.

Individual marine mammal responses to helicopters appear to vary depending on flight altitude and received sound levels. Pinniped species have exhibited overt escape responses to helicopters (Born et al., 1999; Richardson, 1995; Burns and Harbo, 1972; Faye, 1982).

Fixed-wing aircraft may be used to assess marine mammal habitat use, distribution, and movements as the proposed project progresses. Monitoring surveys are typically conducted with aircraft flying above 1,500 feet AGL, unless conditions become unsafe. Greene and Moore (1995) explained fixed-wing aircraft typically used in offshore activities were capable of producing tones mostly in the 68 to 102 Hz range and at noise levels up to 162 dB_{RMS} at the source. Though the noise levels of aircraft are insufficient to create physiological effects among marine mammals, it could produce behavioral responses that include avoidance, increased dive time, etc. The area immediately under the fixed-wing aircraft is where most reactions would be expected to occur.

Flights during winter and early spring would mostly affect polar bears, ringed and bearded seals. Flights occurring during late spring and the open-water season could impact all species of marine mammals found near the LDPI. Polar bears generally ignore aircraft flights unless they are being pursued. Pinnipeds could partially habituate to frequent aircraft flights up to a point; beyond that point, they could respond more overtly to increasing numbers of flights (Richardson, 1995). Cetacean responses to aircraft flights would be similar to those of pinnipeds.

A typical mitigation measure applied by NMFS and USFWS is for aircraft, including helicopters, to fly at 1,500 feet AGL when within 100 feet of whales or seals, or within 0.5 miles of walrus or polar bears (Appendix C, Section C-3). The assumed 1,500-foot AGL minimum flight altitude provision would reduce received noise at the water or ground surface. Imposing a stricter 1,500-foot AGL minimum flight altitude requirement (Appendix C, Section C-4) would further reduce impacts from aircraft sound to marine mammals.

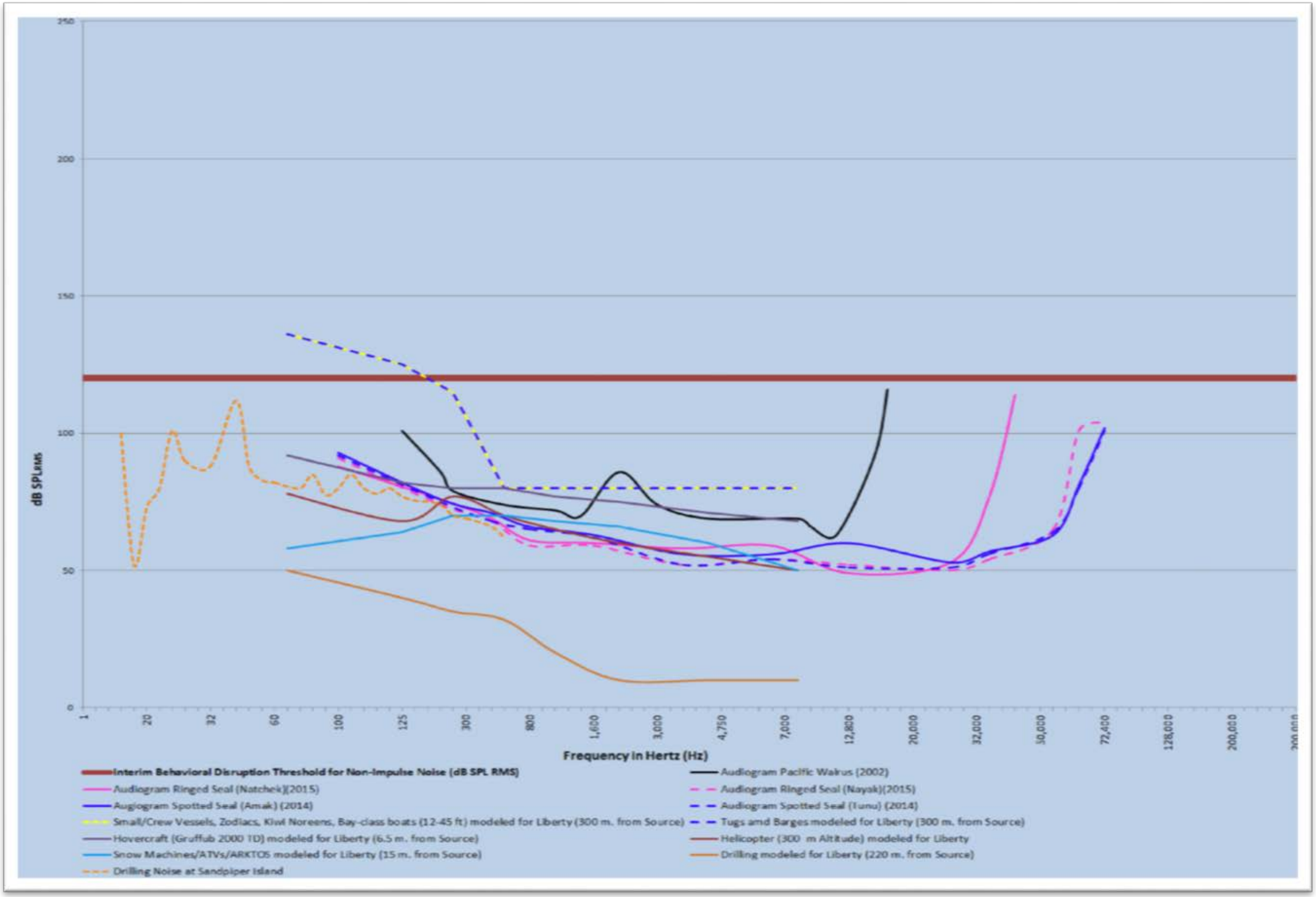

Figure 4-24 A Comparison of Vessel, Snow Machine, Hovercraft, Helicopter, and Drilling Noises; Ringed Seal, Spotted Seal, and Pacific Walrus Audiograms; and the NMFS Interim Behavioral Disturbance Threshold from Noise (Level B Harassment)

Source: Sills Southall and Reichmuth, 2014, 2015; Kastelein et al., 2002; SLR, 2017; NMFS, 2016a.

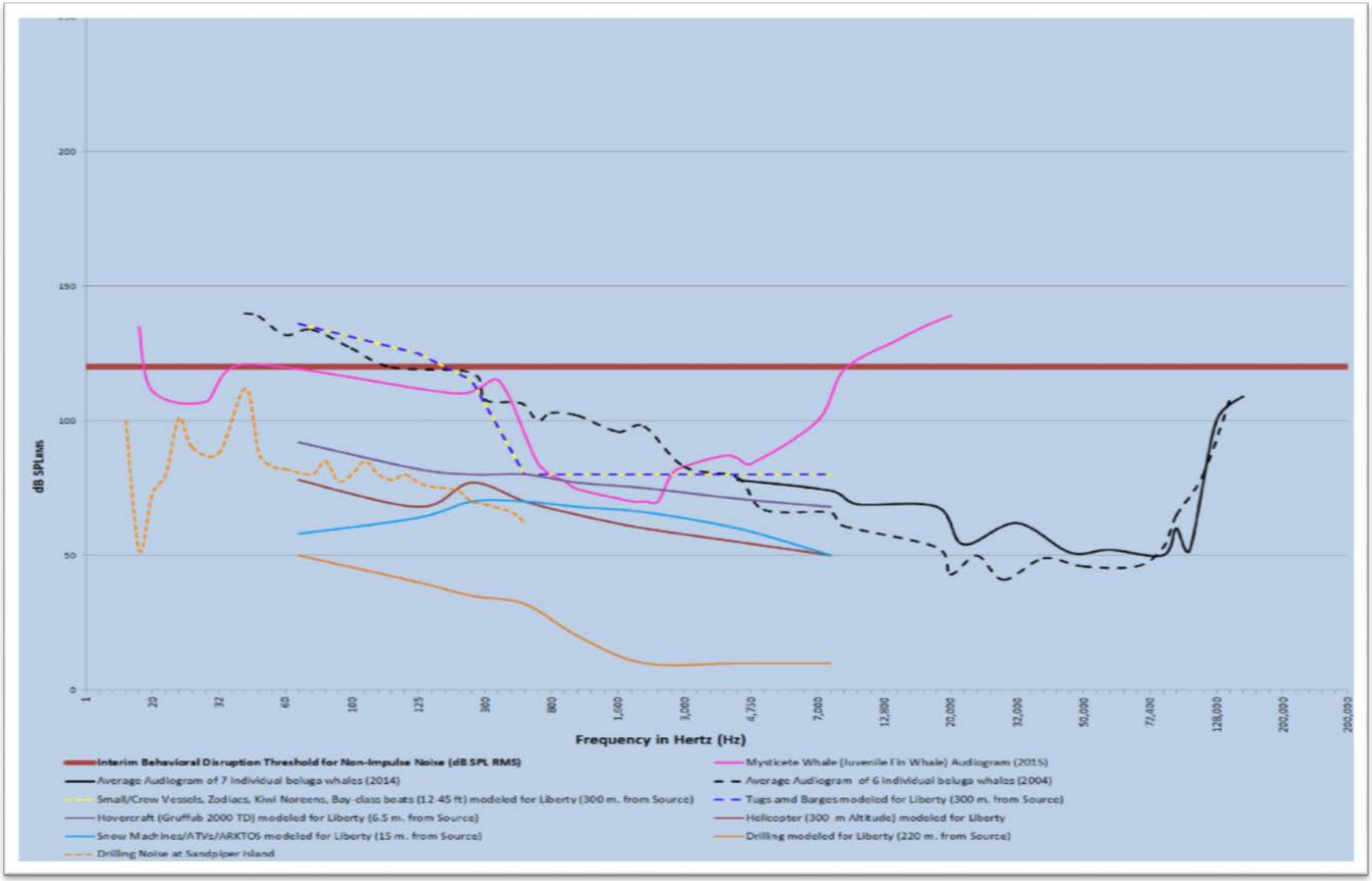

Figure 4-25 A Comparison of Helicopter, Drilling, Hovercraft, Snow Machine, and Vessel Noises, Beluga and Mysticete Whale Audiograms, and the NMFS Interim Behavioral Disturbance Threshold from Noise (Level B Harassment)

Audiograms of beluga whales compared to the sounds emitted by proposed helicopter, drilling, and vessel noises; and the NMFS harassment criteria thresholds.

Source: Miles et al. 1986; Greene and Moore, 1995; Awbrey, Thomas and Kastelein, 1988; Castellote et al., 2014; Nedwell et al., 2004; White et al., 1978; Johnson, McManus, and Skaar, 1989; NMRS, 2016a; SLR, 2017.

4.3.4.2.9 Vessel Noise and Presence

Impacts to marine mammals from vessel operations would occur in the vicinity of the Liberty Proposed Action Area during the open-water season (July through November). In addition, some impacts may be associated with a limited number of barge trips from Dutch Harbor, Alaska to offload materials at West Dock or Endicott to support construction activities. Vessels effects include noise, visual presence, exhaust emissions, traffic frequency, and vessel speed. Marine mammal species, (primarily seals and a few belugas), may be exposed to vessels when seasonal distribution and habitat selection overlaps in time and space with proposed vessel activities in Foggy Island Bay. A mitigation measure typically required by NMFS (Appendix C, Section C-3), requires a reduction in vessel speed within the North Pacific right whale critical habitat. This serves not only to reduce impacts to North Pacific right whale, but to other marine mammals in the area. Vessels are among the loudest regularly occurring man-made sound sources in the U.S. Beaufort Sea (NMFS, 2012b). Vessel sounds associated with existing artificial gravel island operations (e.g., Northstar, Blackwell and Greene, 2006) could affect marine mammals. Larger vessels produce tones at approximately 50 Hz (Richardson et al., 1995). Tugs pulling empty barges can produce noise at 145 to 170dB_{RMS} (Richardson et al., 1995, Table 6.3). Sound from tugs at Northstar was detected 13.4 miles from the source (Rodrigues and Ireland, 2009). Because vessel sounds rapidly attenuate in shallow water, the likelihood of exposures to marine mammals would be reduced. Tug boat sounds were detectable 18.6 miles from Northstar on days with average background noise levels (Blackwell et al., 2009; Blackwell and Greene, 2006). Detectable sounds are not necessarily audible to all marine mammals and may not exceed NMFS' thresholds for injury or behavioral impacts.

Project vessels would operate primarily during open-water and early winter periods. Barges, a hovercraft, and other vessels would be used to transport equipment, personnel, and supplies to the LDPI during the open-water season (Hilcorp, 2015). Vessel presence and noise has the potential to disturb and temporarily displace whales from transit routes. Vessel traffic in support of construction activities would occur in nearshore areas, inshore of the bowhead and beluga whale migration corridors (NMFS, 2012b), and should decrease to background levels within 0.2 miles (Table 4-20).

Whales often tolerate the approach of slow-moving vessels within a few thousand feet, especially when the vessel is not headed towards the whale and when there are no sudden changes in direction or engine speed (Heide-Jorgensen et al., 2003; Richardson et al., 1995; Wartzok et al., 1989). In comparison, pinnipeds typically show limited responses to vessels such as increased alertness, diving, moving from the vessel's path by up to several hundred feet, or by ignoring the vessel.

Non sound related reactions to vessels by marine mammals could occur much closer to vessels. A number of variables determine whether a marine mammal is likely to be disturbed by vessels, including wind direction, the number of vessels, distance between a vessel and the animal, vessel speed and direction, vessel type or size, habituation, threat association, and activity of the marine mammal (e.g., feeding, resting, sleeping).

Table 4-20 Extent of Noise above Interim Behavioral Thresholds for Transportation Activities

Activity	Radius of Noise above Behavioral Threshold				
	Ice Covered	Minimum (Open-Water)	Median (Open-Water)	Maximum (Open-Water)	Airborne
Vessel Traffic, barge (2 hrs/day)	n/a	4,921 feet	6,070 feet	7,218 feet	<49.2 feet
Vessel Traffic, Tugboat (2 hrs/day)	n/a	2,493 feet	2,887 feet	3,346 feet	<49.2 feet
Vessel Traffic, Crew Transport (4 hrs/day)	n/a	656 feet	853 feet	1,050 feet	<49.2 feet
Hovercraft Traffic	n/a	~32.8 feet	230 feet	312 feet	49.2 feet
Helicopter Traffic	n/a	n/a	n/a	n/a	220 feet

Source: SLR 2017

Motorboats modified to run more quietly had improved successes at moving among cetaceans without producing reactions (Schevill, 1968). Pinnipeds in Alaska have habituated to the presence of large vessels unless approached to within approximately 656 feet (Richardson 1995). Richardson (1995) cited studies from Salter (1979) and Fay (1981) in which walruses showed no detectable response to motorboats unless approached too closely. Walruses respond to smells from the vessels and may be approached more closely downwind, but will flush rapidly when approached upwind.

Polar bear reactions to vessels vary depending upon the bear and the situation. Females with cubs are more likely to be wary and avoid vessels, yet adult males may indulge their curiosity and approach vessels. Polar bears tolerate large vessels unless being directly approached (Richardson, 1995), in which case they often attempt to escape. All polar bears are less likely to flee while engaged in eating or resting at a carcass. Since vessels would be in open water and less likely to encounter polar bears, only vessels operating near barrier islands or near sea ice would be likely to disturb polar bears.

The responses of mysticetes are mixed, showing tolerance to vessels that are stationary or distant, and strongly avoiding nearby moving vessels. The responses of odontocete whales differed from those of mysticetes since most toothed whale species commonly approach moving vessels that they do not perceive as threats. However, some species, such as belugas, may display strong avoidance reactions to vessels particularly if they belong to a hunted population (Richardson, 1995).Mysticete whales have long lifespans; bowheads in the western Arctic were commercially hunted until the 1960s and may associate large vessels with whaling. In comparison, odontocetes such as killer whales regularly approach vessels of all size classes, and some dolphins and porpoises seem to relish “riding” in the bow waves of passing vessels. Beluga reactions to vessels are mixed and may vary with location. Some belugas in the Gulf of St. Lawrence seasonally habituate to boats, while others in Arctic Canada show strong escape reactions from vessels and icebreaking (Richardson, 1995). Polacheck and Thorpe (1990) noted harbor porpoises tended to swim away from approaching vessels, while Evans et al. (1994) found varying harbor porpoises responses according to vessel size and behavior.

Small vessels less than 279 feet long can quickly respond to marine mammals in relatively short distances to avoid collisions. When operating, vessel speeds can exceed 16.5 knots. Laist et al. (2001) noted 89 percent of all whale collisions where a vessel killed or severely injured a whale occurred with vessel speeds in excess of 14 knots. No collisions occurred at speeds below 10 knots. The limited distribution of whales in this area and the increased maneuverability of the boats due to their small size will reduce the possibility of ship strikes to whales and other marine mammals. However, requiring vessels to operate at speeds below 10 knots when traveling between worksites and the West Dock or Endicott would further reduce the risk of collisions.

Vessel transits between Dutch Harbor and the proposed Project Area could encounter several species of cetaceans and pinnipeds including those found in the Beaufort Sea and those from the Bering and Chukchi seas. The NMFS (2013, 2016b) analyzed the potential for vessel noise, presence, and strikes on marine mammals in this transit route and concluded the adverse effects were unlikely.

BOEM’s conclusions regarding impacts assume implementation of, and compliance with, the mitigation measures described in Sections C-1 through C-3. Particularly relevant measures include those required by NMFS (see Section C-3) that mitigate the effects of vessel traffic through speed limits and avoidance maneuvers. BOEM has also developed an additional mitigation measure (see Section C-4) requiring vessels traveling between West Dock / Endicott and Foggy Island Bay travel at speeds at or below 10 knots to further reduce collision risk.

Cetaceans in the Proposed Action Marine Transit Route (MTR)

Some ESA-protected cetaceans could be encountered when vessels are operating in the MTR from Dutch Harbor to the Prudhoe Bay region (Figure 2-4). Marine mammals in this portion of the MTR include the blue, fin, humpback, killer, North Pacific right, minke, sperm whales, harbor seals, harbor porpoises, Steller sea lions, and sea otters. Critical habitat for the North Pacific right whale is located in the southeastern Bering Sea. Bering and Chukchi sea species are less abundant and occur only during the open water season, which means they are less likely to encountering vessels than bowhead and gray whales.

4.3.4.2.10 Discharges

Wastewater

During the drilling and operation/production phases of the Proposed Action, no discharges of waste or camp wastewater are planned. Such materials would be injected into a waste disposal well, unless that well is temporarily non-operational. Occasionally, unforeseen events could occur that might necessitate discharging wastewater; however, such discharges would be in accordance with NPDES permits or collected and disposed of at an appropriately permitted onshore facility. Consequently, wastewater discharges under normal operation conditions should not affect marine mammals. Discharges from vessels would be in compliance with USCG requirements and should not affect marine mammals.

Sedimentation

The winter placement of gravel fill for the LDPI and pipeline installation would increase suspended sediment concentrations in the marine waters in the immediate vicinity of the construction sites and create a turbidity plume extending into nearby areas. During the open-water construction season, as compared to winter construction, decreased TSS concentrations are expected. The deposition of fill materials and excavation of the pipeline route would occur during winter when ringed seals and the occasional polar bear would be the only marine mammal species found in the vicinity of the Liberty Project. Turbidity generally doesn’t directly affect marine mammals except through effects to their prey species.

Sedimentation from the construction of the LDPI and the pipelines would result in a short-term release of sediments into the water which would be dispersed across a broad area and should not affect marine mammals directly. Some impacts to prey species could occur and were described in Section 4.3.1, Lower Trophics, and Section 4.3.2, Fish.

4.3.4.2.11 Accidental Oil Spills

**Note: This document refers to “bbl” or barrels of oil. One bbl of oil = 42 gallons.*

Section 4.1.1 describes assumptions concerning spills.

Small and large oil spills are unauthorized events, and considered accidental. Accidental events could include small (less than 1,000 bbl) and large (greater than or equal to 1,000 bbl) spills stemming from the LDPI or the pipeline.

Small Oil Spills

Small refined oil spills (less than 1,000 bbl) could occur at any time. Small refined oil spills would evaporate and disperse within 3 days or less during summer (Appendix A, posted at www.boem.gov/liberty, Tables A.1-7 and A.1-8).

Large Oil Spills

Impacts to marine mammal species from spills greater than or equal to 1,000 bbls would depend on the location, timing, duration, sea and climatic conditions, and response to spill events.

Potential physiological effects that could lead to reduced marine mammal fitness include:

- Irritation, inflammation, or necrosis of skin; chemical burns of skin, eyes, mucous membranes; and inhalation of toxic fumes with potential short- and long-term respiratory effects (e.g., inflammation, pulmonary emphysema, infection), potentially leading to mortality.
- Partial or extensive coating of pelts with oil for polar bears would reduce insulation and could result in hypothermia and ingestion of oil during grooming; either could result in mortalities.
- Ingestion of oil directly or via contaminated prey, leading to inflammation, ulcers, bleeding, damage to liver, kidney, and brain tissues, potentially leading to mortality.
- Disturbance from beach cleanup crews, vessels, and aircraft during spill response and cleanup.
- Oil coating baleen in mysticete whales which could adversely affect baleen functionality in sieving food from seawater.

Beluga, bowhead and, to a lesser extent, gray whales can occur in the vicinity of the Proposed Action Area during the open-water season (Section 3.2.4.1) and could potentially be affected by summer oil spills or winter spills after oil freezes into sea ice and releases into the water as the ice melts. Bowhead whales may be vulnerable particularly to oil-spill effects due to their use of ice edges and migration through leads where spilled oil may accumulate (Engelhardt, 1987). The bowhead whale spring migration across the Alaska Beaufort Sea occurs progressively farther offshore than the fall migration. Consequently bowhead whales would be less likely to contact spills in spring than in fall since they would be farther from the proposed LDPI or its pipeline. Beluga whales concentrate along the continental shelf break which, like the bowhead spring migration, is far offshore of the Proposed Action Area, reducing the potential that belugas would contact spilled oil. As nearshore foragers, gray whales tend to occur closer to coastlines; this would put them at compatibly great potential for contact with oil spills. However, gray whales occur only occasionally in the Beaufort Sea and are sparsely distributed, reducing the likelihood that a spill from the Proposed Action would contact individuals of this species.

Individual whales could encounter the spilled oil and experience direct effects through exposure, and possibly secondary effects through the ingestion of contaminated prey depending on the time of year the spill occurs. However, oil does not adhere to cetacean skin in the same way it does to the pelage of other marine mammals (Engelhardt, 1983; St. Aubin, 1992). Consumption of contaminated prey and the reduction or mortality of local forage fish populations could create periods whereby prey would not be available for an undetermined time period. For example, the fish and invertebrate populations preyed on by beluga whales within the Action Area (i.e. shrimp, cephalopods, Arctic and saffron cod) are vulnerable to oil contamination (Sections 4.3.1 and 4.3.2).

Complications of the above may lead to reduced fitness, injury, and mortalities (NRC 2003; Geraci 1990). Determining mortality rates for marine mammals, particularly for cetaceans, during an oil spill can be difficult. Gray whales found after the 1969 Santa Barbara spill were initially thought to have died from the spill, but that conclusion was reversed after examination of the whales found no linkage to the spill. Similarly, the dead, stranded gray whales observed after the EVOS could not be linked to the spill, and the increased observations of strandings were attributed, at least in part, to the increased search effort associated with the spill (NRC 2003). Many carcasses sink after death and cannot be recovered, making effects determinations for such events problematic.

Large on-ice spills should be contained and cleanup operations begun before contacting open water. Oil spill events occurring during late summer could overwinter and result in contact with polynyas and lead systems the following spring. If a spill occurred in an area near the ice edge or where pack ice was present, marine mammals that use this habitat could be impacted. Weathering should decrease the volatility and toxicity of the spilled oil if the oil became frozen into sea ice.

Oil Spill Response and Cleanup

In the central Beaufort Sea, cleanup activities following an open-water oil spill could involve multiple marine vessels operating in the spill area for extended periods of time. As noted in the discussion of impacts associated with vessel traffic, cetaceans and pinnipeds may react to the approach of vessels with avoidance behavior, or the potential for vessel collisions with marine mammals could increase. Vessels would typically be responding to surface oil. Whales, walrus, and ice seals may be displaced from oiled areas, reducing the potential for contact. In oiled feeding areas, whales, walrus, and ice seals would have a reduced potential for fouling baleen or ingesting oiled prey as long as the vessels were present.

After a large oil spill, helicopter and fixed-wing aircraft overflights would typically be used to track the spill and to monitor distributions of marine wildlife. This monitoring helps guide response, and efforts are made to prevent oil from contacting important animal concentrations or concentration areas. Impacts to marine mammals from aircraft encounters would be transient and animals would typically resume normal activities within minutes.

Marine mammals displaced from oil-contaminated areas by cleanup activities could reduce the likelihood of direct contact with oil. Alaska Clean Seas (2016) and HAK have existing strategies for hazing polar bears away from contaminated areas, with prior authorizations from the FWS to intentionally harass polar bears as necessary.

Implementation of the Proposed Solid Ice Condition (Section 2.5.1) would reduce the possibility of spilled oil contacting marine mammals during the initial drilling of the Liberty production wells. Since bearded seals would be in the lead systems outside of the barrier islands and all other marine mammals would be wintering in areas south of the Arctic, those species would remain unaffected in the event of a large spill on solid shorefast ice. This mitigation would have no effect on a spill originating from a pipeline.

Spills Under Ice

Depending on the location of the spill, large oil spills occurring under sea ice could spread into Stefansson Sound, or rise to the undersea face of the shorefast ice. During spring, some of this oil would likely be transported through the ice to the top of the affected shorefast ice area via capillaries, or reach the water’s surface when broken ice develops. Some of that oil could be cleaned up using conventional methods until shorefast ice degrades and no longer safely permits cleanup activities. If left untreated, the oil remaining in the ice would subsequently break up with the ice and gradually disperse in chunks of ice into the Beaufort Sea. Occurrence of such oiled sea ice would most likely be dispersed over a broad area and the ensuing effects would be similar to those of small spills.

Spills occurring under ice or in the brief period when broken ice is present would be cleaned and removed using techniques developed by Alaska Clean Seas (2016), and HAK.

4.3.4.3 Species-Specific Effects

The species-specific effects analyses for marine mammals addresses the impacts of the Proposed Action on the biology and/or ecology of marine mammals only. Due to differing scales of effect they are not interchangeable with effects analyses for other resources in this document.

4.3.4.3.1 Whales

The Proposed Action

Vessel Traffic in the MTR

Ships can injure whales near the surface (Silber et al., 2010; Laist et al., 2001).

Though the sub-arctic whales differ from bowhead whales in many ways, their auditory abilities, sensitivities, behavior, and physiology are similar enough that the effects analysis for bowhead whales is applicable to any whales that could occur in the MTR. Vessel traffic could affect cetaceans along the transit corridor in a manner consistent with the impacts discussion for bowhead whales.

More specifically, it is unlikely that vessels would strike sub-arctic whales for the following reasons:

1. Few, if any, blue and sperm whales could be encountered because they are generally found in deeper waters than those in which the transit route will occur, and are rare.
2. Only about 29 North Pacific right whales are known to exist
3. Few western North Pacific gray whales have been documented outside their feeding areas in waters around Sakhalin Island, Russia.
4. Mitigation measures that are relevant to vessels and are typically required by NMFS and WS (described in Appendix C, Section C-3) reduce the likelihood of vessel strikes.

Potential Effects on North Pacific Right Whale Critical Habitat

Vessel traffic during activities associated with the MTR could have the potential to affect North Pacific right whale critical habitat primarily through precluding individual whales from using critical habitat due to physical disturbance and noise. For example, whales could be temporarily excluded from a feeding area because of avoidance behavior. Long-term exclusion from a resource is not likely due to the short duration of vessel transits and the size of the area of suitable and accessible North Pacific right whale habitat in Alaska’s marine waters. Vessels can also be involved in discharges of oil or other substances carried by ships.

Right whale critical habitat in the Bering Sea was designated because it is a feeding area for the whales, supporting a large aggregation of prey (copepods). The physical presence of any vessel and the noise created by them would not directly affect the essential feature of right whale critical habitat; rather, they could temporarily make the single feature near the vessels less attractive to right whales. Effects would be short-term and would last as long as the vessels are present. Limited vessel traffic through the MTR is expected to have minimal impacts to the critical habitat, especially if vessel traffic transits around the area rather than transiting through the critical habitat.

The degree to which exclusion adversely affects North Pacific right whales depends on many factors; however, because of their mobility and the vastness of their open water habitat, the effects of a limited number of annual vessel transits on the ability of North Pacific right whales to access their resources in the Bering Sea critical habitat would be relatively low, with only temporary effects, if any.

Please see Section 5.2.1 for a discussion on discharges associated with the marine vessels conveying material to the LDPI within the MTR.

Large Oil Spills

In the unlikely event that a large oil spill from the LDPI were to move into the western Beaufort Sea or the Chukchi Sea, sub-arctic whales, such as fin and humpback whales that could occur in the MTR, are only present during the open water season, occur in very low numbers, and appear widely distributed in the Chukchi Sea with greater abundance occurring in the Russian portions of the Chukchi Sea. The observation and data records regarding these whales observed in the Action Area indicate so few occur there that only one important habitat was identified offshore of Point Hope where it is used from June to September. A few individual whale species could experience similar effects as noted for bowhead whales if contacted by oil during the ice-free period. A large oil spill could result in some individual whales coming into contact with oil, potentially resulting in inhalation of hydrocarbon vapors, baleen fouling, and ingestion of contaminated prey. Temporary displacement from feeding and resting areas could also occur. Whale prey (schooling forage fish and zooplankton) could be reduced or contaminated leading to modified distribution of whales. Temporary and/or permanent injury and non-lethal effects could occur, but mortality is not likely. The effects of large crude oil spills, or natural gas releases would be similar to what was described for bowhead whales.

Reduction or contamination of food sources would be localized relative to the available prey in the western Beaufort and Chukchi seas to whales. Exposure to contaminated prey multiple times over the long lifetime of these whales could increase contamination of tissues through accumulation. This likely would not affect large numbers of whales, because they would be exposed to contaminated prey in localized areas. Because the percent chance of large oil spills occurring is unlikely, infrequent consumption of contaminated prey is unlikely to accumulate to levels that would harm individual whales.

Oil Spill Response Activities

The effectiveness of OSR activities to large oil spills varies from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions and it is reasonable to expect emergency response and cleanup activities that involved aircraft and vessel deployment.

The spill response may include activities that intentionally deflect whales away from or around spilled oil or cleanup operations and other areas of human activity (large numbers of cleanup workers, boats, and additional aircraft). Whales would likely avoid the noise related to a spill response, cleanup and post-event human activities similar to that noted for bowhead whales. Such activities may have limited success depending on whale opportunity, ability, and inclination to avoid the activity, or detour around a spill. Specific animal deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs.

Some displacement from high-value feeding habitats could occur, depending on the circumstances of a specific spill event, if a spill occurs, and that an area important to whales is affected when they are present. Cleanup activity during the open water period is anticipated to result in few impacts to whales because the tendency and opportunity to avoid activity would not be hindered by ice conditions.

Beluga Whales

Ice Road Construction and Use

Ice road construction and use would not affect beluga whales because they are absent from the Proposed Action Area during winter and spring when ice roads would be constructed and used.

Mine Site Development

Mine site development would not affect beluga whales because mine activities would occur onshore with no impacts to the aquatic environment.

LDPI Construction

Most construction would not impact belugas because it would occur during winter and spring when beluga whales are absent. Noise from slope protection installation could potentially impact belugas during the first year of the Proposed Action. General impacts from LDPI construction are detailed in Section 4.3.4.2.

Sheet-, Pile-, and Pipe-Driving

Belugas have been sighted in the Proposed Action Area (Aerts et al., 2008) and occasionally occur near Northstar and Endicott (Aerts et al., 2008; Streever and Bishop, 2013). However, most beluga whales occur in deep water along the continental shelf break, and would be absent and unexposed to project-related effects (Clarke et al., 2015a).

Several audiogram studies completed on belugas (e.g., Awbrey, Thomas and Kastelein, 1988; Castellote et al., 2014; Johnson, McManus, and Skaar, 1989; White et al., 1978) found their functional hearing range overlaps with the frequencies and levels of sounds produced by island construction (Table 4-16, Figure 4-23 and Figure 4-25). While sound source levels from impact pile-/pipe-driving could exceed injury thresholds (Table 4-13 and Table 4-14) portions of the frequencies produced would be too low to be detectable by belugas (Figure 4-23).

Pile-driving noise would attenuate in the shallow environment of Foggy Island Bay, reaching ambient background levels within several miles. Belugas near the LDPI would be exposed to noise up to 148 dB_{RMS} in the 5 to 55 Hz range, from impact and/or vibratory sheet-/pile-driving during construction, and would likely respond by avoiding the area. Masking by pile-driving noises would occur over a limited portion of the frequency range belugas can hear; however, because of the limited bandwidths being masked, adverse effects should not occur (Gales, 1982).

SLR (2017) found the distance to the interim behavioral thresholds (Table 4-15) for vibratory sheet-driving and impact sheet-/pile-driving were 951 feet and 295 feet under ice, respectively, and up to 10.8 miles (within the barrier islands) and 1.4 miles in open-water, respectively. Of these, only sheet-, pile-, or pipe-driving in open water has the potential for creating injury (SLR, 2017). The distances from the Proposed LDPI to interim behavioral thresholds from impact sheet-/pile-driving were 295 feet under ice, and up to 7,382 feet in open-water. For injury thresholds, the distance would extend out to 121 feet (SLR 2017).

Vibratory sheet-driving should not injure beluga whales for several reasons, including that most sheet- and pile-driving would be completed during the ice covered season when belugas are absent, although potentially being conducted up to 15 days during open-water, there are low numbers of beluga observations in Foggy Island Bay; and the zone of injury is small (see above). Although the zone for behavioral effects extends for several miles, vibratory sheet-driving should not adversely affect beluga whales for similar reasons, i.e., they are unlikely to be in the area when the work is being done. Furthermore, mitigation measures are described in Appendix C that would serve to reduce exposure to these sounds. Section C-2 indicates that HAK would stop impact pile-driving if it places sounds above 120 dB in the water during the bowhead whale migration. Furthermore, a BOEM-proposed mitigation measure (Appendix C, Section C-4) would not allow pipe-/pile-driving to be conducted prior to, and during, the subsistence whaling hunt. Adherence to this mitigation measure would reduce the potential for exposure to any noise from pile-/pipe-driving.

If the Proposed Solid Ice Conditions (Section 2.5.1) were to be implemented, the duration for the drilling activities could be extended for additional months or years. Drilling noise is anticipated to have little to no impact on belugas, and although the duration of drilling noise would be extended, drilling impacts would not change.

Vessel Traffic

Beluga whales respond to vessels by altering call types, frequency use, and call rates, and avoiding ships (e.g., Finley et al., 1990; Lesage et al., 1999). The response of belugas to vessels is thought to be partly a function of habituation (NMFS, 2012b).

Sound levels produced by small and large vessels can exceed the behavioral threshold for belugas (Table 4-12 and Table 4-15; Figure 4-25), and injury thresholds for belugas are higher (Table 4-13). Studies at Northstar indicate sound source levels from hovercraft may also exceed behavioral thresholds (131 to 133 dB_{RMS} at 213 feet) (Blackwell and Greene, 2005; Blackwell et al., 2009). SLR (2017) modelled the vessel and hovercraft noises associated with the Proposed Action (Figure 4-25 and Table 4-22), and found the noises could exceed the interim behavioral threshold for beluga whales out to 1.37 miles for vessels and 312 feet for hovercraft. A small percentage of the noise produced could injure beluga whales and none of it occurs at levels exceeding injury thresholds

(Figure 4-25). Figure 4-25 shows the noise produced by vessel traffic would exceed the behavioral threshold for belugas at the lower end of the noise audibility spectrum (SLR, 2017).

Individual belugas that encounter vessel traffic associated with proposed LDPI construction would likely respond by avoiding the area. Physical impacts, such as ship strikes, are not anticipated because belugas would detect and avoid areas near vessels where sound exposure levels exceed tolerable limits, and because belugas are able to outmaneuver slow-moving vessels.

Aircraft Traffic

Aircraft noise can be heard by beluga whales (Figure 4-25). The transmission of in-air sound through the aquatic environment is brief and much of it is deflected by the water's surface (Section 4.3.4, Underwater Noise). Furthermore, most tones produced by aircraft occur below the behavioral threshold for beluga whales (Figure 4-15 and Figure 4-25). Noise at the sound source may exceed this threshold but cetaceans would not be close enough to aircraft to be exposed to it.

Aircraft traffic would occur inshore of the barrier islands, far from the continental shelf break habitat where most belugas reside during the open-water season (Section 3.2.4.1). Occasionally, a few belugas have been sighted in Foggy Island Bay and nearby oil and gas infrastructure (Aerts et al., 2008; Streever and Bishop, 2013), so a few individuals could be disturbed or displaced by aircraft.

Most belugas do not overtly respond to occasional, single passes by low-flying helicopters at altitudes above 500 feet (Richardson and Malme, 1993). Paternaude et al. (2002) recorded reactions of bowhead and beluga whales to a Bell 212 helicopter and Twin Otter fixed-wing aircraft during four spring seasons (1989 through 1991, and 1994) in the western Beaufort Sea. Responses were more common to the helicopter than to the fixed-wing aircraft and included immediate dives, changes in heading, changes in behavioral state, and apparent displacement of belugas (Paternaude et al., 2002). Similar but weaker reactions to fixed-wing aircraft were observed by the authors.

SLR's (2017) helicopter noise model shows that helicopter noise associated with the proposed action would not exceed behavioral or injury thresholds established by NMFS (2016b) (Figure 4-25). The beluga whale audiograms depicted in Figure 4-25 show helicopter noises should remain undetectable or barely detectable to beluga whales submerged in the water. A situational 1,500-foot AGL minimum flight altitude provision described in Appendix C (C-3) would reduce received noise at the water surface to levels below the NMFS threshold. Imposing stricter full-time 1,500-foot AGL minimum flight altitude requirement would further reduce impacts from aircraft sound to whales. Furthermore, there is little likelihood of project-related air traffic over beluga whales since flight corridors would be between the shore and the proposed LDPI, and beluga whales are generally found further offshore.

Habitat Alteration

The LDPI footprint would compromise approximately 24 acres of seafloor and the water column that could serve as habitat for beluga whales. Most beluga whales remain near the ice front and the continental shelf break during summer (Clarke et al., 2015a), which is north of the Proposed LDPI.

The removal of this habitat should not impact beluga whales since the affected area would be a fraction of potential beluga whale habitat.

Pipeline Installation

Beluga whales would not be directly impacted by pipeline installation because they are absent from the Proposed Action Area during winter and spring when the pipeline would be installed.

Facilities Construction

The majority of facilities construction would occur when shorefast ice is present and beluga whales are absent from the Proposed Action Area (Section 3.2.4.1). The presence of increased aircraft and marine vessel traffic during open-water construction could impact belugas. The effects of aircraft and vessel operations are the same as described for proposed LDPI Construction. Aspects specific to facilities construction not previously detailed are described below.

Facilities construction would be supported by aircraft, crew boat, ground traffic, barge, and tug traffic (Hilcorp, 2015). Barge and tug traffic could affect belugas within the transit corridor between West Dock, Endicott SDI, and the proposed LDPI throughout the open-water season. Late season barge traffic could disturb some belugas during the fall migration, but only whales inside the barrier islands.

Whales react most noticeably to erratically moving vessels with varying engine speeds and gear changes and to vessels in active pursuit (NMFS, 2012a). Barges and tug boats execute changes in course or speed slowly, and normally travel at slower speeds than smaller support boats to compensate for steering differences. Because of the inability of barges and tugboats to perform sudden heading changes, belugas are less likely to overtly respond to them.

Generally whales are likely to avoid being within 0.6 to 2.5 miles of barges, though a few whales might not react until a vessel is less than 0.6 miles away (MMS, 2002). As previously described, such effects should involve a few whales, who would respond with small deflections around or away from the vessel. In a recent Biological Opinion for a seismic survey in Foggy Island Bay, NMFS estimated the number of marine mammal exposures to vessel noise greater than or equal to 120 dB to be zero (NMFS, 2014). Marine mammal monitoring by industry during the last few years detected 19 belugas in the area in 2014 (July through August), and 5 belugas in 2015 (July 9 through 19) near the Proposed LDPI site (Smultea et al. 2014, Cate et al. 2015), and passive acoustics detected belugas using the area on five different days in 2015 (July 6 through September 22) (Frouin-Mouy, Zeddies, and Austin 2016). Hence, a small number of belugas in the vicinity of Foggy Island Bay could be exposed to vessel activities.

Facilities construction should have a little or no impact on beluga whales. This is because of the small number of whales at risk of exposure to the noise from construction activities. Effects from air traffic would be minimal because most noises from aircraft would should remain undetectable or barely detectable to beluga whales submerged in the water, and the assumed 1,500-foot AGL minimum flight altitude provision described in Appendix C (C-3) would reduce received noise at the water surface to levels below the NMFS threshold. There is a possible strike risk from vessels used during construction, this risk would be minimized if vessel speeds were reduced to 10 knots or less as described above.

Drilling Operations

Underwater noise from drilling operations could impact beluga whales by displacing them from the area around the Proposed LDPI. Many of these impacts were previously discussed (e.g., Proposed LDPI Construction, Facilities Construction), so only those aspects specific to drilling that have not previously been addressed are discussed below.

Responses of beluga whales to drilling operations are described in Richardson et al. (1995) and summarized here. For example, in the Mackenzie Estuary during summer, belugas were observed regularly within 328 to 492 feet of artificial islands (Fraker 1977a, b; Fraker and Fraker, 1979) suggesting that animals were not overtly disturbed by drilling operations.

In spring, migrating belugas showed no overt reactions to recorded drilling noise (less than 350 Hz) until within 656 to 1,312 feet of the source, even though the sounds were measurable up to 3.1 miles away (Richardson et al., 1991). In contrast, during another drilling noise playback study, overt reactions by belugas within 164 to 984 feet involved increased swimming speed or reversal of direction of travel (Stewart et al., 1983). Figure 4-25 compares the audiograms of captive beluga whales with the sound signature from drilling operations at Sandpiper Island, and the modeled drilling noise from the Proposed LDPI (SLR, 2017). The comparison indicates drilling operations from

Sandpiper Island, an old exploration site, and those modeled for the Proposed LDPI, were below the harassment criteria thresholds established by NMFS (2016a) (Figure 4-25, and Table 4-15 and Table 4-16). Whereas the Proposed LDPI is in shallow water approximately 19.7 feet deep, Sandpiper Island was in 49 feet of water, an environment that would have allowed greater noise propagation, which is consistent with the differences between the two sound signatures in Figure 4-25.

The short reaction distances are partly a consequence of the hearing sensitivity of belugas at low frequencies (Richardson et al., 1995).

Belugas are the cetacean species most likely to experience impacts from drilling noise because small numbers have been observed inside the barrier islands in Foggy Island Bay (Section 3.2.4.1). However, in general, very few belugas are expected to approach the Proposed Action Area.

As with Northstar (NMFS, 2012b), the low source levels and rapid attenuation of drilling sounds from artificial islands in shallow water makes noise inaudible to beluga whales (Figure 4-25), which makes masking not likely to occur.

There would be little to no impacts from drilling operations and noise on beluga whales. With the acoustic monitoring mitigation described in Appendix C (Section C-3), additional steps would be taken to ensure that project-related sounds are at anticipated levels and that any unanticipated adverse effects are addressed.

Transportation

Construction and drilling operations would occur concurrently for several years and vessels are needed to support this work (Table 2-4). The number of vessel trips would increase during this period, which would result in greater potential for disturbance and displacement of whales out to distances of 7,218 feet (Table 4-20). Once construction is complete, the number of marine vehicle trips would decrease; a reflection of the reduced need for vessel support during drilling operations (Table 2-4). This reduction would decrease potential effects of vessel traffic on whales. Impacts from marine traffic are discussed further in Proposed LDPI Construction and Facilities Construction.

Air traffic would occur at a greater frequency during drilling than during construction (2 trips per day during drilling vs. 1-2 trips per day during construction) (Table 2-4). During the 2-year period when drilling and construction activities may overlap, up to 4 trips per day could occur (Table 2-4). Correspondingly, the potential for disturbance or displacement of belugas from aircraft overflights once drilling operations commence would be comparable or higher than during the pre-drilling construction period.

Noise associated with support vessels is expected during drilling and could elicit behavioral effects out to 1.37 miles (Table 4-16 and Table 4-20). Effects from small vessels could include displacement/ avoidance, and limited masking. Beluga whales have exhibited greater responses to a moving sound source (e.g., airgun activity on a moving vessel) than to a stationary sound source (NMFS, 2015). Scheifele et al. (2005) observed shipping noises caused belugas to vocalize louder in the Saint Lawrence Estuary. The acoustic behavior of that beluga population was also studied in the presence of ferry and small boat noise by Lesage et al. (1999), who observed more persistent vocal responses among whales exposed to the ferry noise than small boat noise. Lesage et al. (1999) found the reduction in calling rate may reduce communication efficiency, which is critical to a gregarious species; however, the gregarious nature of belugas necessitates maintaining short distances between group members, which alleviates some of the masking issues. The conclusion of Lesage et al. (1999) found a noise source would have to be very close to limit communication within a group of beluga whales. By implementing mitigation measures from Appendix C (section C-3) such as posting protected species observers (PSOs) onboard vessels, and implementing operational procedures in the presence of whales such as reducing speed and course corrections, the level of effects to beluga whales would be further reduced. For these reasons, and the small number of beluga whale observations in Foggy Island Bay, the level of effects of vessel traffic from the Proposed Action on beluga whales should be negligible.

Production Operations

Production-related activities focus on the operation and maintenance of facilities and equipment. Operations would continue to be supported by resupply via ice roads and, to a lesser extent, summer barges (at an estimated 10 trips per year). Aerial surveillance of the pipeline corridor would be conducted (Hilcorp, 2015, Sections 5.2.3 and 7.10) and vessel-based surveys would be performed to inspect for any damage to the island and offshore pipeline (Hilcorp, 2015, Section 6.2).

With one exception (vessel-based surveys, discussed later in this section), the types of potential impacts to beluga whales from production operations would be the same as those from drilling operations; however, the likelihood of occurrence would be relatively less, since fewer personnel would be needed once construction is complete. A reduction in personnel would result in relatively fewer aircraft and vessel trips for crew transport and resupply (Hilcorp, 2015, Tables 5-3, 5-4, and 5-5).

During the open-water season, vessels were the main contributors to the underwater sound field at Northstar (Blackwell and Greene, 2006). It is likely that these would also be the primary sound source during production operations at the proposed LDPI. Other sounds would include noise from generators, process operations (e.g., flaring, seawater treatment, oil processing, gas injection), and proposed LDPI lighting, all of which are continuous noise that contribute to overall operational sounds at artificial gravel islands (NMFS, 2012a). In a recent Biological Opinion the NMFS concluded production operations at Northstar would not produce incidents of TTS or PTS among cetaceans (NMFS, 2012a). Potential impacts on belugas from production operations at the Proposed LDPI should be less than those of Northstar since beluga whale observations near the Proposed LDPI is in an area generally unused by cetaceans (Section 3.2.4.1).

Personnel from production platforms in Cook Inlet, Alaska, reported belugas within 30 feet of some drilling platforms, and the noises did not seem to disturb them (Gales, 1982; McCarty, 1982). Beluga whales are regularly observed near the Port of Anchorage and the extensive dredging/ maintenance activities that operate there (NMFS, 2003). In a 2012 environmental assessment for ongoing production operations at Northstar, the NMFS determined routine production activities would have minimal impact on belugas (NMFS, 2012b), and it is expected the impacts from production operations at the Proposed LDPI would have even fewer effects.

Effects of sonar noise on belugas could involve behavioral (Figure 4-23) or physiological effects (Figure 4-23); however, side scan sonar produces high frequency noise (Section 4.3.4) that attenuate rapidly and are unlikely to be detected by most belugas because it consists of highly focused, directed streams of noise, and because most belugas reside in waters over the continental shelf break during the open-water season (Section 3.2.4.1). During passive acoustic monitoring of a 2015 open-water season geohazard survey in Foggy Island Bay, belugas were detected in the area on a few days only, and were not detected throughout most of that season (Frouin-Mouy, Zeddies, and Austin, 2016). Furthermore, activities would adhere to the mitigation measures described in Appendix C (C-3.3 and C-3.4, Exclusion Zones / Monitoring) which would further reduce the potential for impacts. Consequently, it is possible, though unlikely, that a few belugas could be disturbed and displaced by geohazard survey noise.

Decommissioning

Decommissioning would have no effect on beluga whales because they are absent from the Proposed Action Area during winter and spring when decommissioning would occur.

Bowhead Whales

Ice Road Construction and Use

Ice road construction and use would have no effect on bowhead whales because they are absent from the Proposed Action Area during winter and spring when ice roads would be constructed and used.

Mine Site Development

Mine site development would have no effect on bowhead whales because they are absent from the Proposed Action Area during winter and because mine activities would occur onshore.

LDPI Construction

Most construction activities would not affect bowhead whales because they would occur on shorefast ice when bowheads are absent from the area (Section 3.2.4.1). Installation of slope protection and pile driving could affect bowhead whales during the first open-water season of the Proposed Action. Slope shaping and armament installation would create a zone for behavioral disturbance between 2,887 and 4,134 feet from the source, and a zone of potential injury less than 32.8 feet from the noise source over a 9.6-hour period (SLR 2017).

Sheet-, Pile-, and Pipe-Driving

The specific auditory sensitivity of bowhead and other baleen whales has not been directly measured. Physical similarities between baleen whales indicate they are specialized for low frequency hearing, with some directional hearing ability (Section 4.3.4, Table 4-12 through Table 4-15; Ketten, 2000; Richardson et al., 1995). The assumed functional hearing range of bowheads includes the frequencies and decibel levels of sounds produced by pile-driving (Table 4-12, Table 4-16, and Table 4-17). Recent models for juvenile fin whales allowed audiograms to be developed for that species (Figure 4-23 and Figure 4-25). For the purpose of analyses, the fin whale audiogram will be used as a proxy for bowhead and gray whale hearing.

Some sheet pile installation (mid-March through mid-June) would coincide with the bowhead whale spring migration into the Canadian Beaufort Sea, which occurs closer to the continental shelf break. In a recent Biological Opinion, NMFS determined noise from construction and operation activities at Northstar (including pile-driving) should be undetectable to migrating whales in spring (NMFS, 2012a).

The fall migration for bowhead whales begins in late August and occurs closer to the shore than the spring migration. They do not migrate inside the barrier islands, so sounds from construction activities should not affect them. Sometimes, an individual might wander near lagoon entrances or barrier islands, but should not be exposed to noises that could create injury or behavioral effects. In such unlikely events, whales would have to closely approach a vessel or the LDPI site when work is occurring in order for behavioral effects to occur, and there should be no potential for acoustic injury.

Most construction would not affect Bowhead whales because shorefast ice would be present and whales would be absent from the Beaufort Sea. Barrier islands would prevent open-water construction noises from propagating beyond the islands because the noises would attenuate (Richardson et al., 1995; USDOI, MMS, 2002; SLR, 2017).

During artificial island construction in the Canadian Beaufort Sea in 1980 through 1984, bowhead whales were observed within 0.5 miles of construction (Richardson et al., 1985, 1990). Bowheads generally tolerated construction noise at noise levels up to 115 dB_{RMS} (Richardson et al., 1990). At levels above 115 dB avoidance reactions were observed. Bowhead responses to the construction of Seal Island were localized and weak (Hickie and Davis, 1983).

SLR (2017) found behavioral effects thresholds for vibratory sheet-/pile-driving and impact pile-driving extended 951 and 295 feet under ice, respectively; and up to 10.8 miles and 1.4 miles in open-water, respectively. Of these activities (Table 4-16), only sheet-, pile- and pipe-driving in open-water has the potential for creating injury (SLR, 2017). The distances from the Proposed LDPI to interim behavioral thresholds from impact pipe-driving were 36 feet under ice and up to 1,312 feet in open-water.

Construction noise would not propagate (SLR 2017) beyond the barrier islands more than a few miles and should not affect the fall bowhead whale migration. A few individual whales could be temporarily affected, however, the behavioral responses of bowhead whales to such activities are limited and brief. For these reasons, and the lack of bowhead whale sightings in Foggy Island Bay, sheet-, pile-, and pipe-driving should have limited effects on bowhead whales. In addition, a BOEM-proposed mitigation measure (Appendix C, Section C-4) would not allow pipe-/pile-driving to be conducted prior to, and during, the subsistence whaling hunt. Adherence to this mitigation measure would further reduce the potential for bowhead whales to be exposed to noise from pile-/pipe-driving.

Vessel Traffic

Bowhead whales noticeably react to erratically moving vessels (NMFS, 2012b). Avoidance reactions by bowheads can begin as far as 2.5 miles from a vessel, and can include subtle alterations in activity, speed and heading. Bowheads sometimes begin to swim actively away from approaching vessels when they come within 1.2 to 2.5 miles. If the vessel approaches to within a few thousand feet, the response becomes more noticeable, and whales sometimes change direction to swim perpendicularly away from the vessel path (Richardson and Malme, 1993; Richardson et al., 1985, 1995).

As with belugas, sound levels produced by small and large vessels can exceed NMFS' acoustics thresholds for bowhead whales (Table 4-12, Figure 4-25).Vessel noise is concentrated at low frequencies (Section 4.3.4, Table 4-12) and would be more impactful to bowhead whales than to belugas because bowhead hearing sensitivity is assumed to be better at lower frequencies.

Multiple studies have reported that after disturbance and displacement by vessels, bowheads may return to a disturbed area within several days (e.g., Koski and Johnson, 1987; Thomson and Richardson, 1987). Some whales may exhibit subtle changes in their surfacing and blow cycles, while others may appear to be unaffected. Bowheads actively engaged in feeding, social interactions, or mating may be less responsive to vessels (MMS, 2002; NMFS 2013). Acoustic studies at Northstar in 2001 initially suggested a small number of bowhead whales in the southern portion of the fall migration corridor were affected primarily by vessel noise (NMFS, 2012a). The data indicated the whales responded by changing calling rates, deflection, or both.

Bowhead whales tend to avoid gravel islands when vessels are operating nearby (MMS, 2002). Migrating bowhead whales whose paths are deflected offshore by no more than a few miles would not likely experience serious energetic losses, and are within the range of normal variability for migrating bowhead whales (NMFS, 2012a).

BOEM assumes implementation of, and compliance with, mitigation measures typically required by NMFS (Appendix C, Section C-3) that mitigate the effects of vessel traffic on whales through certain speed limits and avoidance maneuvers. Adherence to these measure reduces the risk of collision. Furthermore, Laist et al. (2001), found vessels traveling at speeds below 14 knots had reduced likelihoods of striking cetaceans, and vessels operating at or below 10 knots did not strike any cetaceans. Thus, BOEM has developed an additional mitigation measure (Appendix C, Section C-4) requiring vessels traveling between West Dock / Endicott and Foggy Island Bay to travel at speeds at or below 10 knots to further reduce collision risk. Adherence to this mitigation measure would further reduce potential adverse impacts from vessel traffic.

Aircraft Traffic

While the frequency ranges of aircraft overlap with the ranges audible to bowheads (Figure 4-21 and Table 4-12), the transmission of in-air sound through the aquatic environment is brief and much of it deflected at the water's surface (Section 4.3.4). There is little likelihood of project-related air traffic over bowhead whales since flight corridors would be between the shore and the proposed LDPI, and bowhead whales use areas further offshore.

Paternaude et al. (2002), found bowhead whales displayed discernible reactions to helicopters that included abrupt dives, breaching, and short surfacing periods. In a recent Biological Opinion for activities at Northstar, NMFS concluded that even if several bowhead whales reacted to a single aircraft overflight, the reaction would be brief and have no long-term consequences (NMFS, 2012a). For these reasons, the use of aircraft could produce brief behavioral reactions among a small number of whales in Beaufort near-shore areas.

Habitat Alteration

Bowhead whales generally do not occur in the shallow lagoon area where the LDPI will be located. Hence, the permanent removal of this habitat would not affect bowhead whales.

Pipeline Installation

Bowhead whales would not be impacted by pipeline installation since they are absent from the Proposed Action Area during winter and spring when the pipeline would be installed, and because they generally do not occur along the proposed pipeline route. Furthermore, the seafloor acreage affected by pipeline installation constitutes a small fraction of the foraging habitat available to them, and is in waters shallower than bowheads like to frequent.

Facilities Construction

The majority of facilities construction would occur on shorefast ice when bowhead whales are absent from the Proposed Action Area. Aircraft and vessel traffic in support of late season construction could occur during the open-water season (see Proposed LDPI Construction, above). Aspects of facilities construction not already addressed are discussed below.

Facilities construction would be supported by aircraft, crew boat, vehicles, barge, and tug traffic (Hilcorp, 2015). Barge traffic could affect bowhead whales within the transit corridors and could disturb some bowheads during the fall migration.

Barges and tug boats are slow moving and slow to change direction, and bowhead whales generally avoid them by a 0.6 to 1.5 mile margin (MMS, 2002). These effects would involve a few whales reacting with small deflections from vessels. No population-level effects to bowhead whales are likely to occur. Likewise, noise from barges and tug boats should not exceed the NMFS injury thresholds for bowhead whales (Table 4-14). For these reasons, the use of barges and tugboats are less likely to produce overt behavioral responses from bowhead whales.

Airborne, vessel, and passive acoustic surveys have found no bowhead whales in Foggy Island Bay (Clarke et al., 2015a; Cate et al. 2015, Smultea et al. 2014; Frouin-Mouy, Zeddies, and Austin 2016).

Drilling Operations

Drilling operations could potentially impact bowhead whales via disturbance and displacement from noise, and from the presence and noise from aerial and vessel traffic. Many of these impacts are detailed elsewhere in this document (e.g., proposed LDPI Construction, Facilities Construction), so only those aspects specific to drilling that not already described are discussed below.

Playback, modeling, and simulation studies indicate bowhead whales begin responding to low-frequency industrial sounds at levels exceeding 115-120 dB_{RMS} (Richardson et al., 1990, 1995;

Ellison et al. 2016). Drilling noise should be inaudible to mysticete whales (LF Cetaceans) (Table 4-12) and could not exceed the injury threshold for bowhead whales (Table 4-13; Figure 4-25; NFMS, 2016). Behavioral reactions among bowheads might occur out to a distance of 4 miles from the proposed LDPI (Table 4-16); however, the shallow depths in the area along with the consistent lack of bowhead observations suggests bowheads avoid Foggy Island Bay (Clarke et al., 2015a; Cate et al. 2015; Smultea et al. 2014; Frouin-Mouy, Zeddies, and Austin 2016). For these reasons, bowhead whales should be unaffected by drilling at the proposed LDPI. Figure 4-25 shows drilling noise from the proposed LDPI should occur below the minimum detectable noise levels for mysticete whales at 722 feet. For these reasons the reactions of bowhead whales to drilling and operations at the proposed LDPI should be highly localized and involve few whales (NMFS, 2012a).

During the 2005 fall bowhead migration past Northstar, which is father offshore than the LDPI and outside of the barrier islands, whales migrated a little farther north than usual. Subsequent analyses revealed the modification in their migration route was due to environmental conditions, not noise from Northstar. Bowhead whales reduced their vocalizations until passing west of the island, and a fraction of whales slightly shifted their travel routes to the north in years when noise levels from Northstar were above ambient (Blackwell et al. 2006; Blackwell et al. 2008; Richardson et al. 2012). Because of the proposed LDPI location, water depth, and distance of proposed LDPI from the bowhead whale fall migration route, the effects of drilling noise on bowheads are expected to be less than that observed during Northstar development.

If the mitigation described in Section 2.5.1 (Proposed Mitigation Measure) is implemented, the duration of the drilling period could be extended. Additional drilling occurring during the ice-covered season would not impact bowheads as they are not present in the central Beaufort Sea and the immediate LDPI area at this time. Though the duration of drilling noise impacts on bowhead whales would be extended, the effects would remain the same.

Because of the sound signature of drilling noise and the lack of bowhead whales in waters near the proposed LDPI, drilling operations should not affect bowhead whales.

Transportation

Impacts to bowhead whales from transportation are similar to those outlined for beluga whales.

Production Operations

See Production section for beluga whales for a description of impacts to bowheads from production operations.

Monitoring studies conducted since 2000 at Northstar are indicative of the types of impacts to bowhead whales from production at artificial islands in the U.S. Beaufort Sea (e.g., Blackwell and Greene, 2006; Blackwell et al., 2009). These reports indicate that effects from production operations on whales traveling near the southern (proximal) edge of the bowhead whale migration corridor were subtle. Possible deflections during the fall migration are not likely to be injurious to individual animals or their population. While many feeding areas are dynamic and may change location from year to year, Native Alaskan hunters have reported the Kaktovik area as a traditional feeding area for bowhead whales. Monitoring of the bowhead whale migration, as they passed Northstar, has found no evidence of any such shifts to the migration corridor, although brief, localized displacements have been observed (NMFS, 2012a). Most likely, production operations would affect a few individual bowhead whales, but not the migration or the population.

Decommissioning

Bowhead whales are absent from the Proposed Action Area during winter and spring when decommissioning would occur.

Gray Whales

Ice Road Construction and Use

Gray whales are absent from the Proposed Action Area during winter and spring when ice roads would be constructed and used.

Mine Site Development

Gray whales are absent from the Proposed Action Area during winter and because mine activities would occur onshore.

LDPI Construction

Most construction activities would not affect gray whales because they would occur on shorefast ice when whales are absent from the area. Noise from pile driving during installation of the proposed LDPI's slope protection could impact gray whales. Noise impacts to whales are discussed in depth in Section 4.3.4.3.1. Only factors specific to gray whales are analyzed here.

Sheet, Pile-, and Pipe-Driving

Anatomical characteristics of gray and other baleen whales indicates they are adapted for low frequency hearing (Section 4.3.4, Table 4-12; Ketten, 2000; Richardson et al., 1995); a range that encompasses the frequencies and decibel levels of sounds produced by pile-driving (Table 4-16 and Table 4-17). A typical migrating gray whale tolerates steady, low frequency industrial sounds at received levels up to about 120 dB_{RMS} (Malme et al., 1984), or higher-level sounds if the sound source is offset to the side of the migration route (Tyack and Clark, 1998).

Gray whales have not been documented in the Proposed Action Area, though they periodically occur in the Western Beaufort Sea and a few records exist showing them in the eastern U.S. Beaufort Sea (Figure 3-26 and Figure 3-27).

Vessel Traffic

Impact of vessel traffic to whales are described in the beginning of the Marine Mammals section (4.3.4) in Impacts Common to All. Migrating gray whales would change course to avoid vessels.

The potential impacts of vessel noise to gray whales are similar to those described for bowhead whales since both bowhead and gray whales have low frequency hearing (Table 4-6). Because they often occur closer to shore than bowhead whales, gray whales could be exposed to vessel noise during proposed LDPI construction; however, they are scarce in the Beaufort Sea, and have never been documented in the Proposed Action Area, so the relative likelihood of one or more gray whales being affected by vessel traffic during proposed LDPI construction would be low. BOEM assumes implementation of, and compliance with, mitigation measures typically required by NMFS (Appendix C, Section C-3) that mitigate the effects of vessels on whales through speed limits when whales are sighted and via avoidance maneuvers. Adherence to these measure reduces the risk of collision.

Aircraft Traffic

Impact of aircraft traffic to whales are described in the beginning of the Marine Mammals section (4.3.4) in Impacts Common to All, and in the sections on beluga and bowhead whales.

Gray whales are scarce in the Beaufort Sea during the open-water season; none have been recorded in the Proposed Action Area, though they typically occur more often in the Western Beaufort Sea (Section 3.2.4.1, Clarke et al. 2015).

Habitat Alteration

Gray whales would not be impacted by any habitat removal associated with the Proposed Action.

Pipeline Installation

Gray whales would not be impacted by pipeline installation because they are absent from the Proposed Action Area during winter and spring when the pipeline would be installed.

Facilities Construction

The majority of facilities construction would occur during winter months, when gray whales are absent from the Proposed Action Area (Section 3.2.4.2). Gray whales have not been observed in the Proposed Action Area and are unlikely to be impacted by any facilities construction or support activities.

Drilling Operations

Gray whales have not been observed in the Proposed Action Area and would not be impacted by noise from drilling operations.

If the mitigation described in Section 2.5.1 (Mitigation) is implemented, the duration of the drilling period could be extended. Additional drilling occurring during the ice-covered season would not impact gray whales as they are not in the central Beaufort Sea and the immediate LDPI area at this time.

Transportation

Impacts from marine traffic are described in Impacts Common to All Marine Mammals, and in the bowhead and beluga whale sections of this chapter.

Between 1999 and 2003, the California stranding network reported only four serious injuries or mortalities of gray whales caused by vessel strikes, and only one reported in Alaska (Allen and Angliss, 2013). Since gray whales are likely to avoid vessel traffic, and no collisions with vessels have been reported in the Arctic to date, and because of the scarcity of gray whales in the Beaufort Sea, the potential for vessels associated with the proposed LDPI to affect gray whales is limited. Because of gray whale scarcity in Foggy Island Bay, and because those individuals would be familiar with vessels and likely avoid them, vessel strikes are not likely. Furthermore, BOEM assumes assumes implementation of, and compliance with, mitigation measures typically required by NMFS (Appendix C, Section C-3) that mitigate the effects of vessels on whales through speed limits when whales are sighted and via avoidance maneuvers.

Production Operations

Production-related activities focus on the operation and maintenance of facilities and equipment. Operations would continue to be supported by resupply via ice roads and, to a lesser extent, summer barges. Aerial surveillance of the pipeline corridor would be conducted (Hilcorp, 2015, Sections 5.2.3 and 7.10) and vessel-based surveys would be performed to inspect for any damage to the island and offshore pipeline (Hilcorp, 2015, Section 6.2).

The types of potential impacts to beluga, bowhead, and gray whales from production operations would be the same as those from drilling operations; however, the likelihood of occurrence would be lower since fewer personnel would be needed once construction and drilling are complete.

There are no data on the reactions of gray whales to production activities similar to those that would occur under the Proposed Action (NMFS, 2012b). Oil production platforms have been in place off California for many years. Gray whales regularly migrate through that area (Brownell, 1971), but no detailed data on distances of closest approach or possible noise disturbance have been published. Oil industry personnel have reported seeing whales near platforms, and that the animals approach more closely during low-noise periods (Gales, 1982; McCarty, 1982). A typical migrating gray whale tolerates steady, low frequency industrial sounds at received levels up to about 120 dB_{RMS} (Malme et al., 1984), and may tolerate higher level sounds if the sound source is offset to the side of the migration path (Tyack and Clark, 1998). The reaction thresholds to both steady and pulsed sounds are slightly greater for gray whales than for bowheads (NMFS, 2012b).

Decommissioning

Decommissioning would not impact gray whales because they are not found in the Proposed Action Area.

Oil Spill Analysis

Detailed background on BOEM's OSRA process is provided in Appendix A (posted at www.boem.gov/liberty). The OSRA model estimates the conditional and combined probabilities of a large spill contacting a geographic area (i.e., environmental resource area ERA, LS, or GLS) important to one or several species or species groups during a discrete amount of time. A list of whale ERAs can be found in Appendix A, Table A.1-3.

ERAs (no LSs or GLSs were identified for whales) analyzed in this section are those for which the conditional probability of large spill contact was found to be greater than or equal to 5 percent at any point within 360 days of a spill occurring. The conditional probabilities of those ERAs for which contact was less than 5 percent can be found in Appendix A. The ERAs discussed in this section are:

- **ERA 25 (AK BFT Bowhead FM 4).** Part of the bowhead whale fall migration route through the Beaufort Sea, vulnerable to large spills from September through October; and
- **ERA 26 (AK BFT Bowhead FM 5).** Part of the bowhead whale fall migration route through the Beaufort Sea, vulnerable to large spills from September through October (Appendix A, Table A.1-3).

Maps showing the location of whale ERAs are presented in Appendix A.

Conditional Probabilities

The OSRA model calculates conditional probabilities (expressed as a percent chance) of a spill contacting identified whale ERAs. Conditional probabilities are based on the assumption that a large spill has occurred (for further explanation, see Appendix A, posted at www.boem.gov/liberty). For a map of the hypothetical spill sources (proposed LDPI and pipeline) used for the oil spill-trajectory analysis, see Appendix A, Map A-6.

Summer Spills. A large spill during summer (July 1 through September 30) could impact whales, particularly bowhead whales because they migrate westward through the Beaufort Sea in September and October and their fall migration occurs closer to shore than their spring migration (Section 3.2.4.2). The conditional probabilities of a summer large spill from the proposed LDPI or the pipeline contacting a whale ERA are presented in Table 4-21. Bowhead whales are less likely to be directly impacted by a large spill that occurs late in the summer (e.g., late September) because most whales would have migrated through ERAs 25 and 26 before the probability of contact to those ERAs is greater than zero (i.e., 30 days after the spill began, or late October).

Table 4-21 Summer Conditional Probabilities of Large Spill Contacting a Whale ERA

ERA	Source	1-day	3-day	10-day	30-day	90-day	360-day
25	LDPI	<0.5	1%	4%	5%	5%	5%
26	LDPI	<0.5	<0.5%	3%	5%	6%	6%

Winter Spills. A large spill during winter (October 1 through June 30) could impact whales if they were to encounter the spills during the latter half of the fall migration through the Beaufort Sea (Section 3.2.4.2). A large spill during or after freeze-up in winter would be difficult to clean up, and oil could become entrained in the ice, melting out in spring, and contacting lead systems and marine waters where whales are seasonally present. However, the OSRA model found that the conditional probabilities of a large winter spill from the proposed LDPI or pipeline contacting a whale ERA never rose above 1 percent (Appendix A, Table A.2-42). Thus, regardless of when in winter a large spill might occur, the potential for impacts to beluga, bowhead, and gray whales are exceedingly small.

Combined Probabilities

Combined probabilities differ from conditional probabilities in that there is no assumption that a large spill has occurred. Instead, combined probabilities reflect the chance of one or more large spills occurring over the life of the Proposed Action, and of any portion of that spill contacting any portion of a particular ERA. Combined probabilities do not factor in any cleanup efforts. For more background information, see Appendix A posted at www.boem.gov/liberty, Section A-2.

The OSRA model found the combined probabilities of a large spill occurring and contacting a whale ERA within 360 days to be less than 1 percent, regardless of whether the spill occurred during winter or summer months.

Oil Spill Response

The conditional or combined probabilities do not consider the effectiveness of spill response activities to mitigate large spills which could range from highly effective under ideal conditions to largely ineffective depending upon the specific circumstance. An OSRP would be required prior to drilling and production activities.

Depending on the location of the spill, OSR could take some time to begin. OSR equipment is cached in Deadhorse and in Utqiaġvik, about 150 miles west of Deadhorse. OSR personnel would be expected to work with the NMFS on the management of whales and seals in the event of a spill and to work with the FWS on walrus and polar bear management activities.

During OSR activities, oiled fish carcasses would be collected when feasible, which could lessen the risk of belugas ingesting oiled prey items. In some circumstances, oiled fish floating in broken ice and in open leads would be very difficult to locate and recover. Removal of all types of oiled carcasses (birds, seals, fish, and other mammals) is an important primary OSR activity. This removes a source of secondary poisoning to scavengers and predators.

Hazing may be very effective in the case of small spills or in relatively discrete areas. Most marine mammals would be likely to avoid the high level of activity associated with cleanup activities.

In general, cleanup activities could result in short- or long-term displacement of whales and their prey from preferred habitats and increased human interactions and disturbance. Conversely, cleanup activities would likely decrease the likelihood that marine mammals may come into contact with oil by displacing them from oiled areas.

Proposed Mitigation

If the Proposed Solid Ice Condition (Section 2.5.1) were to be implemented, the presence of 18 inches of solid shorefast ice would prevent oil spills originating at the LDPI from contacting sea water during initial drilling of the production wells. During winter, cetaceans (beluga, bowhead, and gray whales) will not be in the central Beaufort Sea, but in their wintering grounds in the Bering Sea, or the Sea of Cortez. Hence, cetaceans would not be affected by large on-ice spills originating from the LDPI.

Conclusion for Cetaceans

The occurrence of any species of whale in the Proposed Project area is uncommon to rare. The only activities capable of producing injury to whales are vessel strikes and pile-/pipe-driving. The majority of pile-/pipe-driving would be completed when the area is ice-covered, before cetaceans would be expected to occupy the area. The risk of vessel strikes would be mitigated by adherence to typical measures required by NMFS which provide speed limits and operational maneuvers in the vicinity of a whale or groups of whales (Appendix C, Section C-3).

Some noises from vessel and helicopter use and facility construction activities may be audible to cetaceans, however, most construction activity noises, and drilling noises, are barely audible to cetaceans as shown in audiograms (Figure 4-23) and should not affect them. Vessel noise would occur in shallow near-shore environments where whales should not occur and noise would attenuate rapidly. For these reasons, vessel noise should have little to no effect on cetaceans. Helicopter noise would originate 1,500 feet AGL and would likely have little to no effect on cetaceans.

Overall, the Proposed Action has a limited potential to affect a small number of individual whales by eliciting avoidance behaviors over a small area during the open-water season. Consequently, the effect of the Proposed Action on beluga, bowhead, or gray whale populations would be negligible.

Two mitigation measures would further reduce impacts. Limiting project vessel speeds to 10 knots between West Dock/Endicott and the project site would reduce or eliminate strike potential (Appendix C, Section C-4) for whales in that area. The adoption of the Proposed Solid Ice Condition (Section 2.5.1) would ensure no cetaceans are contacted from a large on-ice spill from the proposed LDPI during initial well drilling.

Alternative 2 (No Action)

Under this Alternative, the Proposed Action would not be approved and the actions described would not take place. The status of the beluga, bowhead, and gray whale stocks in the U.S. Beaufort Sea would continue with current population trends.

Alternative 3 (Proposed LDPI Relocation)

Alternative 3A: Relocate LDPI Approximately One Mile to the East

The water depth at Alternative 3A is 21 feet, which does not represent enough of an increase in water depth to make this location useable habitat for cetaceans. Although winter construction of the proposed LDPI and associated pipeline would take longer than under the Proposed Action, the potential impacts to whales would not change as these activities would occur in the winter when whales are absent from the area. Drilling at the Alternative 3A location would require a larger rig with more hydraulic horsepower, increasing from the proposed 2,100 hp drill rig to a 3,000 hp rig with an increased torque capability, and increased hookload capacity. This would increase the sound levels to which whales could be exposed.

Alternative 3B: Relocate LDPI Approximately 1.5 Miles to the Southwest

It is unlikely that whales would occur between the shore and the site of Alternative 3B. The water at this location is still too shallow (17 feet) to provide useable habitat for cetaceans. The construction of the Alternative 3B LDPI site and associated pipeline would take less time than the Proposed Action, but, as with the Proposed Action, these activities would take place in the winter when cetaceans are absent. In addition, Alternative 3B would require a larger drill rig with more hydraulic horsepower, increasing from the proposed 2,100 hp drill rig to a 3,000 hp rig with an increased torque capability, and increased hookload capacity. This would increase the sound levels to which whales could be exposed.

Overall, Alternative 3 would expose whales to longer periods of initial project construction and drilling. Alternatives 3A and 3B are, like the Proposed Action, within the barrier islands. A location inside of the barrier islands would in all likelihood dampen sounds from drilling. SLR (2017) modeled noise for drilling at the Proposed LDPI (Figure 4-22 and Figure 4-23) and found the drilling noise should occur below the minimum detectable levels for marine mammals. Drilling noise should not exceed any behavioral (Table 4-16) or injury (Figure 4-22 and Figure 4-23) thresholds (NMFS-2016a).

Therefore, impacts to beluga, bowhead, and gray whales would be the same for Alternative 3 compared to the Proposed Action.

Alternative 4 (Alternate Processing Locations)

Alternative 4 would relocate the processing facilities from the proposed LDPI to an onshore location (Section 2.2.5). Two options exist for onshore processing – use of an existing facility, and use of a new facility.

Production operations not associated with process facilities operations would remain approximately the same for Alternative 4 as the Proposed Action.

This alternative would not change the number of wells or length of time for drilling compared to the Proposed Action so impacts on whales would remain the same as the Proposed Action. However, without processing facilities on the proposed LDPI to separate and condition the reservoir gas for living quarters and drilling operations power generation, either diesel would need to be barged to the proposed LDPI or natural gas would need to be provided to the proposed LDPI via a pipeline – possibly from the shore-based processing facility. If the barging diesel option is chosen, this would increase vessel traffic between West Dock and Foggy Island Bay (Figure 2-2) increasing the chance of injury from boat strikes, and impacts from vessel noise and presence. If the pipeline option is chosen this would have no increased impact on whales because pipeline construction and installation would not overlap temporally with cetaceans.

Under Alternative 4, the size of the proposed LDPI would be smaller with processing facilities not located on site. As a result, there could be less overall construction noise and activity. However, since most construction activities are planned to occur in February and March when whales are absent from the area, there would be only a slight reduction in impacts to whales under Alternative 4.

Pile driving for installation of sheet wall around the proposed LDPI could occur when whales are in the area. As the amount of driven sheet pile wall installed around the proposed LDPI for slope protection would be reduced, impacts from pile-driving would be reduced.

Beluga, bowhead, and gray whales would not be affected by onshore and offshore pipeline construction and installation associated with this Alternative because they are typically absent from the area from January through May.

Similarly, facility construction for this Alternative would have no impact to whales because it would occur during the winter months when whales are typically absent from the area.

The primary benefit to beluga, bowhead, and gray whales of onshore processing provided by Alternative 4 is that it would move potential impacts associated with construction of the processing plant and actual processing (noise, physical presence, and some spills associated with processing activities) farther away from the marine environment. There would be a reduction in noise and activity if processing was conducted onshore because there would be less construction (i.e., less pile driving, fewer barge trips) on the offshore proposed LDPI. However, there would still be sources of noise even with a processing facility onshore; i.e. pumps to push the multiphase hydrocarbons to onshore processing.

Overall, impacts to beluga, bowhead, and gray whales would be slightly less (i.e. less pile-driving, less construction, fewer vessel trips) for Alternative 4A and 4B compared to the Proposed Action because noise occurrence would be reduced (although not necessarily to lower levels). However, impacts would still occur due to noise from construction and development of the proposed LDPI, drilling and production noise, and noise from pumps associated with the multiphase flow needed for onshore processing. Impacts would still be considered negligible for activities associated with development and production, and accidental spills. Therefore, for whales, Alternative 4A and 4B have the similar impacts as the Proposed Action.

Alternative 5 (Alternate Gravel Source)

Alternatives 5A and 5B would relocate the gravel mine to one of two locations (Section 2.2.6). This would affect the number and placement of ice roads and the footprint and levels of activity at the mine site, but would not alter the types or durations of activities during the open-water season. Therefore, the types and level of impacts to beluga, bowhead, and gray whales from Alternative 5A or 5B would not differ from those described for the Proposed Action.

4.3.4.3.2 Pacific Walrus and Seals

Pacific Walrus

The Proposed Action

Pacific walruses are rarely found in the proposed Project Area. Unless otherwise described, the effects of the proposed activities would produce temporary, non-chronic behavioral or physiological effects on walruses. Table 4-13 through Table 4-15 show the injury thresholds for Pacific walruses and Figure 4-22 and Figure 4-24 show the sound signature overlap between walrus hearing shown as audiograms versus the noise signatures produced by different proposed activities.

The only noises associated with the Proposed Action which could impact Pacific walruses would be from sheet-, pipe-, and pile-driving (Table 4-18), but only if walruses remained in the vicinity of such activities for a prolonged period of time. This is unlikely because of the scarcity of walruses in the Beaufort Sea, the timing of driving activities, and walrus avoidance of noisy areas.

Oil Spills

Individual Pacific walruses occasionally occur in the Proposed Action Area during the open-water season and could be impacted by spills during that time. Walruses that come into contact with crude or refined oil could experience acute and long-lasting effects including irritation to eyes, mouth, and mucus membranes, irritation and damage to respiratory organs from inhalation, and kidney and liver damage from ingestion of contaminated prey, and mortality in extreme cases. Further detailed information on the physiological impacts of oil contact to marine mammals is presented in Section 4.3.4.2.

Large Oil Spills

The OSRA model found conditional and combined probabilities of a large spill contacting Pacific walrus ERAs, LSs, and GLSs within 360 days to be less than or equal to 1 percent and unlikely. No walrus aggregation areas should be contacted by a large spill.

A large spill is unlikely to contact individual Pacific walruses because they are uncommon seasonal residents in the Beaufort Sea. The adoption of the proposed timing mitigation that allows drilling during the ice-covered season only (Section 2.5.1) would ensure no walruses are contacted from a large spill at the proposed LDPI during initial drilling, though pipeline spills could occur.

Alternative 2 (No Action)

Under the No Action Alternative the proposed development and production activities would not be approved and there would be no effect to Pacific walruses. The Pacific walrus population would continue with current population trends.

Alternative 3 (Proposed LDPI Relocation)

Alternative 3 would relocate the proposed LDPI either approximately 1 mile east or 1.5 miles southwest of the proposed site. This would increase the time required to build the LDPI (Section 2.1.3) but would not affect the timing or duration of pile-driving. The impacts to Pacific walruses from Alternative 3 are the same as those described for the Proposed Action and thus negligible.

Alternative 4 (Alternate Processing Locations)

Alternative 4 would relocate the processing facilities from the proposed LDPI to either the existing Endicott SDI or to a new facility located near the Badami tie-in (Section 2.2.5). Both options reduce the potential for disturbance and displacement of walruses because construction (and associated noise production) would be of shorter duration with less vessel traffic. However, construction noises associated with onshore processing added to the marine environment could disturb or displace Pacific walruses. Since walruses are uncommon and sparsely distributed in the Proposed Action Area, impacts would be negligible.

Alternative 5 (Alternate Gravel Source)

Alternatives 5A and 5B would relocate the gravel mine. This would affect the number and placement of ice roads and the footprint and levels of activity at the mine site but would not alter the types or durations of activities during the open-water season. The impacts to Pacific walruses from Alternative 5 would be the same as those described for the Proposed Action, and thus negligible.

Bearded Seal

The Proposed Action

Ringed and spotted seals share enough biological similarities with bearded seals that they can be used as a proxy for effects on bearded seals.

Ice Road Construction

The segment of the bearded seal DPS that overwinters in the Beaufort Sea almost exclusively uses lead systems and polynyas during winter when ice roads would be constructed. No known lead or polynya systems occur near the Liberty prospect. Thus, bearded seals should not occur in the Proposed Action Area when ice roads are being constructed or are in use.

Mine Site Development

The proposed mine site is located inland and far away from any potential bearded seals or their habitat and so no bearded seals should be affected by mining activities.

LDPI Construction

The LDPI would be constructed during winter and early parts of spring when shorefast ice extends from the Beaufort coastline to a point many miles north of the proposed LDPI site. Shorefast ice, where bearded seals live, ends beyond the McClure Islands so bearded seals should not occur in the Proposed Action Area when the LDPI is being constructed.

Sheet-, Pile-, and Pipe-Driving

Impact pile and vibratory sheet-/pile-driving would be used to install the proposed LDPI. While the majority of this work would occur during the ice-covered season and thus no bearded seals are likely to be present, some work would occur during the open-water season (see Chapter 2). Impact pipe- and pile-driving could produce an injury among pinnipeds, with PTS thresholds extending out to approximately 1,727 feet (40-minute exposure) for impact sheet-/pile-driving, approximately 785 feet (2-hour exposure) for impact pipe-driving, and vibratory pile-driving for approximately 66 feet (2.5-hour exposure) (SLR 2017).

LDPI construction that occurs during open-water season would require the use of aircraft (including fixed-wing and helicopters) and vessels (including hovercraft) to move people and materials to and from the site. Figure 4-24 shows the noise characteristics of most aircraft and vessels, and compares them to audiograms of ringed and spotted seals. No audiograms have been completed for bearded seals to date; however, ringed and spotted seals share enough biological similarities with bearded seals that they can be used as a proxy for analyzing the noise effects on bearded seals. Aircraft and vessels produce enough noise to disturb bearded seals. Effects from aircraft and vessels would be transient, lasting briefly, and the SELs would not create injuries (Table 4-13), although behavioral disturbance thresholds could be surpassed (Figure 4-25).

Work conducted in the open-water or broken ice could affect bearded seals. By implementing mitigation strategies described in Appendix C (Section C-1 through C-3), such as maintaining a 1,500 AGL flight altitudes within a 100 feet of seals, the effects would be reduced. Imposing a stricter 1,500-foot AGL minimum flight altitude requirement would further reduce impacts from aircraft sound to seals (see Appendix C, Section C-4).

Pipeline Installation

The majority of the proposed pipeline between the LDPI and the Badami pipeline would be constructed during the ice-covered season (see Chapter 2), when bearded seals are absent. However, some pipeline installation work could occur in open-water when they could be present. Figure 4-22 and Figure 4-24 show equipment used in pipeline installation activities, and the hearing thresholds for bearded seals. No noises would be produced that are capable of injuring pinnipeds and only limited behavioral effects would be possible.

Facilities Construction

Facilities construction would occur on the LDPI over several seasons (Figure 2-1). Work at the site would generate noise, mostly behind the LDPI seawall, which would buffer some construction noise. Consequently, facilities construction noises would be similar to but slightly less than those from gravel island construction (Figure 4-22 and Figure 4-25). Figure 4-22 and Figure 4-25 show most facilities construction noises occur below the behavioral thresholds for pinnipeds.

Drilling Operations

Bearded seals would not be present during winter drilling. The remainder of the year they could be present in the Proposed Action Area. In the 1980s, drilling noises were recorded at Sandpiper Island (near the proposed LDPI). Results from that study found the loudest noises occurred between 20 and 50 Hz, and reached their maximum decibel source level of 145 at the 40 Hz frequency (Miles et al., 1986). Table 4-12 shows bearded seals hear frequencies between 50 Hz and 80 kHz, indicating the frequency band of 20 to 50 Hz from drilling exceeds the minimum hearing threshold for seals, generally covering around 0.033 percent of the bandwidth audible to bearded seals. No notable industry-related acoustic components were observed above 200 Hz out to 2 nautical miles, and at 5 miles no man-made drilling noises were detectable.

Table 4-13 shows the modeled PTS and TTS thresholds for phocid seals such as bearded seals to be 201 dB SEL_4. Considering the maximum source level from drilling at the proposed LDPI should be about 151 dB_{RMS}, there is no potential for drilling to produce injury among bearded seals (SLR 2017).

The effects from drilling on bearded seals would mostly consist of slight behavioral changes around the proposed LDPI.

Production Operations

Blackwell, Greene, and Richardson (2004) noted noises from production operations reached 1.9 or 2.5 miles from Northstar, and Moulton et al. (2005) noted no differences in seal use of the area at that time.

Decommissioning

The noises and other disturbances produced during decommissioning would be similar to those produced during construction of the proposed LDPI. However, decommissioning could likely be accomplished in less time than construction. Furthermore, by the time decommissioning is initiated, many seals in the area would have likely habituated to the noise and activity associated with the proposed LDPI (Moulton et al. 2005).

Oil Spills

In a review of studies conducted on ringed seals analyzing the impacts of hydrocarbons on seal fitness and mortality, BOEM has determined that ringed seals are a reasonable biological proxy for bearded seals due to their biological similarities. Contact with crude oil could injure bearded seals (NRC, 2003), and the more volatile compounds in an oil slick, particularly aromatic volatiles, usually have the greatest toxicity. In-situ, cold-water measurements (Payne et al., 1984) have demonstrated toxic compound concentrations decrease significantly over time. Studies concerning the effects of crude oil ingestion and exposure on ringed seals (Geraci and Smith, 1976a) conclude the risk of seals accidentally ingesting large amounts of oil is low. Moreover, only small, transient effects were identified during necropsies of seals fed potent fractions of carbon tetrachloride. Immersion studies by Smith and Geraci (1976) found ringed seals can develop mild liver damage, kidney lesions, and severe eye damage from immersion in crude oil, etc., which was later supported by Frost and Lowry (1994). Unlike the animals in the immersion study, seals in the open water would have ice as a resting/escape platform as well as water depth and distance for escape routes from an oil spill, which they should be able to detect and avoid (St.Aubin, 1990).

The self-correction of many of the effects from crude oil contact have been documented among ice seals, particularly by purging their bodies of hydrocarbons through renal and biliary pathways, providing the duration of exposure isn't too great (Engelhardt, Geraci, and Smith, 1977; Engelhardt, 1982, 1983, 1985; Smith and Geraci, 1975; Geraci and Smith, 1976a, 1976b; St. Aubin, 1990). However, Spraker et al. (1994) observed lesions in the thalamus of harbor seal brains after they were oiled, possibly explaining motor and behavioral anomalies (Englehardt 1983). Lowry, Frost, and Pitcher (1994) also observed reproductive complications in harbor seals having been exposed to oil during the EVOS.

Overall, the severity of injury correlates with the duration of exposure and quantities of crude oil contacted.

Small Oil Spills

Small spills in the winter would be unlikely to affect bearded seals due to their absence from the shorefast ice areas surrounding the proposed LDPI. A small spill during the remainder of the year could have some adverse effects on bearded seals; however, the relatively small size of the spill should prevent any prolonged exposures from occurring.

Large Oil Spills

In the event of a large crude oil spill, or a gas release, some bearded seals could be affected. Due to sea floor topography, bearded seals forage between the continental shelf break and coastal areas. Ice formation and gouging in shallower waters along the Beaufort Sea coastline prevents the presence of benthic invertebrates in many areas. For this reason, bearded seals mainly use deeper waters where they can feed on benthos at depths where ice normally cannot reach the bottom. There are no documented concentration areas for bearded seals in the U.S. Beaufort Sea, so no Beaufort Sea ERAs have been developed for them. A proportionately small fraction of the bearded seal population is believed to overwinter in the Beaufort Sea lead systems where they mostly haul out for resting, molting, and pupping on ice floes and pack ice many miles to the north of the proposed LDPI.

Large spills contacting lead or polynya systems could result in some bearded seal mortalities, especially if young seal pups are present (St. Aubin, 1990). Large spills contacting leads and polynyas would require time to travel from the spill site to a lead or polynya, weathering and dispersing along the way, lowering the volume of oil that would eventually contact leads. Over time, oil could gel or emulsify in low temperatures making spill patches easier to detect and avoid by bearded seals.

ERAs (46, 48, and 62) have been identified as particularly important Chukchi Sea habitat to bearded seals for the OSRA spill analysis. Contact probabilities below 5 percent have a greater than 95 percent chance of not being contacted, are not reasonably foreseeable events, and will not be analyzed. The Annual Conditional Probabilities found in Appendix A (posted at www.boem.gov/liberty), Tables A.2-1 through A.2-6 do not show ERAs 46, 48, or 62 being contacted by a large spill from the proposed LDPI, or the PL. Likewise, no contacts greater than 5 percent are reflected in Tables A.2-19 through A.2-24, and A.2-34 through A.2-42 for the Summer or Winter Conditional Probabilities. No LS or GLS were identified as important to bearded seals.

Large spills could result in the loss of a few individuals during the open-water season or when large amounts of broken ice is present. Winter on-ice spills should not affect bearded seals and under-ice spills would be unlikely to contact bearded seals, including Beaufort Lead Systems (ERAs 30 through 37) where the probability of a winter spill contacting the leads would be less than or equal to 1 percent and not foreseeable.

The location of the proposed LDPI in shallow water, lack of contact with bearded seal ERAs, ubiquitous shorefast ice surrounding the proposed LDPI, relatively small presence of bearded seals in the Beaufort Sea, and the assumption that bearded seals can identify and avoid spilled oil indicates that bearded seals are unlikely to be adversely impacted by a large spill during winter. During periods of open-water or broken ice, potential mortalities of a few bearded seals could occur, however the assumed large spill sizes are unlikely to result in mortalities.

The effects of the Proposed Action on bearded seals would be negligible. Only a large spill during the open-water season has potential to harm some bearded seals; however, the effects of such a spill would be limited by the spill size, trajectory, constituents, weathering, residence time in the environment, and the effectiveness of the spill response. No population-level effects in the bearded seal stock could result from any individual or combination of activities in the Proposed Action, and no mortalities should occur from a large oil or diesel spill. For these reasons the Proposed Action should have a negligible level of overall effects on bearded seals.

If the Proposed Solid Ice Conditions (Section 2.5.1) were to be implemented during the initial drilling period, the presence of solid shorefast ice would prevent oil spills at the LDPI from contacting sea water. Most bearded seals abandon the Beaufort Sea during winter, and those remaining in the Beaufort Sea lead systems should be unaffected by large on-ice spills; however, spills from pipelines could occur and affect seals.

Oil Spill Response

People, boats, and aircraft are components of spill cleanup activities and could displace some bearded seals from oiled areas. These effects would occur during cleanup operations but would not significantly affect individual bearded seals or the Beringian DPS of bearded seals. Implementation of the proposed mitigation measures (Section 2.5) would ensure no bearded seals are contacted from a large on-ice spill from the proposed LDPI during initial drilling.

Alternative 2 (No Action)

The No Action alternative would not affect bearded seals. The Beringian bearded seal DPS would continue with current population trends.

Alternative 3 (Alternate LDPI Locations)

The effects and levels of effect from Alternative 3 would be the same as was described for the Proposed Action.

Alternative 4 (Alternate Processing Locations)

The effects and levels of effect from Alternative 4 would be the same as was described for the Proposed Action.

Alternative 5 (Alternate Gravel Sources)

The effects and levels of effect from Alternative 5 would be the same as was described for the Proposed Action.

Ringed Seal

The Proposed Action

Ice Road Construction

A small number of ice seals, particularly ringed seals, could be impacted by ice road construction, maintenance and use, and the use of lesser developed trails over ice. Seals have been documented overwintering in lairs and using ice habitat in the vicinity of nearshore ice roads in the central Beaufort Sea (Williams et al., 2006). Ice roads can create habitat that some ringed seals will exploit. Maintained ice roads can act like pressure ridges where the weaker, adjacent ice near the ice road cracks allowing ringed seals to exploit the cracks for breathing holes and possibly lairs in places where snow builds up.

In the course of normal ice road activity mechanized equipment could uncover lairs potentially disturbing, injuring, or killing seals. For example, in April 2018 a ringed seal pup was observed from the Eni Spy Island ice road adjacent to the location where workers were removing rig mats (i.e., metal plates) beneath the surface of the ice road. These rig mats occurred at a location where a fissure in the ice warranted additional structural support to facilitate the safe passage of truck traffic. It appeared that the removal of the mats disturbed the seal and lair because they were located approximately 4 feet from where work had occurred the previous day to remove snow and ice that had accumulated on top of the rig mats.

Two additional records document how seals may be impacted by mechanized vehicles traversing the ice over less developed trails in nearshore areas. While neither incident occurred on a developed ice road, they indicate how mechanized equipment could potentially impact seals attracted to ice roads or trails. In 1998, a bulldozer making a trail for an on-ice seismic project near the Maguire Islands drove over a ringed seal lair killing a pup and possibly injuring the adult (MacLean, 1998). In April 2018, an incident occurred on the Northstar Island sea ice trail in which a ringed seal pup climbed out of a hole in the ice onto the ice surface. The hole was made by a Tucker tracked vehicle after it was pulled out of a brine pocket it had fallen into earlier in the day.

These three examples are the only recorded ringed seal incidents in the past 20 years and BOEM anticipates that this trend will continue. There is also no data available on incidents of behavioral disturbance which might have occurred but not noticed by vehicle operators.

While travel corridor activities across the near-shore areas, such as ice road and ice trail construction, maintenance, and use could disturb, injure, or kill ringed seals near these types of operations, these activities would impact a small number of individual seals compared to the miles of ice roads that have been constructed and used. Impacts to the ringed seal population would be temporary and localized to the immediate area of the travel corridor. NMFS requirements from MMPA authorizations and best management practices would further limit the potential for disturbance or displacement of ringed seals as a result of ice road activity.

In regards to seal behavior, the ice road construction for Northstar affected the behavior of a few seals; they avoided creating lairs within 0.4 miles of the ice road. Overall there was little effect on ringed seal distribution and abundance (Richardson and Williams, 1999, 2000, and 2001; Williams et al., 2006). A small number of adult ringed seals and pups would likely be affected in a similar manner here. However, sections of ice road crossing grounded shorefast ice would not affect any ringed seals.

Over ungrounded ice areas (less than 5 miles from the Kadleroshilik River, and less than 7.5 miles from the Endicott SDI), the number of seals displaced from their lairs would probably number 1 to 2 seals per mile of ice road (Section 2.1.1, Years 1 through 5).

This displacement would not affect the ringed seal population or greatly affect their distribution in Foggy Island Bay, though some lairs and denning sites could be destroyed early in the season during ice road construction, if ice roads traversed lair habitat. The effects would occur periodically over the 25-year life of the Proposed Action, but only when ice roads are constructed and used. Even though injury or death could occur to individual seals, the impacts of winter season, travel corridor activity such as ice road or ice trail construction or use, to the ringed seal population would be temporary and localized to the immediate area of the travel corridor. NMFS requirements from MMPA authorizations and best management practices would further limit the potential for disturbance or displacement of ringed seals as a result of ice road and trail activity.

Currently, NMFS requires that activities should be at least 492 feet from an identified ice seal structure (Appendix C, Section C-3). If lairs can be located, which is difficult, adherence to this measure would reduce potential impacts.

Mine Site Development

The effects of mine site development on ringed seals would be consistent with what was described for bearded seals.

LDPI Construction

Ringed seals use the shorefast ice areas surrounding the proposed LDPI. For this reason, they could be affected, particularly by construction noise and gravel placement. The noises produced from proposed LDPI construction are similar to what was depicted in Figure 4-25.

Sheet-, Pile-, and Pipe-Driving

Vibratory sheet pile-driving has a maximum 120 dB_{RMS} behavioral threshold out to approximately 10.9 miles from the source. The PTS injury threshold for vibratory sheet pile-driving extends out to approximately 1,080 feet and only seals remaining within that distance could experience a PTS. Impact sheet-/pile-driving has a median 160 dB_{RMS} behavioral threshold out to approximately 1.3 miles, and a PTS injury threshold extending out to approximately 1,726 feet. Impact pipe-driving has a maximum 160 dB_{RMS} behavioral threshold out to approximately 1,312 feet from the source. The PTS injury threshold for impact pipe-driving extends out to approximately 787 feet. In order for a PTS injury to occur from any form of pile-driving, an animal must remain within the PTS noise zone for prolonged periods of time (SLR 2017).

The proposed LDPI would affect ringed seals by changing several acres of underwater habitat; however, the proposed LDPI could provide haulout opportunities for seals at times when sea ice is absent, such as in late summer. Ringed seals are likely to be affected to varying degrees by vibratory and impact sheet-, pile-, and pipe-driving. However, such impacts could not result in population-level effects. The most likely effect would be temporary behavioral responses.

Pipeline Installation

Ringed seals could occur along the pipeline route between the proposed LDPI and the pipeline tie-in. A Ditch Witch is used to trench pipeline routes, and they produce noise up to 122 dB at frequencies of 5 Hz–3.15 kHz (Table 4-16 and Figure 4-25), which could not cause physical injury to ringed seals. The noises from a Ditch Witch slightly exceed the 120 dB behavioral threshold, and overlap about 2 percent of the hearing range for ringed seals.

The proposed pipeline would begin in about 19 feet of water and end at the coast. Water depths of 9–10 feet are too shallow for ringed seals to use in winter. Only water depths between the proposed LDPI and the 10-foot bathymetric line provide winter habitat where ringed seals could potentially be affected, or around the first 15,000 feet of the proposed pipeline (2015 Liberty EIA, Figure 4.1.6-4). The remaining 15,000 feet of pipeline would be laid through ice frozen into the seabed, and could not affect seals. Assuming a high-end density of 1 ringed seal per 0.4 square miles for winter, no more than 5-10 ringed seals are likely to be affected by trenching in a subsea pipeline in winter.

Moving heavy equipment across the fast ice could crush or collapse some ringed seal dens. Some seal dens and seal pups could be injured or killed if such an event occurs, but this would not be a population-level impact. Surveying and avoiding den locations would mitigate such impacts.

Facilities Construction

The effects of proposed LDPI construction on ringed seals would be consistent with that described for bearded seals.

Drilling Operations

The effects of drilling on ringed seals would be similar to what was described for bearded seals with the exception that ringed seals are year-round residents of Foggy Island Bay. Ringed seals could be affected at any time during operations; however, there is no potential for ringed seal injuries. Some behavioral effects would be expected; but ringed seals would be insulated from noise in their dens during winter (Blackwell, Lawson, and Williams, 2004).

Production Operations

The effects of production operations on ringed seals would be consistent with what was described for bearded seals.

Decommissioning

The effects of Decommissioning on ringed seals would be consistent with what was described for bearded seals.

Oil Spills

The effects of oil spills on ringed seals would be similar to what was described for bearded seals. Ringed seals are more common in the Beaufort Sea than are bearded seals, especially in winter. Though the effects to individuals would be consistent with those described for bearded seals, ringed seals are more likely to be contacted by spilled oil due to their greater numbers, and year-round presence in the Beaufort Sea, particularly in Foggy Island Bay.

Small Oil Spills

A small spill from the proposed LDPI should not affect ringed seals during winter, since the spill would spread out onto the ice sheet and would be cleaned up quickly. A small spill during the open-water season or broken ice could affect ringed seals though it would be unlikely to spread beyond the LDPI’s berms and seawall. The most likely venues for a small spill to contact ringed seals would be through a pipeline rupture, or spills from vessels. Only a winter pipeline rupture along the first 2.84

miles has the potential to contact ringed seals. Summer pipeline spills could occur anywhere along the pipeline.

Large Oil Spills

A large crude oil or gas release could affect ringed seals. No concentration areas for ringed seals have been documented in the Beaufort Sea, so no ERAs have been developed for them. Though most ringed seals are believed to vacate the Beaufort Sea during winter, some remain in the Beaufort using areas of shorefast ice, particularly in lead systems.

Large winter spills from LDPI would likely spread across a solid sheet of sea ice and should not affect many ringed seals. Such a spill could be cleaned up and removed from the area efficiently; however, a winter spill from the pipeline could sequester in and under the sea ice which could affect more seals.

Large spills contacting lead or polynya systems could result in some ringed seal mortalities, especially if seal pups are present (St. Aubin, 1990). Though ringed seals in the lead system could be affected, they could haul out on ice to escape the oil spill. Furthermore, patches of the lead system would likely be contacted, not the entire lead system.

Large spills contacting leads (ERAs 30-37) and polynyas would require time to travel from the pipeline to a lead or polynya. Oil traveling under ice would weather and disperse along the way or combine with sea ice, which could lower the volume of oil reaching leads.

The Beaufort Sea Spring Lead System (ERAs 20 through 37) could provide higher quality ringed seal habitat in the OSRA. Contact probabilities are all less than 5 percent, and so have a greater than or equal to 95 percent probability of not being contacted, and so are not reasonably foreseeable events and will not be discussed further. A winter spill from LDPI (5,100 bbl) would be unlikely to result in any ringed seal mortalities, though a winter spill from the pipeline (1,700 or 5,000 bbl) would likely produce a few mortalities. A prompt and efficient OSR would reduce the impacts on ringed seals.

Only a large, under-ice spill from a pipeline (1,700 or 5,000 bbl) could potentially cause harm to ringed seals, but would be limited by the assumed spill size, trajectory, constituents, weathering, residence time in the environment, and by the spill response. Population-level effects to the ringed seal stock from any small or large spills should not occur. Consequently, the Proposed Action should have a negligible level of effects on the ringed seal population. The adoption of the proposed mitigation (Section 2.5) would not prevent pipeline spills from contacting ringed seals.

If the Proposed Solid Ice Conditions (Section 2.5.1) were to be implemented, the presence of 18-inch thick solid shorefast ice would prevent oil spills originating at the LDPI from contacting sea water during initial drilling only. During winter, ringed seals overwinter in the shorefast ice zone around the proposed LDPI, and a few could be affected by a large on-ice spill contacting dens or breathing holes used by ringed seals. Spills from buried pipelines could occur regardless of whether or not the proposed mitigation is adopted.

Oil Spill Response

The effects of OSR would be the same as was described for bearded seals.

Alternative 2 (No Action)

The No Action alternative would not affect ringed seals. The Western Arctic ringed seal stock would continue with current population trends.

Alternative 3 (Alternate LDPI Locations)

The effects and levels of effect from Alternative 3 would be the same as was described for the Proposed Action.

Alternative 4 (Alternate Processing Locations)

The effects and levels of effect from Alternative 4 would be the same as was described for the Proposed Action.

Alternative 5 (Alternate Gravel Sources)

The effects and levels of effect from Alternative 5 would be the same as was described for the Proposed Action.

Spotted Seal

The Proposed Action

Ice Road Construction

Spotted seals do not use the Beaufort Sea when ice road construction would be occurring, or when ice roads would be in use. For this reason, ice roads and ice road construction will not affect spotted seals.

LDPI Construction

Spotted seals are absent from the Beaufort Sea when much of the LDPI construction activities would occur. Some activity would occur during summer after the island is built, however those activities would occur on the island and behind the perimeter berm of the island, and mostly would not affect spotted seals. For this reason the construction of the LDPI should not affect spotted seals. Post-construction, the LDPI presence could provide a haulout location for seals to rest between bouts of foraging.

Sheet-, Pile-, and Pipe-Driving

The effects of vibratory and impact sheet- and pipe-driving on spotted seals are consistent with what was described for ringed and bearded seals. While the majority of pipe-/pile-driving would be conducted when the area is ice-covered, some may occur in the open-water season as well. HAK estimates that pipe-/pile-driving may occur for up to 15 days in the open-water season. The absence of spotted seals in the Beaufort Sea from fall through spring would prevent pipe-/pile-driving from affecting them, however, there would likely be some behavioral effects and potential injury amongst some spotted seals if the work occurs in open-water (Table 4-14, Table 4-18 and Table 4-19).

Vibratory and impact sheet-, pile-, and pipe-driving would likely produce temporary behavioral changes among spotted seals. Injuries to spotted seals are less likely because of their seasonal presence, and the remote chance of reaching SEL levels necessary to produce injury.

Pipeline Installation

Spotted seals would be absent from the Beaufort Sea when the pipeline would be trenched into the sea floor. For this reason, they should not be affected by pipeline installation including the operation of a Ditch Witch.

Facilities Construction

Winter construction activities would not affect spotted seals and the noise and activity associated with summer construction, particularly slope shaping and armament installation, would produce temporary behavioral reactions amongst spotted seals (Figure 4-22).

Drilling Operations

The effects of drilling on spotted seals would be similar to what was described for bearded seals with no potential for injury. Such effects could only occur during the summer when spotted seals are present. Potential for behavioral disturbance exists; however, as shown in Figure 4-24, most drilling noises should occur below the audiogram threshold of spotted seals.

Production Operations

The effects of production operations on spotted seals would be consistent with what was described for bearded seals.

Oil Spills

The effects of oil spills on spotted seals would be similar to what was described for ringed and bearded seals in open-water conditions. Spotted seals are believed to be less common than bearded or ringed seals in most of the Beaufort Sea; however, marine mammal monitoring (BPXA, 2014) observed more spotted seals in Foggy Island Bay at the LDPI site, than all other marine mammal species combined. Though the effects to individuals would be consistent with those described for ringed and bearded seals, spotted seals may avoid some areas of spilled oil by venturing into freshwater or using terrestrial haul outs.

Small Oil Spills

Small winter spills would not affect spotted seals. The effects of spills during open-water would be consistent with what was described for bearded and ringed seals.

Large Oil Spills

Large crude oil spills or gas releases could affect some spotted seals during summer. ERAs 1 (Kasegaluk Lagoon Area), 46 (Wrangel Island 12 nautical miles buffer 2), 48 (Chukchi Lead System), 62 (herald Shoal Polynya 2), 64 (Peard Bay Area/Franklin Spit Area), 65 (Smith Bay Spotted Seal Haulout), 68 (Harrison Bay), and 69 (Harrison Bay/Colville Delta) have been identified as important resource areas for spotted seals in the Beaufort and Chukchi Seas. GLSs 148 (Kolyuchin Bay), 169 (Smith Bay Spotted Seal Haulout, and 173 (Harrison Bay Spotted Seal Haulout) were also identified as important to spotted seals.

Between 5 percent and 6 percent of modeled spill trajectories contacted ERA 68 from a LDPI summer spill between 30 and 360 days, and there was a 5 percent contact probability of a LDPI spill contacting ERA 69 after 90 days. No ERAs had contact probabilities greater than or equal to 5 percent by winter spills, nor by annual spills. Likewise no GLSs had contact probabilities greater than or equal to 5 percent.

Only a large spill could harm spotted seals, but the effects are dependent on the spill size, trajectory, constituents, weathering, residence time in the environment, and effectiveness of the spill response. No population-level effects to spotted seals should occur from oil spills or from the activities associated with the Proposed Action. For these reasons the Proposed Action should have a negligible level of overall effects on spotted seals.

The Proposed Solid Ice Condition described in Section 2.5.1 would have no effect on spotted seals, as they are not in the area during solid ice conditions. For this reason, the additional drilling time associated with the application of this measure would also not impact spotted seals.

Oil Spill Response

The effects of OSR would be the same as was described for bearded seals.

Alternative 2 (No Action)

The No Action alternative would not affect spotted seals. The Alaska spotted seal stock would continue with current population trends.

Alternative 3 (Alternate LDPI Locations)

The effects and levels of effect from Alternative 3 would be the same as was described for the Proposed Action.

Alternative 4 (Alternate Processing Locations)

The effects and levels of effect from Alternative 4 would be the same as was described for the Proposed Action.

Alternative 5 (Alternate Gravel Sources)

The effects and levels of effect from Alternative 5 would be the same as was described for the Proposed Action.

Conclusion for Pinnipeds

BOEM's assessment of effects of the Proposed Action on pinnipeds includes implementation of, and compliance with, mitigation measures described in Appendix C (Section C-1 through C-3). These measures include lease stipulations, actions committed to by the operator, and measures required by Cooperating Agencies. These measures reduce potential adverse effects on marine mammals through requirements such as use of minimum altitudes and established routes by aircraft; acoustic monitoring to validate anticipated noise levels and use exclusion zones where appropriate; use of avoidance maneuvers by vessels when in the presence of marine mammals; and use of protected species observers where appropriate; and other measures (see C-1, C-2, and C-3).

Overall effects from the Proposed Action on the Pacific walrus population would be negligible. Pacific walruses are rarely found in the Project Area. For those few animals that might use the project area, adherence to the measures described in Appendix C (Section C-1 through C-3) would ensure that there would be little to no impact to the population of Pacific walrus.

Overall effects of the Proposed Action on the bearded seal population would range from negligible to minor. Much of the construction activity would occur during solid ice conditions when bearded seals are not in the area. However, some activities would occur during the open-water season and could affect bearded seals. Those activities include pile-/pipe-driving during LDPI construction, the majority of which would occur during solid ice but could extend into the beginning of the open-water season; aircraft and vessels moving to and from the site during the life of the project; and noise from drilling, production, and operation activities that would occur for the life of the project. Little to no impacts on the bearded seal population are anticipated because pile-/pipe-driving is a short-term activity that would occur only during LDPI construction, primarily during solid ice when no bearded seals are present, and drilling, production, and operation noise extends into open-water just a short distance from the island. Aircraft and vessels would adhere to the measures described in Appendix C (Section C-1 through C-3), ensuring that remaining impacts would be short-term and/or localized, and thus minor.

Overall effects of the Proposed Action on the ringed seal population would range from negligible to minor. Ringed seals could be present during both solid ice and open-water conditions. Effects could occur from noise generated by pile-/pipe-driving during LDPI construction; noise from, and presence of, aircraft and vessels moving to and from the site during the life of the project; noise from the drilling, production, and operation of the project; and the construction of ice roads/trails. Also, creation of the LDPI would remove several acres of underwater habitat that ringed seals have used, but also creates habitat for haul outs, as has been noted at Northstar. It is anticipated that effects on individual ringed seals could occur from noise during the open-water season, and would consist of short-term behavioral changes, although noise from drilling/production/operation extends into open-water just a short distance from the island. Ringed seals could be disturbed or possibly injured during ice road/ice trail construction, maintenance or use, although such incidents are rare.

Overall effects of the Proposed Action on the spotted seal population would range from negligible to minor. Spotted seals only occur in the Beaufort Sea during summer, and thus are not affected by activities that occur during the solid ice season. In the open-water season, spotted seals would be affected by the same activities as ringed and bearded seals. Impacts to spotted seals during the open-water season would be similar to impacts described for bearded and ringed seals, and their responses would be the same as well.

4.3.4.3.3 Polar Bear

The Proposed Action

Ice Road Construction and Use

Polar bears occur at low densities on the mainland coast, barrier islands, and sea ice of the Proposed Action Area during winter and spring months when ice road activities would occur. Pregnant female polar bears may occupy dens in the area from November through April, although some bears may not enter dens until late November or early December (Amstrup and Gardner, 1994). Both suitable maternal den habitat and historical den sites are present in the Proposed Action Area.

Ice road construction and use produces noise, vehicle traffic, and human presence that can disturb or displace polar bears from the immediate area (USDOI, USFWS, 2011). Alternately, non-denning bears can be drawn to ice road activities due to presence of attractants such as food waste, or out of curiosity (see further discussion in Human-Bear Interactions, below) (USDOI, USFWS, 2011; USDOI, USFWS, 2015). The type and extent of disturbance and displacement impacts can vary depending on the polar bear's life history status (e.g., pregnant/post-partum vs. not pregnant). For this reason, disturbance and displacement impacts to bears in maternity dens are discussed separately from impacts to non-denning bears.

Denning Polar Bears

Polar bears generally are not very sensitive to noise or other anthropogenic disturbances (Amstrup, 1993; Richardson et al., 1995); however, females and offspring in maternity dens may be more sensitive to noise and vehicle presence than non-denning bears (Amstrup and Gardner, 1994). Behavioral responses of denning females and of family groups are variable; denning females may be tolerant of nearby ground traffic in winter and spring (Amstrup, 1993; USDOI, USFWS, 2011; USDOI, 2012). In addition, snow cover is an effective insulator, preventing the attenuation of noise into dens (MacGillivray et al., 2003).

The commencement date of ice road construction is dependent upon ice conditions (e.g., thickness), but would likely begin in mid to late December, after most bears have entered maternal dens and shortly before they would give birth (Harington, 1968; Ramsay and Dunbrack, 1986). Disturbance from ice road construction and use could cause den abandonment for females in the immediate area. Pregnant bears could be displaced from dens in the early part of the denning season (early winter), and to a lesser extent pregnant individuals or those with newborn cubs could be displaced later in the season (Amstrup, 1993; Derocher and Stirling, 1992; Linnell et al., 2000; Ramsay and Dunbrack, 1986). Pregnant females or post-partum females that abandon dens in mid-winter are at increased risk of mortality from starvation and exposure because female bears in maternal dens fast until emergence in the spring and pregnancy and lactation increase the energetic cost of survival during what is already a period of energy deficit. Early emergence of cubs, even in spring, can have adverse consequences because cub survival is correlated with their weight at the time they exit the maternity den (Blix and Lentfer, 1979; Derocher and Stirling 1992).

Ice roads for the Proposed Action would continue to be used and maintained through mid-April each year (possibly as late as May for offshore sections). Female polar bears and cubs exit dens in March through April (Amstrup and Gardner, 1994; Bishop and Streever, 2016).

After emerging, family units can spend several days in the vicinity of the den before permanently abandoning it (USGS data cited in USDOI, USFWS, 2006). During this time females and cubs may be particularly susceptible to disturbance (USDOI, USFWS, 2012).

The potential impacts of disturbance and displacement to females and cubs could be greater than for non-denning bears. The energetic consequences of moving away from disturbance may be more pronounced in energy-depleted mothers and energy-limited offspring. Disturbance and displacement can also result in the separation of family units (USDOI, USFWS, 2011). Both of these impacts could in turn affect the health and survival of females and offspring. However, with the exception of cub mortality from separation, reactions of family units to anthropogenic activities are generally brief and temporary, and not of long-term consequence to individuals (USDOI, USFWS, 2011).

Non-Denning Polar Bears

Polar bears that are not occupying maternity dens are active throughout the winter and may occur in the Proposed Action Area as they use the coastline and sea ice for foraging, resting, and traveling. Non-denning bears appear to be less sensitive to industrial noise and activities than denning females (Richardson et al., 1995; Smith et al., 2007).

If a non-denning bear was disturbed by ice road construction and use, whether through auditory or visual stimuli, the animal could react by moving away from the area of activity. Bears could be deflected away from transit corridors and access to important habitat (e.g., foraging areas) or, alternately, towards areas of Proposed Action activity (see further discussion in Habitat Loss and Alteration and Human-Bear Interactions, below). However, this disturbance and displacement would be temporary and localized (USDOI, USFWS, 2011; USDOI, USFWS, 2012).

Habitat Loss and Alteration

Ice road construction and use can seasonally alter limited areas of potential polar bear critical habitat both on-shore and offshore; however, these impacts are temporary and affect only a small portion of habitat available to polar bears (USDOI, USFWS, 2012). Under the Proposed Action, ice road footprints would temporarily alter terrestrial and barrier island denning, and sea ice designated critical habitat; the acreage made unavailable would vary among years but would be greatest during the first two years of the Proposed Action.

Polar bears may alter their travel route to avoid contact with human activities or because intentional hazing deflects them away from the area (USDOI, USFWS, 2011; USDOI, USFWS, 2012); however, such effects would be localized and would not prevent bears from accessing areas altogether. Furthermore, polar bears are commonly documented crossing roads and navigating the oil fields at Prudhoe Bay and other developed portions of the onshore and nearshore Beaufort Sea coastline without apparent difficulty; therefore, oil and gas infrastructure is not considered to act as a significant barrier to polar bear movements (USDOI, USFWS, 2011; USDOI, USFWS, 2012).

Ice roads are likely to affect females once they exit maternity dens with cubs-of-the-year because they can produce a disturbance and displacement response caused by auditory or visual stimulus. After den emergence, females will move to sea ice foraging habitat to replenish depleted energy stores. Ice road presence and traffic could possibly lead to early den abandonment by the mother, putting the cubs at risk because they may not be able to survive the sea ice environment away from the "protective" environment of the den site.

Ice road construction and use could affect polar bears indirectly through prey impacts. Ice roads may displace ringed seals from pupping lairs or haulouts, and seals could abandon breathing holes near ice roads. However, disturbances would likely only temporarily affect a few ice seals and affect only a small proportion of potential foraging habitat; and thus would not impact bears' overall ability to successfully obtain and consume prey (USDOI, USFWS, 2011).

Human-Bear Interactions

Anytime human activities overlap with habitat used by polar bears there is potential for human-polar bear interactions. An increase in human-bear interactions can occur if bears are deflected away from coastal travel corridors and towards developed areas. The presence of attractants (e.g., food waste) associated with construction activities and traffic can also increase human-bear interactions (Streever and Bishop, 2013; Streever and Bishop, 2014; USDOI, USFWS, 2015cjp). In addition, ice roads can increase ease of access to areas where attractants and human activity are present (USDOI, USFWS, 2011).

Most polar bears observed by the oil and gas industry in the U.S. Beaufort Sea exhibit no discernible change in behavior in response to anthropogenic activities (USDOI, USFWS, 2011). Polar bears are curious and while some individuals may avoid or retreat from human activities, others may approach to investigate. Bears that enter areas of industry activity may be actively deterred (or hazed/harassed) so that they vacate the site. Hazed bears could experience temporary disturbance and stress from some deterrence activities (e.g., from acoustical devices, moving vehicles, spotlights) and may walk, run, or swim away. For healthy bears, any stress they experience from this activity would likely be short-term; bears that have walked or swam long distances may experience longer periods of stress and may have to rest elsewhere prior to resuming normal activities such as feeding. Bears that are deterred using more aggressive methods (e.g., projectiles such as bean bags and rubber bullets), would likely experience stress and short-term pain (USDOI, USFWS, 2011).

Other Sources of Injury or Mortality

Physical injury or mortality of polar bears as a consequence of ice road activities is extremely unlikely due to the alert and highly mobile nature of the species.

Vehicle-Bear Collisions

Traffic on ice roads poses a collision risk to polar bears; however, no such incidental collisions of polar bears and terrestrial vehicles have been documented on the North Slope (USDOI, USFWS, 2012). 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 the majority of ice road traffic supporting the Proposed Action is comprised of slow-moving construction vehicles, bears transiting ice roads would have sufficient time to move out of the way of any oncoming traffic (Hilcorp, 2015, Table 5-6).

Contaminant Exposure

Ice road-related operations would require the use of substances that can be both attractive and toxic to wildlife. Polar bears could be exposed to these toxins if they are not properly stored or if small spills occur and are not fully contained and cleaned-up. No known illnesses or mortalities of polar bears have been definitively linked to chemical exposure from North Slope oil and gas activities; however, Amstrup et al. (1989) investigated the remains of a polar bear that appeared to have ingested ethylene glycol (antifreeze) and rhodamine B (two compounds used to mark roads and runways during winter months) shortly before its death. A similar incident involving an adult female and yearling was investigated by FWS in 2012 (Streever and Bishop, 2013). Because standard chemical storage and disposal procedures are typically implemented during North Slope oil and gas operations, it is unlikely that a polar bear would come into contact with harmful substances. Small refined oil spills could occur during ice road construction and use. Potential impacts to polar bears from small spills are addressed in Oil Spills – Small.

Potential for impacts to polar bears and polar bear critical habitat from most ice road construction and use during the Proposed Action would be seasonal and would not persist longer than the first two years (the period when multiple roads would be needed to support proposed LDPI construction and pipeline installation). Long-term seasonal disturbance, displacement, habitat loss alteration, and increased potential for human-bear interactions could occur along the annual ice road system connecting the proposed LDPI to the Endicott SDI because this road would be present each winter and spring throughout the 5-year life of the development project (USFWS, 2011). Because these impacts would be long-term and could result in adverse minor impacts to local population levels individual animals, ice road construction and use would have moderate minor effects to polar bears. This level of effect would be reduced to negligible to minor with the implementation of mitigation measures described in Appendix C, particularly pre-activity maternal den surveys (Section C-2, C-3). This, coupled with reactive mitigation measures designed to minimize anthropogenic impacts to recently discovered dens in the area, would greatly reduce the potential for impacts to pregnant females and denning family units.

Mine Site Development

As with ice road construction and maintenance activities, the spatial and temporal extent of the mine site development overlaps with winter and spring polar bear critical habitat and both denning females with newborn young and non-denning polar bears may be found in the area. Likewise, mine site activities have the potential to disturb and displace individuals, alter or remove polar bear critical habitat, increase the likelihood of human-bear interactions, and contribute to injury or mortality of individual polar bears. These impacts have been discussed in Ice Road Construction and Use, above; only aspects specific to development of the proposed mine site that have not previously been are addressed are discussed further.

Disturbance and Displacement

Construction of the mine site would involve multiple blasting events to remove substrate and this could cause denning and non-denning polar bears to avoid or vacate the area. For transient bears this displacement would be brief and would not result in long-term effects to bear health. Females with recently-birthed young could abandon nearby maternal dens; early den abandonment can have adverse consequences on the health, growth, and survival of both mothers and offspring. Such impacts can be short-term and acute as well as have long-term, chronic effects to individuals. Blasting would occur for a brief period during one season.

The temporal and geographical extent of potential exposure to polar bears would be extremely limited.

Habitat Loss and Alteration

Mine site development for the Proposed Action would result in both short-term and long-term impacts to potential polar bear critical habitat. Excavation would permanently remove approximately 21 acres of land, some of it critical habitat (terrestrial denning) because the proposed mine site remediation would convert the excavated footprint to artificial aquatic habitat (Hilcorp, 2015). It is possible that remediation could produce topographical features around the perimeter of the site that are conducive to maternal denning; however, the likelihood and extent to which this could occur is not presently known.

In additional to the 28-acre ice pad surrounding the mine site, construction and emergency response offices would be stationed on a 45-acre grounded pond south of the Badami seasonal ice road (Hilcorp, 2015, Figure 10-2). These offices would be accessed via an approximately 0.4-acre ice road spur off of the Badami ice road. These facilities would make some critical habitat unavailable for use for one winter, but no long-term alterations or loss of habitat would result from these temporary facilities.

Potential for impacts to polar bears from mine site development activities would be seasonal and would not persist longer than a 6-month period during Year 2. Critical habitat (terrestrial denning habitat) loss could occur at the excavation site because of proposed remediation plans to convert the area to aquatic habitat; however the amount of habitat removed would comprise a very small portion of the habitat available to polar bears. Furthermore, FWS does not consider denning habitat to be limiting the population size of the SBS polar bear stock (C. Perham, pers. comm. in USDOI, USFWS, 2008). The blasting events would be the one activity which could affect polar bears the most. While such impacts can be short-term and acute as well as have long-term, chronic effects to individuals, any individuals at maternal den sites within the vicinity could be impacted by the blasting. The blasting effects, and because activities themselves would occur over a relatively short time period, and long-term impacts would be limited to localized critical habitat alteration, mine site development would have moderate effects to polar bears. While compliance with the assumed mitigation measures described in Appendix C (Section C-2, C-3) would not reduce the impact level to negligible, they would lessen the potential for disturbance, displacement, and human-polar bear interactions during mine site activities.

LDPI Construction

LDPI construction would have the greatest potential to impact polar bears during winter and spring months because bears are more likely to occur in the Proposed Action Area during that time (Section 3.2.4.11). Polar bears are occasionally reported by industry during the open-water season (e.g., Bisson et al., 2013); bears encountered in the water or on land during proposed LDPI construction could also be affected by proposed LDPI construction activities.

LDPI construction could disturb and displace transient individuals and family units, alter polar bear critical habitat, increase the likelihood of human-bear interactions, and contribute to injury or mortality of individual polar bears. These impacts have been discussed in Ice Road Construction and Use, above; aspects specific to construction of the proposed LDPI not previously addressed, are addressed in the sections that follow.

Disturbance and Displacement

In addition to noise and presence of ground traffic and construction vehicles, construction of the proposed LDPI would require the support of helicopters, hovercraft, and vessels. The noise and presence of aircraft and vessels can disturb and temporarily displace polar bears, although responses can vary greatly among individuals (Richardson et al., 1995).

Underwater construction sounds would have minimal effects to on-ice polar bears because bears are unlikely to hear underwater sound above ice (USDOI, USFWS, 2012). Swimming bears would also be minimally affected by underwater sounds (e.g., sheet-/pile-driving) because sound in open water would be attenuated; additionally, polar bears generally do not dive much below the surface and they normally swim with their heads above the surface, where noises produced underwater are weak (Greene and Richardson, 1988; Richardson et al., 1995).

Aircraft

Under the Proposed Action, aircraft to support construction would transit between the proposed LDPI and Deadhorse and/or the Endicott SDI, with 1 to 2 helicopter trips occurring per day (Table 2-4). Polar bears are known to run from sources of noise and the sight of aircraft, especially helicopters (Amstrup, 1993; Bishop and Streever, 2016; Richardson et al., 1995; Streever and Bishop 2014). The effects of fleeing from aircraft are likely to be minimal if the event is temporary, the animal is otherwise non-stressed, and the flight occurs in low ambient temperatures. However, with increased temperatures, a short run may be enough to overheat a polar bear, and a bear already experiencing stress that swims a long distance could require rest for a long period prior to reinitiating essential life functions such as feeding. Persistent aircraft travel could displace polar bears from localized areas in the flight path (USDOI, USFWS, 2012). Additionally, small cubs could become separated from their mothers (USDOI, USFWS, 2012). Denning bears may also abandon or depart their dens early in response to repeated noise produced by extensive aircraft overflights (Amstrup, 1993; USDOI, USFWS, 2011).

Vessels

If an encounter between a vessel and a swimming bear were to occur, it would most likely result in only a minor disturbance (e.g., the bear may change its direction or temporarily swim faster) as the vessel passes the swimming bear (USDOI, USFWS, 2012). Although it has not been thoroughly documented, persistent disturbance from vessels operating within one lateral mile of barrier islands could prevent use of localized areas of barrier island critical habitat (USDOI, USFWS, 2012). However, vessel traffic to support the proposed LDPI construction would only occur between West Dock and the LDPI or Endicott SDI and the LDPI and, therefore, is not expected to prevent use of the remaining habitat.

Habitat Loss and Alteration

Construction of the proposed LDPI would turn approximately 24 acres of marine sea ice critical habitat into a man-made island. Anthropogenic activity associated with the island would limit its ability to be used for any reason by polar bears. In the past, polar bears have used man-made islands on the North Slope for denning and resting areas. During construction of Spy Island in the winter season of 2010 to 2011, a polar bear denned in the terraced, gravel bags that armor the island. The female entered the den in the early winter 2010 during a lull in construction activity. Once the company was aware of the bear, they ceased work on the island. This minimized disturbance to the bear and allowed her to successfully leave the island with her offspring. In addition, bears constantly use the man-made, offshore islands as resting sites and are sometimes dispersed by safety personnel after they are discovered. Depending on the tolerance level of individual polar bears to human activities, bears may use structures as resting areas (USDOI, USFWS, 2012). Multiple bears have used Oooguruk, Northstar, and the West Dock and Endicott causeways for resting and traveling (Bishop and Streever, 2016; USDOI, USFWS, 2012).

Human-Bear Interactions

Facilities to support 100 construction and drilling personnel would be installed on the proposed LDPI (Hilcorp, 2015). The increase in personnel would increase the likelihood of human-bear interactions, as described in Ice Road Construction and Use. However, the proposed LDPI was engineered to minimize access by polar bears (Hilcorp, 2015); therefore, the increase in potential encounters is less than if the same support facilities and personnel were stationed onshore.

The duration of potential for impacts from proposed LDPI construction would be less than one year and most potential impacts would be no more than short-term behavioral responses. Long-term sea ice critical habitat alteration would occur at the LDPI; however, the amount of habitat altered would comprise a very small portion of the sea ice habitat available to polar bears. Because activities themselves would occur over a relatively short time period and long-term impacts would be limited to localized critical habitat alteration that could marginally increase potential for human-bear interactions, LDPI construction would have minor effects to polar bears and a negligible effect on polar bear populations. While compliance with the assumed mitigation measures described in Appendix C (Section C-2, C-3) would not reduce the impact level to negligible, they would lessen the potential for disturbance, displacement, and human-polar bear interactions from proposed LDPI construction. Impacts on individual bears could occur, but impacts at the population level are not expected to rise above minor.

Pipeline Installation

Pipeline installation could disturb and displace denning and transient individuals and family units, alter polar bear critical habitat, increase the likelihood of human-bear interactions, and contribute to injury or mortality of individual polar bears. These impacts have been discussed in previous sections; aspects specific to pipeline installation not previously addressed, are addressed in the sections that follow.

Habitat Loss and Alteration

Construction of the offshore portion of the pipeline would temporarily exclude a few polar bears from using some sea ice habitat, although it would only last during the construction season. These impacts have been discussed in previous sections; aspects specific to pipeline installation not previously addressed, are addressed in the sections that follow.

Ringed seals could be disturbed and displaced from the immediate area, potentially altering their distribution and availability to polar bears. These impacts would be localized and temporary, persisting for only one winter and spring.

Staging areas and support facilities would make some potential denning habitat unavailable during construction of the onshore portion of the pipeline similar to the offshore portion of the pipeline. This impact would not persist longer than one winter and spring. HAK would be required to conduct pre-construction den detection surveys to identify any maternal den sites in the footprint of proposed staging areas, support facilities, and shore-crossing (Appendix C, Section C-2 and C-3), and these surveys would need to be approved by the FWS.

Installation of Vertical Support Members (VSMs) and a new gravel pad for pigging facilities at the Badami tie-in would permanently remove approximately 0.6 acres of potential denning habitat. However, the edges of the gravel pad could create suitable denning habitat if sufficient drifting snow accumulates. The onshore pipeline would be elevated a minimum of 7 feet to prevent it from hindering wildlife movements, including polar bears.

Construction of the approximately 300-foot long pipeline shore-crossing would temporarily alter critical habitat along the coast, an important transit area for non-denning polar bears. The unavailability of this area would be short-term, lasting no longer than one winter and spring (Hilcorp, 2015). Construction of the shoreline crossing may have long-lasting impacts to polar bear denning habitat, however. Coastal bluffs at the interface between mainland and marine habitat are areas of relatively greater denning use (Durner et al. 2004; Durner et al. 2006). Installation of a thaw stable gravel plug near the waterline as well as backfill could modify topographical features at this interface. Gravel placement could create habitat conducive to denning and/or decrease or remove the physical characteristics key to suitable denning habitat (USDOI, USFWS, 2012).

The approximately 10-foot tall thermal siphons installed along the length of the shore crossing could be perceived as an obstacle to transiting bears if they are especially sensitive to the presence of human structures. More likely, however, polar bears would have no difficulty in navigating the siphons; bears regularly move through areas of much more pervasive infrastructure (USDOI, USFWS, 2012).

Human-Bear Interactions

An additional temporary camp housing unit having up to 125 workers may be installed onshore during the 3rd Quarter Year 2 to support pipeline and facilities installation (Hilcorp, 2015). The increase in personnel as well as the additional camp (a potential source of attractants) would increase the likelihood of human-bear interactions, as described in Ice Road Construction and Use.

Potential for most impacts to polar bears from pipeline installation would be less than one year and result in no more than short-term behavioral responses. Long-term critical habitat alteration would occur at the gravel tie-in pad, the shoreline crossing, and VSM locations; however, the amount of critical habitat altered would comprise a very small portion of the terrestrial denning critical habitat available to polar bears. Because activities themselves would occur over a relatively short time period and long-term impacts would be limited to localized critical habitat alteration, pipeline installation would have minor effects on polar bears.

While implementation of, and compliance with, assumed mitigation measures described in Appendix C (Section C-2, C-3) would not reduce the impact level to negligible, they would lessen the potential for disturbance, displacement, and human-polar bear interactions during pipeline installation activities.

Facilities Construction

Facilities construction activities could impact polar bears in the manners described in Ice Road Construction and Use and proposed LDPI Construction, including disturbance and displacement of denning and non-denning bears, increased likelihood of human-bear interactions, and contribution to injury or mortality of individual polar bears. These impacts have been discussed in previous sections; aspects specific to facilities construction that have not previously been addressed are discussed in the sections that follow. No impact to habitat beyond that already described in previous sections is anticipated.

Disturbance and Displacement

In addition to aircraft, crew boat, and ground traffic, facilities construction would be supported by barge and tug traffic. Vessel traffic would transit between offshore and nearshore barrier island habitat (Figure 2-3). Exact routes would be dependent on weather and safety conditions, however, barges passing within 1 mile of barrier islands could disturb and displace polar bears from barrier island critical habitat (USDOI, USFWS, 2012).

During the open-water season polar bears, including family units, are periodically observed at the Endicott SDI (Bishop and Streever, 2016; Streever and Bishop, 2013; Streever and Bishop, 2014). Facilities construction activities at Endicott could disturb polar bears resting or traveling the SDI, and the chance of human-bear interactions would be increased. However, bears using the Endicott SDI are likely habituated to or at least tolerant of the level of human activity that occurs there, otherwise they would avoid the area.

Potential for impacts to polar bears from facilities construction would occur intermittently over a 3-year period, with the greatest potential during the second autumn of the Proposed Action, when the majority of facilities to support personnel and construction would be installed. Temporary disturbance and localized displacement could occur, as could human-bear interactions. Because activities themselves would occur over a relatively short time period and no long-term impacts (such as critical habitat loss) are anticipated, facilities construction would have minor effects to polar bears. HAK would be required to conduct pre-construction den detection surveys to identify any maternal den and required to develop implements a polar bear interaction plan (Appendix C, Section C-2 and C-3). While implementation of these assumed mitigation measures would not eliminate impacts, they would lessen the potential for disturbance, displacement, and human-polar bear interactions during construction activities.

Drilling Operations

Drilling operations could impact polar bears via disturbance, increased potential for human-bear interactions, and contribution to injury or mortality of individual polar bears from drilling support activities. These impacts have been discussed in previous sections; aspects specific to drilling operations not previously addressed, are addressed in the sections that follow.

Drilling operations introduce the potential for a large spill to occur. Impacts of large spills to polar bears are presented in Oil Spills, Large Spills.

Disturbance and Displacement

Polar bears near routine industrial activities may habituate to these stimuli and show less vigilance than bears not exposed to such stimuli (USDOI, USFWS, 2012). In 2011, a female bear denned throughout the winter on an industrial island and remained in the den while construction occurred. Once the company was aware of the bear near the time when she was emerging, they ceased work on the island. This minimized disturbance to the bear and allowed her to successfully leave the island with her offspring (USDOI, USFWS, 2012). Habituation to stimulus such as noise is generally considered to be positive because polar bears may experience less stress from industrial activity; however, it may also increase the risk of human-bear encounters.

During the 2017 exploration drilling season at ENI's Nikaitchuq drilling island polar bears, including those attended by cubs or juveniles behaved as though unaffected by drilling operations (ENI 2017). Based on the observed behaviors of polar bears to gravel island construction and operation, incurring energetic losses or stresses among polar bears is very unlikely.

Impacts from drilling operations during the open-water season would be minimal. Underwater drilling noise during the open-water season would be unlikely to affect polar bears in the LDPI area because they do not dive below the surface much and typically swim with their heads out of the water (Richardson et al., 1995).

Impacts from drilling operations during the ice-covered season would be minimal as well. Transient bears moving through the area may encounter in-air drilling noise; however, impacts from noise levels would be limited to the island interior and the LDPI vicinity (SLR, 2017). Bears would have to be in the immediate vicinity of the LDPI facilities to be impacted by drilling noises where they would more likely be deterred for safety reasons because of their presence, rather than affected by drilling operations.

Denned polar bears are not expected to be impacted by drilling activities because the nearest potential polar bear denning habitat is along the coast and it is not within the ensonified area of drilling operations (SLR, 2017) that could disturb or injure bears. In addition, the drifted snow of the dens would insulate drilling noises (MacGilvaray et al., 2003) from denned polar bears. Thus, no denned bears are expected to be impacted by drilling operations during the ice-covered season. Further, underwater drilling noise produced during periods of sea ice coverage would have minimal effect on polar bears because ice would prevent noise attenuation (USDOI, USFWS, 2012).

Construction and drilling operations would occur concurrently for several years (Figure 2-1). The number of vessel and surface vehicle trips would increase during this period, which would result in greater potential for disturbance and displacement of polar bears on land or ice or in dens. Impacts from marine and surface traffic are discussed further in proposed LDPI Construction and Facilities Construction, and Ice Road Construction and Use, respectively.

Aircraft traffic would continue to support project activities during drilling but at a greater frequency than during construction activities. Correspondingly, the potential for disturbance or displacement of polar bears from aircraft overflights during drilling operations would be comparable or higher than during construction. As detailed in proposed LDPI Construction, impacts from aircraft noise and presence would be short-term and result in, at most, limited and brief behavioral reactions.

Potential impacts to polar bears from drilling operations would include temporary disturbance and localized displacement, as well as increased potential for human-bear interactions. No long-term impacts, such as critical habitat loss, are anticipated.

The Proposed Solid Ice Condition (Section 2.5.1) would shift much of the risks associated with a large oil spill from summer months to winter months. A large spill which occurred during the solid ice conditions of winter would likely have less impacts to polar bears than a summer spill into open water, because a spill during solid ice conditions would disperse over a smaller area, would be more easily cleaned up, and more easily avoided by bears. Restricting reservoir drilling to winter months would also extend the time period required to complete the overall drilling program, but as drilling would not be occurring when bears are as active, and when spills are more easily contained and cleaned up, the additional few months to couple of years of drilling activity would not meaningfully increase or decrease impacts from an oil spill to polar bears.

Production Operations

Production would commence after the completion of the first three wells. It is anticipated that first oil would be produced in during the third winter (1st Quarter, Year 4). Construction and drilling activities would be ongoing during that time. By 1st Quarter, Year 5, drilling would likely be complete and only production-related activities would continue.

Production-related activities focus on the operation and maintenance of facilities and equipment (Section 2.1.5). Operations would continue to be supported by resupply via ice roads and, to a lesser extent, summer barges (at an estimated 10 trips per year). Aerial helicopter surveillance would be conducted of the offshore and onshore pipeline corridor on a weekly or other periodic basis. A bathymetry vessel would survey the offshore pipeline annually during the open-water season.

The types of potential impacts to polar bears from production operations would be the same as those from drilling operations; however, the likelihood of occurrence would be relatively less, as fewer personnel would be needed once construction and drilling are complete. A reduction in personnel would result in relatively fewer aerial, vessel, and ground vehicle trips for crew transport and resupply (Hilcorp, 2015, Tables 5-3, 5-4, and 5-5), and generation of fewer attractants (e.g., food waste).

The potential for impacts to polar bears from production operation would be continuous over a 22-year period. Temporary disturbance and localized displacement could occur, and as could human-bear interactions. It is assumed that HAK would implement and comply with mitigation measures described in Appendix C (Section C-2, C-3) to conduct pre-construction den detection surveys to identify any maternal den and to develop implements a polar bear interaction plan. Because no long-term impacts (such as habitat loss) are anticipated, production operations would have negligible effects on polar bears.

Decommissioning

Decommissioning would occur over an 18-month period; the removal of facilities and abandonment of wells would likely require two winter seasons. Under the Proposed Action it is anticipated that all installed surface facilities associated with the Proposed Action would be removed, including proposed LDPI slope protection, the onshore pipeline, and VSMs. The subsea pipeline would be flushed of all contaminants, ends cut and sealed, and abandoned in place. The proposed LDPI likely would be left in place to allow waves and current to reshape the proposed LDPI naturally.

Decommissioning could impact polar bears via disturbance and displacement, increased potential for human-bear interactions, and contribution to injury or mortality of individual polar bears. The likelihood and duration of these impacts would be comparable to those described in previous sections (e.g., impacts from removal of on-ice proposed LDPI modular facilities would be similar to impacts from module installation).

The abandoned LDPI and gravel pads (as they erode or if they are not removed) could provide polar bears with additional barrier island and denning habitat. For example, the Staging Pad, an isolated, abandoned gravel pad isolated approximately 4.3 miles northeast of the Milne Point Central Processing Facility, is the most consistent location of polar bear denning on the North Slope; 8 maternal dens have occurred on this man-made pad in the last 9 years. Bears have also successfully denned on a decommissioned exploration gravel pad on Cross Island and on the runway ramp at the Bullen Point Long Range Radar Station (USDOI, USFWS, 2012).

Summary

The duration of potential for impacts from decommissioning would persist for no more than approximately 18 months. Most potential impacts would be no more than short-term behavioral responses. Implementation of, and compliance with, assumed mitigation measures described in Appendix C (Section C-2, C-3) decreases the potential for disturbance, displacement, and human-polar bear interactions. Abandonment of the proposed LDPI and gravel pad sites could provide polar bears with additional potential habitat (if not removed). Because activities themselves would occur over a relatively short time period and long-term impacts would be limited to localized habitat alteration, decommissioning would have minor effects on polar bears.

Oil Spills

Polar bears can occur in the Action Area year-round and therefore have the potential to be affected by oil spills during any season. An oil spill in the fall or spring during the formation or break-up of sea ice would be a greater risk to polar bears than spills occurring at other times of year because of difficulties associated with clean up during these periods, and the presence of bears in the prime feeding areas over the continental shelf (Amstrup, Durner, and McDonald, 2000; Amstrup et al., 2006; Helm et al., 2015; USDOI, USFWS, 2015cjp). During the autumn freeze-up and spring break-up periods, any oil spilled in the marine environment would likely concentrate and accumulate in open leads and polynyas, areas of high activity for both polar bears and seals (Helm et al., 2015; Neff, 1990). The potential impacts of a spill would be greatest where polar bears are relatively aggregated, such as Barter and Cross islands during the fall open-water period (Amstrup, Durner, and McDonald, 2000; Amstrup et al., 2006; Helm et al., 2015; USDOI, USFWS, 2015cjp).

Polar bears that come into contact with crude or refined oil could experience acute and long-lasting effects, including irritation to eyes, mouth, and mucus membranes, irritation and damage to respiratory organs from inhalation, and kidney and liver damage from ingestion of contaminated prey (Ortisland et al., 1981). Contact with and ingestion of petroleum by polar bears can also cause hair loss, anemia, anorexia, increased metabolic rate, elevated skin temperatures, and stress response (Derocher and Stirling, 1991, St. Aubin, 1990).

Polar bears scavenge animal carcasses; it is unclear whether polar bears would avoid contaminated carcasses. In addition, polar bears are known to be attracted to petroleum products and can be expected to actively investigate oil spills; they also are known to consume foods fouled with petroleum products (Derocher and Stirling, 1991; St. Aubin, 1990). Oiled polar bears would likely ingest oil during grooming efforts and would be susceptible to hypothermia. Heavily oiled bears would not survive unless capture and cleaning efforts were successful (Ortisland et al., 1981). Further detailed information on the physiological impacts of oil contact to marine mammals is presented in Section 4.3.4.2.11, Accidental Oil Spills.

Small Oil Spills

Small spills (less than 1,000 bbl) of refined oil could occur during construction, drilling, production, and decommissioning. Small spills of crude oil could occur during drilling and production.

In the event that a small spill occurred, individual polar bears or their prey could come into contact with oil. However, a small spill is unlikely to contact polar bears, even if it entered water bodies or wetlands, because polar bears are sparsely distributed (USDOI, USFWS, 2012). Additionally, most small spills assumed to occur during the Proposed Action would be 2 to 3 bbl (with an average of 0 to 9 bbl spilled annually) and a 3-bbl refined oil spill evaporates and disperses within 24 hours during summer months (Appendix A, posted at www.boem.gov/liberty).

If an individual polar bear contacted or ingested oil it could experience acute and chronic physiological impacts, up to and including mortality. The OSRA analyses in Appendix A shows a small winter spill could not contact any lead or polynya systems making it unlikely any polar bears could come into contact with oil spilled under the ice. Furthermore, it is unlikely polar bears would contact small spills, and even if such an event were to occur, any adverse effects to a single or few individuals could not cause population-level effects. For these reasons small spills would have negligible effects on polar bears. Those impacts would be further reduced by spill response such as containment by booms or absorbent pads that may help prevent small spills from reaching the water, or by burning off the spilled materials (Alaska Clean Seas 2016).

Large Oil Spills

A large spill (greater than or equal to 1,000 bbl) could occur during drilling or production; however, the OSRA estimates that there is a 99.33 percent chance of no large spills occurring during the Proposed Action (Appendix A posted at www.boem.gov/liberty). Because large spills are of important concern, BOEM assumes a large spill could occur and conducts a large oil spill analysis for the development and production activities (Section 4.1.1.3).

In the unlikely event of such an oil spill, the extent of impact would be influenced greatly by the volume, trajectory, and timing of the spill as well as the period that oil remains in the environment (Amstrup, Durner, and McDonald, 2000; Amstrup et al., 2006; Helm et al., 2015). Polar bears present in the vicinity of an oil spill might or might not be contacted by the oil due to personal preferences, avoidance or attraction behavior, ice conditions, or weather patterns, and questionable whether polar bears avoid or are attracted to oil (Geraci and St. Aubin, 1990). If a large oil spill occurred in the vicinity of an aggregation of polar bears, any substantial loss of individual bears would represent a major impact to the local population (Amstrup, Durner, and McDonald, 2000; Amstrup et al., 2006; Helm et al., 2015; USDOI, MMS, 2002).

Oil Spill Analysis

Detailed background on BOEM's OSRA process is provided in Appendix A (posted at www.boem.gov/liberty). The OSRA model estimates the conditional and combined probabilities of a large spill contacting a geographic area (i.e., ERA, LS, GLS) important to one or several species or species groups during a discrete amount of time. A list of polar bear ERAs and GLSs can be found in Appendix A, Table A.1-5. Oil spill impacts to ice seals, such as ringed seals, could impact polar bears by limiting prey available to them, or by causing mortality from secondary contamination. Impacts to ice seals are presented in Appendix A-7.

ERAs and GLSs (no LSs were identified for polar bears) analyzed in this section are those for which the conditional probability of large spill contact was found to be greater than or equal to 5 percent at any point within 360 days of a spill occurring. The conditional probabilities of those ERAs and GLSs for which contact was less than 5 percent can be found in Appendix A. The ERAs and GLSs discussed in this section are:

- ERA 92 – Thetis, Jones, Cottle and Return Islands, important polar bear barrier island critical habitat and maternal denning habitat; vulnerable to large spills year-round;
- GLS 176 – Land Segments 98 through 129, important summer coastline critical habitat for polar bears; vulnerable to large spills from June through August;
- GLS 178 – Land Segments 104 through 129, important fall coastline critical habitat for polar bears; vulnerable to large spills from September through November; and
- GLS 179 – Foggy Island Bay, important polar bear coastline critical habitat and maternal den habitat; vulnerable to spills year-round (Appendix A, Table A.1-5).

Maps of these polygons are presented in Appendix A.

Conditional Probabilities

The OSRA model calculates conditional probabilities (expressed as a percent chance) of a spill contacting identified polar bear habitats (ERA polygons, LSs, or GLSs). Conditional probabilities are based on the assumption that a large spill has occurred (for further explanation, see Appendix A, posted at www.boem.gov/liberty). For a map of the hypothetical spill sources (proposed LDPI and pipeline) used for the oil spill trajectory analysis; see Appendix A, Map A-6.

Summer Spills

A large spill during summer (July 1 through September 30) could impact polar bears coming ashore due to sea ice retreat or in preparation for denning later in the fall/winter season. The areas in the Beaufort Sea that would be particularly important include barrier islands where bears may den as well as rest after long swims to shore from the pack ice edge, and the main coastline – an important travel corridor to access terrestrial denning critical habitat and winter sea ice foraging areas (Derocher et al., 2013; Fischbach et al., 2007; USDOI, USFWS, 2015). The conditional probabilities of a summer large spill from the proposed LDPI or the pipeline contacting a polar bear ERA or GLS are presented in Table 4-22.

Winter Spills

A large spill during winter (October 1 through June 30) could impact polar bears on nearshore or offshore ice or at polynyas and open lead systems. A large spill in winter would be difficult to clean up, and oil could become entrained in the ice, melting out in spring and contacting lead systems and coastal areas. In winter, polar bears range throughout the ice-covered waters of the Beaufort Sea (Section 3.2.4.11). They may be found near polynyas and open leads where they prey on seals. In spring, new family units emerge from dens and could come into contact with oil that has melted out of the ice. The conditional probabilities of a winter large spill from the proposed LDPI or the pipeline contacting a polar bear ERA or GLS are presented in Table 4-23.

Table 4-22 Summer Conditional Probabilities of a Large Spill Contacting a Polar Bear ERA or GLS

Resource Area	Source	1 day	3 days	10 days	30 days	90 days	360 days
ERA 92	LI	<0.5	2%	8%	10%	11%	11%
ERA 92	PL	<0.5	1%	3%	<0.5	5%	5%
GLS 176	LDPI	12%	28%	40%	43%	43%	43%
GLS 176	Pipeline	27%	40%	46%	48%	48%	48%
GLS 178	LDPI	12%	25%	30%	30%	30%	30%
GLS 178	Pipeline	26%	34%	37%	37%	37%	37%
GLS 179	LDPI	24%	48%	57%	58%	58%	58%
GLS 179	Pipeline	53%	72%	77%	78%	78%	78%

Notes: Summer = July 1-September 30
ERA = Environmental Resource Area
GLS = Grouped Land Segment

Table 4-23 Winter Conditional Probabilities of a Large Spill Contacting a Polar Bear ERA or GLS

Resource Area	Source	1 day	3 days	10 days	30 days	90 days	360 days
ERA 92	LI	<0.5%	2%	7%	10%	10%	10%
ERA 92	PL	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GLS 176	LDPI	4%	10%	14%	16%	17%	17%
GLS 176	Pipeline	5%	13%	16%	17%	18%	18%
GLS 178	LDPI	4%	9%	13%	14%	14%	14%
GLS 178	Pipeline	11%	16%	18%	18%	19%	19%
GLS 179	LDPI	21%	46%	55%	57%	57%	57%
GLS 179	Pipeline	51%	69%	76%	77%	77%	77%

Notes: Winter = October 1 through June 30
ERA = Environmental Resource Area
GLS = Grouped Land Segment

Combined Probabilities

Combined probabilities differ from conditional probabilities in that there is no assumption that a large spill has occurred. Instead, combined probabilities reflect the chance of one or more large spills occurring over the life of the Proposed Action, and of any portion of that spill contacting any portion of a particular ERA. Combined probabilities do not factor in any cleanup efforts. For more background information, see Appendix A, (posted at www.boem.gov/liberty) Section A-1.4.3.

The OSRA model found the combined probabilities of a large spill occurring and contacting a polar bear ERA or GLS within 360 days to be less than 1 percent, regardless of whether the spill occurred during winter or summer months.

Oil Spill Response

The conditional or combined probabilities do not consider the effectiveness of spill response activities to mitigate large spills which could range from highly effective under ideal conditions to largely ineffective depending upon the specific circumstance. An OSRP would be required prior to exploration or development and production activities.

OSR commencement time could vary depending on the location of the spill. OSR equipment is cached in Deadhorse and in Utqiaġvik, about 150 miles west of Deadhorse. OSR personnel would be expected to work with FWS on walrus and polar bear management activities in the event of a spill and to work with NMFS on the management of other marine mammals present in the area.

During OSR activities, oiled carcasses would be collected when feasible, which could lessen the risk of polar bears ingesting oiled prey items. In some circumstances, oiled seals or seal carcasses floating in broken ice and in open leads would be very difficult to locate and recover. Removal of all types of oiled carcasses (birds, seals, fish, and other mammals) is an important primary OSR activity. This removes a source of secondary poisoning to scavengers and predators.

Hazing may be very effective in the case of small spills or in relatively discrete areas. Most marine mammals would be likely to avoid the high level of activity associated with cleanup activities. Polar bears may be curious and may approach personnel who are on shore or in vessel. Wildlife response activities could involve hazing bears away from an area, or capturing and transporting an oiled bear for cleaning and treatment though it is unlikely that an oiled bear would survive.

In general, cleanup activities could result in short- or long-term displacement of polar bears and their prey from preferred habitats and increased human interactions and disturbance. Conversely, cleanup activities would likely decrease the likelihood that marine mammals may come into contact with oil by displacing them from oiled areas. These would not produce population-level impacts but could affect polar bears in the immediate vicinity; therefore, OSR would have minor impacts to polar bears.

Periodically polar bear maternal dens go undetected during pre-activity den surveys and are discovered during activities (e.g., ice road use, drilling operations). As described in Section C-2 of Appendix C, BOEM assumes that mitigation to minimize impacts to polar bears will be applied, i.e., upon discovery of the den, all activity within a 1-mile radius must cease and FWS be contacted to assess and provide guidance to the operator.

Conclusion for the Proposed Action

Impacts to polar bears from the Proposed Action assumes implementation of the mitigation measures for marine mammals described in Appendix C (Sections C-1 to C-3). These measures reduce the likelihood of disturbance, displacement, and physical harm of polar bears by requiring minimum approach distances, pre-activity maternal den surveys, and a site-specific human-polar bear interaction plan. Most of these impacts would be the result of human-bear interactions. These interactions, including deterrence events, would be short-term behavioral changes on the bears in the vicinity of the LDPI. Impacts to the population from routine activities associated with the Proposed Action are anticipated to be short-term and localized, although the Proposed Action could result in major impacts to individual polar bears if they were exposed to a large oil spill. Overall, impacts from the Proposed Action are not anticipated to exceed a minor level of effect.

Alternative 2 (No Action)

Under Alternative 2, the No Action Alternative, the proposed development and production activities would not be approved, and there would be negligible levels of effect to polar bears.

Alternative 3 (Alternate LDPI Locations)

Alternative 3 would relocate the proposed LDPI to one of two locations. Alternative 3A would place the proposed LDPI approximately 1 mile east of the Proposed Action site; Alternative 3B would place the proposed LDPI approximately 1.5 miles southwest of the Proposed Action site (Section 2.2.4). The ways in which aspects of the Proposed Action would be affected in some cases differ between Alternative 3A and Alternative 3B; therefore each option is discussed separately in comparison with the Proposed Action.

Alternative 3A: Relocate LDPI Approximately One Mile to the East

Under Alternative 3A, the proposed LDPI would be relocated approximately 1 mile east of the Proposed Action site. As a result, most ice road routes would differ from those anticipated under the Proposed Action. In addition, lengths would differ: The ice road from the mine site to the proposed LDPI location would be shorter; the ice roads from the proposed LDPI to the Badami tie-in and from the proposed LDPI to Endicott SDI would be longer. Because the Alternative 3A site is in deeper water, a larger quantity of gravel and 7 to 10 days of additional construction days would be needed, resulting in a greater amount of ice road traffic during proposed LDPI construction, and a greater amount of activity at the mine site. The mine site footprint may be larger (unless deeper extraction from the existing footprint would meet gravel needs). Because the construction period would be extended, it is possible that proposed LDPI slope protection installation activities could extend farther into fall.

Since the Badami tie-in point would not change, the pipeline route would be longer and approximately 1 mile closer to the Kadleroshilik River Delta, an area of higher density potential denning critical habitat. The additional length of the pipeline would necessitate 8 percent more time to complete installation.

Because the Alternative 3A site is in deeper water and farther from the reservoir, the length of the wells would increase and additional time (approximately 70 to 80 days vs. 45 days) would be required to complete the wells. This would increase the length of time during which a large personnel population would be present on the LDPI.

During production operations there could be an increased need for aerial pipeline surveys and summer ancillary activities because the pipeline route would traverse the 100 percent overflood probability boundary (increasing the potential for strudel scour effects to the pipeline).

Decommissioning activities would be the same but could extend over a longer period of time because of the longer pipeline and potentially larger mine footprint.

Similar to the Proposed Action, impacts to polar bears assumes implementation of the mitigation measures for marine mammals included in Appendix C (Sections C-1 to C-3). Compared to the Proposed Action, Alternative 3A would have a greater potential for disturbance and temporary displacement of polar bears from ice road and aircraft traffic and greater potential for human-bear interactions during the relatively longer construction and drilling periods and decommissioning activities. Long-term impacts to habitat could be greater because the gravel mine footprint would be increased. In addition, the proximity of the pipeline to the Kadleroshilik River Delta likely would increase potential adverse effects to denning bears and the suitability of potential denning critical habitat at that location. While there is a slight increased potential for impacts to polar bears from Alternative 3A, the level of impact is anticipated to be short-term and localized, and thus minor.

Alternative 3B: Relocate LDPI Approximately 1.5 Miles to the Southwest

Under Alternative 3B, the proposed LDPI would be relocated approximately 1.5 miles southwest of the Proposed Action site. As with Alternative 3A, most ice road routes and lengths would differ from those anticipated under the Proposed Action. The ice road from the mine site to the proposed LDPI location and the ice roads from the proposed LDPI to the Badami tie-in would have different trajectories; the ice road from the proposed LDPI to Endicott SDI the ice road for pipeline installation would both be shorter. Because the Alternative 3B site is in shallower water, a small quantity of gravel and 4 to 6 fewer days of construction days would be needed, resulting in less ice road traffic during proposed LDPI construction, and less activity at the mine site. The mine site footprint may be smaller and/or shallower.

Since the Badami tie-in point would not change, the pipeline route would be shorter and the pipeline would take 10 to 14 fewer days to install.

Because of the increased distance from the reservoir, the length of the wells would increase and additional time (approximately 120 days vs. 45 days) would be required to complete the wells. This would increase the length of time during which a large personnel population would be present on the proposed LDPI.

Decommissioning activities would be the same but could occur over a shorter period of time because of the shorter pipeline and potentially smaller mine footprint.

Similar to the Proposed Action, impacts to polar bears assumes implementation of the mitigation measures for marine mammals included in Appendix C (Sections C-1 to C-3). Alternative 3B would have comparably less potential for disturbance and displacement of polar bears from ice road and aircraft traffic. There would be less potential for human-polar bear interactions during ice road construction, mine site development, proposed LDPI construction and pipeline installation, but greater potential for such interactions during the longer drilling operations phase. Because the footprint of the ice roads, mine site, and pipeline is smaller, less critical habitat would be altered (Table 4-24). While there is a slight decreased potential for impacts to polar bears from Alternative 3B, the level of impact is anticipated to be short-term and localized, and thus minor.

Alternative 4 (Alternate Processing Locations)

Alternative 4 would relocate the processing facilities from the proposed LDPI to an onshore location (Section 2.2.5). Two options exist for onshore processing including use of an existing facility and construction, and use of a new facility. The ways in which aspects of the Proposed Action would be affected differ between Alternative 4A and Alternative 4B, therefore each option is discussed separately in comparison with the Proposed Action.

Alternative 4A: Relocate Oil and Gas Processing to Endicott

Under Alternative 4A, processing would be relocated to Endicott. Because processing equipment would no longer be on the LDPI, the proposed LDPI surface footprint would be reduced to 5.4 acres and construction of the smaller proposed LDPI would take 18 to 20 fewer days. The mine site footprint would be smaller, and duration of mine site development shorter, because less gravel would be needed.

The pipeline would route from the proposed LDPI to Endicott; no onshore pipeline activities would occur beyond installation, monitoring, and maintenance at the connection to the Endicott SDI. The pipeline itself would be 2.8 miles longer, for a total length of 8.4 mi. The 3-phase flowline would be 14 inches in diameter instead of 12 inches and would require 50 percent more construction materials. As a result, pipeline installation would take 40 to 50 additional days, and would have a larger footprint.

Activities associated with facilities installation (e.g., marine vessel traffic) would be reduced because fewer modules would be needed on the island. Human presence during production would be concentrated at Endicott, a site of existing anthropogenic activity; however, fewer personnel would be needed on the proposed LDPI during production operations. As a result, fewer crew transfers would be required, and less waste would be generated at the LDPI.

Decommissioning would require less time and activity because this alternative would reduce the amount of infrastructure to be removed.

Impacts to polar bears from the all action alternatives assumes implementation of the mitigation measures for marine mammals described in Appendix C (Sections C-1 to C-3). Overall, Alternative 4A would have comparatively less potential for disturbance and displacement of polar bears during mine site development, proposed LDPI construction, facilities installation, production operations, and decommissioning because less new infrastructure would need to be installed. Potential for disturbance and displacement from pipeline installation would be greater because of the longer amount of time needed to place the flowline; however, the additional time constitutes a very small fraction of the life of the Proposed Action. The potential for human-polar bear interactions would be less than for the Proposed Action during all phases except pipeline installation, since the installation timeline would be extended. The loss or alteration of polar bear critical habitat from Alternative 4A would be less than under the Proposed Action because the footprint of the mine site and proposed LDPI would be smaller and existing facilities (which are not considered polar bear critical habitat) would be used (Table 4-24). The potential effects of Alternative 4A are less than the Proposed Action, but are still short-term and localized. Alternative 4A also has short-term and localized impact to undeveloped polar bear terrestrial habitat, which is increasingly important in light of trends in sea ice loss. Overall the level of impacts from Alternative 4A would be minor.

Alternative 4B: Relocate Oil and Gas Processing to a New Onshore Facility

Under Alternative 4B, a new onshore processing facility would be constructed near the proposed Badami pipeline tie-in. Construction would include a new gravel production pad on which processing equipment and support facilities (e.g., personnel housing) would be located, and either an all-season gravel road or boat dock to allow facilities access during shoulder seasons and ice-free months. The onshore facilities would require additional personnel during all phases of the Proposed Action. While the new pad would require gravel, the reduction in proposed LDPI surface footprint would result in an overall decrease in the amount of gravel needed for the Proposed Action. As a result, the mine site footprint would be smaller, and duration of mine site development shorter. In addition, proposed LDPI construction would decrease by 15 to 20 days.

The pipeline route would follow that proposed for the Proposed Action; however, the larger diameter of the flowline would result in a larger footprint and an additional 10 to 15 days for installation.

Facilities installation activities at the proposed LDPI would decrease because less equipment would be needed offshore. However, throughout facilities construction and production operations, a greater amount of traffic and anthropogenic activity would occur onshore.

Decommissioning activities would be dependent on whether the onshore infrastructure could be used for other oil and gas projects or if all surface structures would be removed. If onshore infrastructure were to remain, decommissioning would focus on the proposed LDPI and pipeline and would require less time and activity because less infrastructure would need to be removed. If all surface structures were to be removed, the time needed to complete decommissioning would be extended to allow for removal of structures both on and offshore.

Similar to the Proposed Action, impacts to polar bears assumes implementation of the mitigation measures for marine mammals described in Appendix C (Sections C-1 to C-3). Overall, Alternative 4B would have comparatively greater potential for impacts to polar bears because of the installation and continuous use of onshore facilities in an area of terrestrial polar bear habitat. While the proposed LDPI and gravel mine footprints would be smaller, the potential for disturbance and displacement of polar bears, and the likelihood of human-polar bear interactions, would be greater than the Proposed Action because a larger proportion of activities would occur onshore and human presence would be continuous in that area (Table 4-24). However, these effects would be localized to the area described in Alternative 4B, and the level of effects are determined to be minor.

Alternative 5 (Alternate Gravel Sources)

Alternatives 5A and 5B would relocate the gravel mine. Each of the alternative locations would differ in potential impacts to polar bears. The types and potential for impacts during pipeline installation, facilities construction, drilling and production operations, and decommissioning are not expected to differ between the Proposed Action and Alternative 5, with the exception of an extended proposed LDPI construction window if the Duck Island Mine site is used.

Alternative 5A: East Kadleroshilik River Mine Site #2

This site lies approximately 2 miles inland from the coast and 7 miles from the proposed LDPI, placing it farther from the polar bear shoreline transit corridor than the Proposed Action mine site. Placement further from the shore could slightly reduce potential disturbance, displacement, and human-bear interactions compared to the Proposed Action. Longer ice roads, and possible different ice road routes, would be required to transport gravel during proposed LDPI construction and likely to support pipeline installation. Temporary critical habitat loss from mine site support facilities would occur but would not persist any longer than under the Proposed Action.

Overall, East Kadleroshilik River mine site #2 would have comparably greater potential for disturbance and displacement of polar bears during the ice road construction and use because of the longer roads. Long-term impacts to critical habitat from the mine site itself could be slightly lessened because it is farther from the high-traffic polar bear transit area; however, the need for longer ice roads would temporarily alter a greater amount of potential habitat. The potential for human-polar bear interactions is not expected to differ notably from the Proposed Action (Table 4-24).

While there is increased potential for impacts to polar bears from the use of East Kadleroshilik River mine site #2, impacts would not rise to the threshold of producing population-level impacts. Therefore the level of impacts from this option would not differ from that described for the Proposed Action.

Alternative 5B: East Kadleroshilik River Mine Site #3

This site lies 15 miles from the proposed LDPI. This mine site would be at greater risk for erosion and would be closer to the polar bear shoreline transit corridor than the Proposed Action mine site. Longer ice roads, and possible different ice road routes, would be required to transport gravel during proposed LDPI construction and likely to support pipeline installation. Temporary habitat loss from mine site support facilities would occur but would not persist any longer than under the Proposed Action.

Overall, East Kadleroshilik River mine site #3 could have comparably greater potential for disturbance and displacement of polar bears during the ice road construction and use because of the longer roads and proximity to polar bear denning critical habitat. Additionally, potential impacts to polar bears traveling along the shoreline would be increased due to the site’s proximity to the coast.

Impacts to habitat could be increased. The potential for human-polar bear interactions is not expected to differ notably from the Proposed Action (Table 4-24).

While there is increased potential for impacts to polar bears from the use of East Kadleroshilik River mine site #3, impacts would not rise to the threshold of producing population-level impacts. Therefore the level of impacts from this option would not differ from that described for the Proposed Action.

Table 4-24 Alternatives 2-5 Gravel Mine Location and Impacts to Polar Bears Compared to the Proposed Action

Alternative	Disturbance or Displacement	Habitat Loss or Alteration	Human-Polar Bear Interactions	Comparative Level of Impacts
2: No Action	less (none)	less (none)	less (none)	less (none)
3A: Proposed LDPI Relocation East	greater	greater	greater	same
3B: Proposed LDPI Relocation Southwest	less	less	less to more (phase-dependent)	same
4A: Onshore Processing at Existing Facility	less	less	less	less
4B: Onshore Processing at New Facility	greater	greater	greater	same
5A: East Kadleroshilik River Mine Site #2	greater	greater	same	same
5B: East Kadleroshilik River Mine Site #3	greater	same	same	same

4.3.5 Overall Conclusions for Marine Mammals

The Proposed Action has many similarities to other previous projects in the Beaufort Sea, such as Endicott, Northstar, Oooguruk, and Nikiachuk. To date such projects have not produced any documented changes in marine mammal populations or regional distributions, nor have they produced any chronic behavioral responses. Due to advances in technology, planning, and work experience in the Arctic, and due to the location of the Proposed Action, the overall effects from the proposed action should be less than that of the Northstar Project, and slightly greater than the Oooguruk or Nikiachuk Projects.

4.3.6 Terrestrial Mammals

Caribou, muskoxen, brown bear, and Arctic fox, and Arctic ground squirrel are the terrestrial mammals most likely to be affected by the Liberty Development. The following analyses consider potential impacts to each of the key mammal species described, and provides an overall conclusion for terrestrial mammals as a group.

Typical oil and gas development impacts related to habitat, disturbance, mortality, and productivity of terrestrial mammals are described in the Point Thomson Final EIS (USACE, 2012a, Section 5.10); the 2007 Liberty DPP Environmental Assessment (EA) (USDOI, MMS, 2007a; BPXA, 2007, Sections 3.1.9; 3.2.6; and 3.3.9); and the 2002 Liberty DPP Final Environmental Impact Statement (FEIS) (USDOI, MMS, 2002, Section III.A.1 and III.A.2.d).

Impacts to terrestrial mammals and their dens, burrows, foraging, insect-relief areas, and resting habitats could come from:

- aircraft operations
- vehicle operations (including heavy equipment)
- gravel mining
- onshore ice roads

- wildlife/personnel interactions
- habitat alteration
- pipeline construction
- oil spills

4.3.6.1 Impacts Common to All Species

4.3.6.1.1 Aircraft

Helicopters will be used in support of the Proposed Action. Air traffic associated with the Proposed Action will generally be above 1,500 feet AGL unless human health or safety is at risk. Most air traffic from Deadhorse to the proposed LDPI would pass over the middle of the Sagavanirktok River Delta. The potential for disturbance to animals using the delta would be present during all seasons, but would be greatest during spring and summer because more terrestrial mammals are present or active in the Proposed Action Area at that time of year.

According to Greene and Moore (1995, pp.102-110), helicopters are capable of producing tones mostly in the 68 Hz to 102 Hz range at noise levels up to 151 dB_{RMS} at the source. Additionally, they radiate more sound forward than backwards, which means noise levels would be audible at greater distances ahead of the aircraft than to its rear.

Helicopter noise is generally audible for tens of seconds as a helicopter is approaching or departing an area. Generally, terrestrial mammal responses vary depending on aircraft flight altitude and received sound levels, and range from no reaction from habituated animals to violent, injurious escape responses.

No fixed wing operations are included as part of the Proposed Action.

4.3.6.1.2 Vehicles

Vehicular activity in the Proposed Action Area would create temporary disturbances along existing and proposed transportation corridors. The most likely cause of Proposed Action-related mortality to terrestrial mammals would be vehicle collisions on gravel and ice roads.

Caribou, muskoxen, grizzly bears, and most furbearers are sensitive to vehicles. As with aircraft, vehicles could frighten terrestrial mammals and cause escape behavior that could result in injury or separation from offspring. An individual animal may or may not show signs of sub-lethal effects of vehicular disturbance that result in an overall decrease in an individual animal’s fitness.

Greene et al. (2008) determined ice road construction was one of the least noisy activities occurring during the construction of the Northstar Project (Table 4-25).

Table 4-25 Northstar Project Heavy Equipment Noise

Sound Source	Broadband SPL at 100 m (dB re 20 μPa)	Frequency Bandwidth of produced noise ≥100 dB re 20 μPa
Bulldozer	114.2	31.5 Hz–125 Hz
Augering	103.3	None
Pumping	108.1	500 Hz–1 kHz
Ditch Witch	122	<5 Hz - 3.15 kHz
Trucks	123.2	<5 Hz–500 Hz
Backhoe	124.8	<5 Hz–1.2 kHz
Vibrahammer, sheet-driving	142.9	23 Hz–25 Hz
Sheet Pile-driving	132	5 Hz–55 Hz
*Background Noise	78–110	20 Hz–5 kHz

Note: * Highly variable due to changing environmental variables.
Source: Greene et al., 2008; Blackwell, Lawson, and Williams, 2004.

4.3.6.1.3 Gravel Mining

The proposed gravel mining would occur during winter and is unlikely to impact terrestrial mammals, including hibernating grizzly bears.

4.3.6.1.4 Wildlife-Human Interactions

Causes of animal aggression toward humans are often related to food-conditioning of bears and foxes. Also, many foxes on the North Slope are carriers of the rabies virus. These circumstances can create increases in aggressive behavior toward humans. Interactions that might occur between humans and animals include unintentional harassment or disturbance of parturient (preparing to give birth) females, and isolation of young animals from their mothers. A few animals could be killed because they behave aggressively towards humans, or because they display defensive responses to the actions or presence of humans.

Because some animals can become a threat to human safety, they may be killed to defend human life, though such incidents are uncommon.

4.3.6.1.5 Pipeline Construction

The onshore pipeline landing would be trenched for about 300 feet before transitioning to an aboveground pipeline (7 feet or greater above the ground surface) which is unlikely to impact terrestrial mammals. Pipeline construction would likely result in short-term, localized disturbance, and long-term loss of approximately 24 acres of tundra habitat.

4.3.6.2 Accidental Oil Spills

In the event of an oil spill, some terrestrial mammals may be exposed to oil along the coastline and onshore pipelines.

The severity of harm caused to terrestrial mammals by oil spills varies according to a number of factors, such as:

- **The amount of exposure of each animal to oil.** The greater the area an oil spill covers, the more difficult it becomes for animals to avoid the oil particles, and the greater the magnitude of exposure. Furthermore, as the time period over which oil is present increases, so too does the likelihood of exposure to the spill for individual animals.
- **The contact pathway for each animal exposed to oil.** The oil exposure pathway (ingestion, absorption, or inhalation) can influence the rate and severity of the effects. Animals with varied diets could have fairly limited contact with oil via ingestion since their diets are more flexible. Conversely, animals such as muskoxen tend to show a good deal of habitat fidelity and may readily relocate to avoid contaminated foraging areas.
- **The physical state and health of individual animals.** The age and overall health of an animal would be a determining factor on the degree of harm caused from oil spill exposure. Individuals with lower fitness could be impacted more than robust individuals in prime condition. Consequently, the young, old, injured, or diseased would most likely manifest adverse responses to spilled oil before young and healthy adults would (Ober, 2016).

Potential effects on terrestrial mammals could include:

- Irritation, inflammation, or necrosis of skin
- Chemical burns of skin, eyes, mucous membranes
- Inhalation of toxic fumes with potential short- and long-term respiratory effects (e.g., inflammation, emphysema, infection, pneumonia)

- Partial or extensive coating of pelts with oil which could reduce insulation and result in hypothermia and/or ingestion of oil during grooming; either could result in mortalities
- Ingestion of oil directly, or via contaminated food, leading to inflammation, ulcers, bleeding, damage to liver, kidney, and brain tissues
- Absorption of oil through the skin damaging the liver and kidneys, causing anemia, suppressing the immune system, inducing reproductive failure, and in extreme cases killing an animal
- Extended travel and search time to locate alternative insect relief and foraging areas
- Relocation of home ranges or increased competition at grazing areas due to loss of food resources
- Decreased access to quality foraging areas
- Decreases in diet diversity, which could lead to reduced overall health
- Greatest impacts could occur when energetic requirements are high
- Disturbance from spill cleanup activities

Complications of the above could quickly lead to reduced fitness, injury and mortalities. In addition to immediate effects, mortalities and chronic sub-lethal effects could affect individual fitness, reproduction, prey availability and behavior, and lifespan of some individuals.

While caribou and muskoxen might accidentally consume oil by grazing on oiled plants, grizzlies and furbearers may ingest it by scavenging on an oiled carcass or by predating oiled animals. The potential effects to terrestrial mammals from ingesting crude oil could be lethal, based on studies where cattle were exposed to oil (Osweiler, 2016).

The conditional and combined probabilities represent the probability of some portion of a large spill, released from LI (LDPI) or PL (LDPI to Badami pipeline), contacting ERAs, GLSs, or LSs. Only those ERAs or GLSs identified as having special importance for terrestrial mammals will be analyzed, and only those ERAs or GLSs having contact probabilities greater than or equal to 5 percent will be described in detail.

The use of greater than or equal to 5 percent as the delineation for subsequent analyses is based on the 95 percent confidence interval that is typically used in the sciences, and represents what would be deemed reasonably foreseeable. For the purpose of the species-specific spill analyses, a probability value of less than or equal to 5 percent indicates there is a greater than or equal to 95 percent probability the ERA or GLS would not be contacted by spill materials, while a probability value greater than or equal to 5 percent indicates there is a less than 95 percent probability of no contact.

Oil slicks originating at the proposed LDPI or from a pipeline rupture should have limited effects on terrestrial mammals under most conditions. If a large spill were to wash ashore during the summer, up to several thousand caribou could come in contact with the oil if they were aggregated into large herds such as when seeking insect relief areas along the coast. Few muskoxen, Arctic foxes, or grizzly bears are likely to be oiled under such conditions because of low population densities, distribution across a large geographic area, and life cycle characteristics. Foxes and grizzly bears could potentially be impacted by feeding on oiled caribou or marine mammal carcasses.

During winter, an on-ice spill could occur; however, the proposed Liberty site occurs in an area of continuous shorefast ice which would prevent spilled oil from entering the Beaufort Sea.

Small pipeline ruptures under shorefast ice could be difficult to detect since there wouldn’t be a loss in pipeline pressure sufficient to stop the pipeline. These spills are unlikely to contact any terrestrial mammal habitat and will not impact terrestrial mammals.

Large oil spills occurring under sea ice could spread into Stefansson Sound, or could rise to the bottom of the shorefast ice. During spring some of this oil would likely be transported through the ice to the top of the affected shorefast ice area via capillaries in ice. Some of that oil could be cleaned up using conventional methods until shorefast ice degrades and no longer safely permits cleanup activities. The oil remaining in the ice would subsequently break up with the ice and gradually disperse in chunks of ice into the Beaufort Sea.

If the Proposed Solid Ice Conditions (Section 2.5.1) were to be implemented, the presence of 18 inches of solid shorefast ice would prevent oil spills originating at the LDPI from contacting sea water during initial drilling only. During winter, terrestrial mammals such as caribou, muskoxen, and grizzly bears do not venture onto sea ice, while Arctic foxes actively scavenge seal carcasses left by polar bears. For this reason, only Arctic foxes have any real likelihood of contacting an on-ice spill. Spills from buried pipelines could occur regardless of whether or not the proposed mitigation is adopted.

4.3.6.2.1 Oil Spill Response and Cleanup, and Spill Drills

OSR activities that could affect terrestrial mammals include air traffic, vessels operating in nearshore areas, and the presence of people working to remove spilled oil. Vessel and aircraft traffic associated with an OSR and cleanup may startle caribou, muskoxen, bears, or wolves.

Summer cleanup tactics would involve placement of deflection boom and skimmers along the mainland shoreline. Vessel-based reconnaissance and skimming would continue during the following open-water season if oil were present. These activities may result in a few terrestrial mammals being displaced from the cleanup area, which would reduce their risk of exposure to spilled oil. Collectively, these measures would minimize the likelihood of oil reaching the shoreline, and minimal impacts to terrestrial mammals would be expected.

It is likely some bears and other scavenging mammal species could be disturbed while feeding on carcasses, potentially creating bear-human conflicts. Cleanup activities such as beach cleaning may be performed with a high degree of success using newer technologies (Painter, 2011), particularly if substrate is silty or sandy or if there is a layer of permafrost near the substrate surface. However, other activities such as spill cleanup under ice or in areas of broken ice may be more problematic (NRC, 2014; PAME, 2014).

4.3.6.3 Species-Specific Effects

4.3.6.3.1 Caribou

The Proposed Action

Aircraft Operations

Caribou could respond to aircraft noise with heightened alertness, nervousness, and flight responses, though the documented reactions of caribou to aircraft were from aircraft flying below 1,500 feet and/or circling and repeatedly flying over caribou groups. Caribou are most sensitive to disturbance and displacement from preferred habitats early during the calving period, though no caribou are expected to use the onshore portions of the Proposed Action area during calving; most calving occurs east of this area.

HAK committed in the DPP to coordinate aircraft flights with regulatory agencies to avoid disturbances to biological resources. In addition, a typical mitigation measure applied by NMFS and USFWS is for aircraft, including helicopters, to fly at 1,500 feet AGL when within 100 feet of whales or seals, or within 0.5 miles of walrus or polar bears (Appendix C, Section C-3). Imposing a stricter 1,500-foot AGL minimum flight altitude requirement (Appendix C, Section C-4) would serve to reduce impacts from aircraft on terrestrial mammals as well as other species. This minimum altitude would reduce the potential impacts from aircraft operations, especially during calving.

Vehicle Operations

No year-round roads will be built to support Proposed Action. Ice roads would last into early June, and some vehicle traffic would use existing roads. Consequently, vehicle traffic on onshore ice and permanent roads could affect caribou and their newborn calves in May and early June. Those effects would likely produce reactions among caribou out to a distance of up to 1,969 feet during the insect relief periods (Murphy and Curatolo, 1987).

Increased summer traffic associated with the Proposed Action may lead to an increase in disturbance to caribou moving through the Sagavanirktok River Delta, and traffic increases to 15 vehicles or more per hour could result in delays or deflection of caribou groups crossing the Endicott Road.

No caribou are expected to use the Sagavanirktok River Delta area near the Endicott Road during calving, as most calving locations occur farther east. Cows and calves may move closer to the coast and the delta during post-calving in late June.

Heavy Equipment

The noise and activity associated with heavy equipment operations could cause caribou to avoid using habitat in the vicinity of roads, pipelines, and gravel mines being constructed. The avoidance behavior should last only as long as the heavy equipment remains in operation; however, some heavy equipment can damage tundra vegetation such that several years can pass before the damaged areas recover to an ecological state usable by caribou. Such damage to the vegetation would be restricted to relatively small areas and would most likely not affect the presence or absence of caribou.

Gravel Mining

Most caribou migrate south of the Proposed Action Area during winter when gravel would be mined, but small bands could persist in the area during winter mining activities. Such disturbances would likely persist for the duration of gravel mining activity.

The most likely response from caribou to active gravel mining would be avoidance by around one mile while gravel extraction occurs (Boulanger et al. 2012).

Onshore Ice Roads

Research suggests caribou in the U.S. Arctic generally avoid areas within 2.4 miles of oil field roads after road construction is completed (Cameron et al., 1992; Joly, Nellemann, and Vistness, 2006). However, some have suggested avoidance is not guaranteed, and caribou may habituate to infrastructure and human activity (Haskell et al., 2006).

Lawhead et al. (2004) reported few calves were observed within 1.2 miles of roads during spring caribou calving, and densities were reduced up to 2.4 miles from those same roads. Cameron et al. (2002) evaluated changes in the distribution of calving Central Arctic Herd (CAH) caribou at the Kuparuk-Milne Point area. Before construction of a road system to Milne Point, caribou were found in a single, more or less continuous concentration, roughly centered where the road was later built. After construction of the road, caribou calved in areas to the east and west of the road. Ground observations of caribou within the Kuparuk area from 1978 through 1990 noted caribou increasingly avoided zones of intense activity, especially when calving (Smith, Cameron, and Reed, 1994).

Use of ice roads would cease when the ice melts, providing caribou time to adjust, and lessening the potential to affect calving caribou. Further, as ice roads melt and tundra begins growing, post-partum female caribou would remain unaffected by the melted ice road and would likely feed enough to enter fall in reasonable or good condition.

Wildlife-Human Interactions

Caribou are inquisitive and do not typically avoid buildings or facilities unless activity is occurring at a camp or work site. They frequently use the Trans-Alaska Pipeline as shade on sunny days, travel in areas where the pipeline is elevated, and travel along roads, so it is reasonable to assume some caribou would position themselves around buildings for protection from inclement weather, or for shade. None of these behaviors would result in measurable impacts to caribou.

Habitat Alteration

The construction of roads and gravel pads for facility-building sites would result in the removal of small areas of tundra-grazing habitat, but this represents a relatively small portion of available habitat to caribou and muskox populations.

Cronin, Whitlaw, and Ballard (2000) recognized oil development may affect caribou in some manner, while maintaining that impacts have not resulted in negative population-level effects, particularly with the CAH which has grown during a period of oil field development at rates comparable to those in undeveloped areas (Ballard, Cronin, and Whitlaw, 2000).

Caribou successfully cross under pipelines that are elevated a minimum of 7 feet above the tundra, a requirement for onshore pipelines in the National Petroleum Reserve-Alaska, and pipelines without adjacent roads and vehicle traffic are unlikely to affect caribou movements (Lawhead et al., 2006).

Pipeline Construction

Construction of the pipeline tie-in pad and installation of the VSMs and aboveground portion of the pipeline would create onshore winter traffic. These activities could potentially cause short-term noise disturbance and displacement, or collisions with small numbers of caribou and muskoxen wintering on the ACP.

Oil Spills

Small Oil Spills

The effects of a small spill on caribou would also be determined by the coincidence of a spill and lifecycle timing for caribou. A winter spill from an onshore pipeline is unlikely to impact caribou since most of the CAH winters in and to the south of the Brooks Range and because winter conditions would permit cleanup crews to remove the oil. In comparison, a small spill from a ruptured nearshore pipeline near an insect relief area could have adverse consequences if caribou entered the hydrocarbon-contaminated shallows and beaches while seeking relief from biting insects.

Large Oil Spills

GLSs 156 (WAH [Western Arctic Caribou Herd] Insect Relief), 167 (TCH [Teshekpuk Lake Caribou Herd] Insect Relief/Calving, 174 (CAH Insect Relief/Calving), 183 (PCH [Porcupine Caribou Herd] Insect Relief), and 184 (PCH Calving) were identified as important caribou habitat; however, only GLS 174 and 167 had any contact probabilities greater than or equal to 5 percent. All others had contact probabilities less than 5 percent and so will not be analyzed further. GLS 177 also has some instances where the probabilities of contact from a spill would be greater than or equal to 5 percent. Table 4-26 shows conditional probabilities of contact from a large spill in summer and winter, and the annual probability of contact. A summer spill (October 1 through June 30) has probabilities of 12 percent to 47 percent of contacting GLS 174 based on the number of days spill constituents are permitted to persist in the environment and whether the spill originated at the LDPI (LI) or the offshore portion of the proposed pipeline (PL). Likewise winter probabilities for contacting GLS 174 were 6 percent to 24 percent (Appendix A, posted at www.boem.gov/liberty, Table A.2-9), and Annual Probabilities ranged from 7 percent to 30 percent (Appendix A, Table A.2-3).

Table 4-26 Conditional Probabilities of a Large LDPI or Pipeline Spill Contacting a Given ERA

ID	GLS Name	1 day		3 days		10 days		30 days		90 days		360 days	
		LI	PL	LI	PL	LI	PL	LI	PL	LI	PL	LI	PL
174	CAH Insect Relief/Calving (Summer)	12	27	28	40	40	46	42	47	42	47	42	47
174	CAH Insect Relief/Calving (Winter)	6	13	14	19	20	22	22	24	22	24	22	24
174	CAH Insect Relief/Calving (Annual)	7	16	17	24	25	28	27	30	27	30	27	30
167	TCH Insect Relief/Calving (Summer)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	4	2	5	3	5	3

LI = Liberty Development and Production Island PL = Proposed Pipeline

The OSRA model also showed probabilities of contacting GLS 167 as less than 5 percent until 90 days when the probability for a spill originating at the LDPI (LI) increased to 5 percent.

For this analysis, we assume that a large onshore pipeline spill could occur and oil could reach less than 5 acres of vegetation along the pipeline landfall to the Badami tie in. Caribou should not be attracted to spills on the tundra, and such a spill has a limited ability to directly affect caribou, although caribou could contact or ingest contaminated vegetation.

Oiled adult caribou would be unlikely to suffer from compromised insulation during summer, though they could absorb oil through the skin or inhale toxic hydrocarbons. Unlike adult caribou, caribou calves could suffer or die if the insulative abilities of their fur became compromised.

Caribou shed their fur in the late spring. Oiling events prior to their annual fur shedding would have a much smaller effect on such individuals; however, caribou whose fur became oiled after the spring fur shedding could not shed their oiled hair until the following summer. In the interim those individuals would periodically groom themselves, breed, calve, and nurse caribou calves. Such individuals would feel the effects of topical contamination and losses in insulation to a greater degree than those who were able to shed their fur along with any remaining hydrocarbons.

Toxicity studies of crude oil ingestion in cattle (Rowe, Dollahite, and Camp, 1973) showed the possibility of anorexia (significant weight loss) and aspiration pneumonia leading to death. Caribou oiled by contact with a spill in lakes, ponds, rivers, or coastal waters might then die by inhaling toxic hydrocarbons or absorbing them through the skin if exposed to large quantities of hydrocarbons.

Spill Response

Caribou have been observed using sea ice as a salt lick, and it is possible that they may ingest oil from contaminated sea ice during spring (Rexford, 1996; ExxonMobil, 2002).

In the event of a large oil spill contacting and extensively oiling coastal habitats with herds or bands of caribou during the insect season, the presence of humans, boats, and aircraft operating in the area involved in cleanup activities is expected to cause displacement of some caribou in the oiled areas and contribute temporarily to seasonal stress on some caribou. This effect is expected to occur during cleanup operations (perhaps one or two seasons) but is not expected to significantly affect the caribou herd movements or the foraging activities of the populations.

Alternative 2 (No Action)

The No Action alternative would not impact caribou. Local caribou populations would continue with current population trends (Section 3.2.5).

Alternative 3 (Alternate LDPI Locations)

The effects and levels of effect from Alternative 3 would be the same as described for the Proposed Action because the level of onshore activity and aircraft traffic is anticipated to be the same as for the Proposed Action.

Alternative 4 (Alternate Processing Locations)

In this alternative, oil and gas processing would be relocated from the proposed LDPI to an onshore processing facility either at Endicott (an existing facility) or a new onshore facility.

Alternative 4A (Relocating to Endicott as a processing location) would not create additional impacts to caribou because Endicott is an existing facility with ongoing activity and traffic patterns already in place.

Relocation to build a new processing facility at an onshore location would require additional construction onshore that would result in habitat losses and disturbances, and would introduce the year-round presence of people, including the risk of vehicle collisions. This could impact caribou calving and insect relief by discouraging caribou presence in the area. Because the onshore areas south of the proposed LDPI are considered calving grounds for the CAH, there could be long-term adverse effects to those elements of the CAH that normally select coastal areas for calving.

Alternative 5 (Alternate Gravel Sources)

The effects and levels of effect from Alternative 5 on caribou would be the same as was described for the Proposed Action because the alternate mine sites would be located in similar habitat as the proposed mine sites, and roughly the same size and construction schedule.

4.3.6.3.2 Muskox

The Proposed Action

Aircraft Operations

Muskoxen, like caribou, react to low-level (below 1,000 feet AGL) helicopter overflights. HAK committed in the DPP to coordinate aircraft flights with regulatory agencies to avoid disturbances to biological resources. Implementation of a minimum altitude of 1,500 feet AGL, and avoiding flights over calving grounds between May 1 and June 15, would reduce the potential impacts from aircraft operations (Appendix C, Section C-4).

Vehicle Operations

Unlike caribou, muskoxen concentrate their feeding activity in riparian areas. In addition, though muskoxen do occur on the Prudhoe Bay Oilfield, they are much lower in numbers than caribou and are widely distributed, which makes them less likely to use roads or encounter vehicles.

Heavy Equipment

The use of heavy equipment is not proposed in muskoxen habitat.

Gravel Mining

Muskoxen use riparian habitats on the North Slope, such as where the gravel mining site would be located. The activities associated with gravel mining for the Proposed Action would serve to exclude muskoxen from a very small portion of potential habitat and would have no long-term effects.

Onshore Ice Roads

The use of onshore ice roads associated with the Proposed Action is unlikely to impact muskox as they generally do not browse and or travel during winter.

Wildlife-Human Interactions

Muskoxen are unlikely to overlap spatially or temporally with onshore activities associated with the Proposed Action. A wildlife avoidance plan that includes keeping a safe distance from muskoxen would mitigate any potential impacts.

Habitat Alteration

The Proposed Action could result in small amounts of habitat loss from gravel mining, facility and pipeline construction, and slightly reduced habitat access caused by physical or behavioral barriers created by roads, pipelines, and facilities (Clough et al., 1987, as cited by Winters and Shideler, 1990; Garner and Reynolds, 1986).

Muskox tend to remain in the same general area year-round (Jingfors, 1982), which suggests they are able to habituate to oil and gas activities. In addition, the overall amount of potential disturbed habitat associated with the Proposed Action is very small when compared to the overall available muskox habitat in onshore areas adjacent to the Proposed Action. Habitat alteration associated with the Proposed Action is unlikely to affect muskox.

Pipeline Construction

Muskoxen have been exposed to the Trans-Alaska Pipeline System (TAPS), and other pipelines throughout the Prudhoe Bay, Kuparuk, Alpine, and Badami oil fields for decades, but remain in those areas year-round (Jingfors, 1982). Unless disturbed by people, muskoxen may feed near aboveground sections of pipelines (DeathMagneticgil, 2011). In addition, muskoxen have expanded westward from the Arctic National Wildlife Refuge to use the Sagavanirktok River valley in spite of the road systems and pipelines that were present and continue to be built (Reynolds, Wilson, and Klein, 2002). Construction of the pipeline tie-in pad and installation of the VSMs and aboveground portion of the pipeline would create onshore winter traffic. These activities could potentially cause short-term noise disturbance and displacement, or collisions with small numbers of caribou and muskoxen wintering on the ACP, though this would not result in population level effects.

Oil Spills

Small Oil Spills

Small spills occurring in the offshore could only affect muskox in the water or along the coastline. The effects would be similar to what was described for caribou; however, the low population density of muskoxen would make the likelihood of muskoxen contacting spilled materials from a pipeline rupture very remote.

Large Oil Spills

GLSs 185 (Yukon Muskox Wintering), and 177 (Beaufort Muskox) were identified as important Muskox habitat; however, GLS 185 has contact probabilities less than 5 percent and will not be analyzed further. Instead a general OSRA analysis shows Land (ERA 0) could be contacted, potentially exposing some muskoxen to spilled materials. GLS 177 also has some instances where the probabilities of contact from a spill would be greater than or equal to 5 percent. Table 4-27 shows conditional probabilities of contact from a large spill in summer and winter, and the annual probability of contact. A summer spill (October 1 through June 30) has probabilities less than 5 percent of contacting GLS 177; however, some winter probabilities (30, 90, and 360 days) are greater than or equal to 5 percent for large spills originating at the LDPI (LI), and are shown in Table 4-27.

Table 4-27 Conditional Probabilities of a Large LDPI or Pipeline Spill Contacting a Muskox ERA

ID	Environmental Resource Area Name	1 day		3 days		10 days		30 days		90 days		360 days	
		LI*	PL*	LI	PL	LI	PL	LI	PL	LI	PL	LI	PL
0	Land (1 July–30 Sep)	25	53	54	74	74	85	85	91	88	93	88	93
0	Land (1 Oct–30 Jun)	22	51	51	72	72	84	84	90	88	93	88	93
0	Land (1 Jan–31 Dec)	22	51	52	72	72	84	84	90	88	93	88	93
177	Beaufort Muskox Habitat (Winter)	<0.5	<0.5	1	0	4	1	5	2	5	2	5	2

Note: LI = Liberty Development and Production Island PL = proposed pipeline

The information contained in Table 4-27 indicates that should a large spill occur at the proposed LDPI, there is a 22 percent to 88 percent probability of the spill contacting a coastal area within 360 days of release, and a 51 percent to 93 percent probability of such a spill originating from the offshore portion of the proposed pipeline contacting land.

Large spills occurring in the offshore environment from the proposed LDPI or the submerged sections of the pipeline could affect muskoxen in a manner consistent with that described for caribou above. Unlike caribou, the potential exists to only affect a few muskoxen due to their sparse distribution across the North Slope and their tendency to remain in a general area for extended periods of time. Furthermore, muskoxen do not seek areas of insect relief. Instead, they rely on their thick long fur to protect them from insects. Large spills from an onshore pipeline rupture would be unlikely to affect muskoxen, though the spill response may serve to keep muskoxen away from spilled materials. Overall, a large spill would have a minor level of effect on muskoxen; however, implementation of an OSRP would reduce the impacts to a negligible level of effects.

Oil Spill Response

For the most part, the effect of onshore oil spills would be very local and would contaminate tundra in the immediate vicinity of the pipeline; spill response would not be expected to significantly disturb muskoxen range or habitat use.

Alternative 2 (No Action)

The No Action alternative would not impact muskoxen. Local muskox populations would continue with current population trends (Section 3.2.5).

Alternative 3 (Alternate LDPI Locations)

The effects and levels of effect from Alternative 3 would be the same as described for the Proposed Action because the level of onshore activity and aircraft traffic would be anticipated to be the same.

Alternative 4 (Alternate Processing Locations)

In this alternative, oil and gas processing would be relocated from the gravel island to an onshore processing facility either at Endicott (an existing facility) or a new onshore facility

Relocating to the Endicott as a processing location would not impact muskoxen because Endicott is an existing facility with traffic patterns already in place.

Relocation to build a new processing facility at an onshore location would require additional construction onshore that would result in habitat losses and disturbances, and would introduce the year-round presence of people, including the risk of vehicle collisions. Such disturbances could have adverse effects on calving and foraging muskox in the area around the facility. The onshore areas south of the LDPI have some muskox habitat, and there could be long-term adverse effects to muskox that feed or calve in coastal areas, particularly riparian areas.

Year-round access roads to transport personnel to and from the work site would create an ongoing disturbance that could not be mitigated, leading to a moderate level of effects. The additional year-round vehicle traffic needed for an onshore processing facility would also have an added adverse effect on muskox, which may leave riparian areas during spring, summer, and fall to feed in coastal areas. For these reasons, Alternative 4 would have a minor level of effect on muskox.

Alternative 5 (Alternate Gravel Sources)

The effects and levels of effect from Alternative 5 would be the same on muskoxen as was described for the Proposed Action because the alternate mine sites would be located in similar habitat as the proposed mine sites, and roughly the same size and construction schedule.

4.3.6.3.3 Grizzly Bear

The Proposed Action

Aircraft Operations

Grizzly bears are widely distributed across the North Slope of Alaska, but the low productivity of the local plant communities requires large ranges to support each individual bear. Consequently, few grizzlies would be encountered by any flights associated with the Proposed Action.

HAK committed in the DPP to coordinate aircraft flights with regulatory agencies to avoid disturbances to biological resources. Implementation of a minimum altitude of 1,500 feet AGL (Appendix C, Section C-4) would reduce the potential impacts from aircraft operations.

Vehicle Operations

Vehicle use on ice roads during winter should not affect hibernating grizzly bears.

Heavy Equipment

Onshore heavy equipment operations would occur concurrently with ice road construction when grizzly bears would be hibernating and thus are unlikely to impact grizzly bears.

Gravel Mining

The proposed gravel mine is in a substrate not typically used for denning by grizzly bears, and mining activities would take place in the winter when bears are hibernating. Thus, gravel mining activities are unlikely to impact grizzly bears.

Onshore Ice Roads

Onshore ice road construction would overlap with the October/November through late April denning period for grizzly bears. Consequently, few grizzly bears should be disturbed by ice road construction, maintenance, or use. The ice road could cross or pass by active grizzly bear dens, which could lead to grizzlies being disturbed from their dens in winter, or cause collisions between vehicles/heavy equipment and bears, or bear-human conflicts. Potential mitigation measures would require the project proponent to survey the onshore segment of the ice road route and make route alterations to avoid bear dens, limit the traveling speed of vehicles/equipment to 25 mph, and establish grizzly bear-human avoidance protocols to ensure bears aren't attracted to work areas or people.

Wildlife-Human Interactions

Some bears are likely to habituate to human noise and presence, leading to increased encounters. Grizzlies typically respond to ground-based human activities more strongly than to aircraft, especially when encounters occur in open areas such as the Arctic Slope (McLellan and Shackleton, 1988). Harding and Nagy (1980) noted grizzly bears in Canada habituating to camps and human activity, with few actually entering camps. Most bears were frightened off by groups of people or vehicles, however, a few individuals who continually entered camps had to be captured and relocated to other areas. The establishment of permanent settlements (oil fields, mines, etc.) usually leads to human-bear encounters on a regular basis and to conflict, particularly when bears learn to associate humans with food (Schallenberger, 1980; Harding and Nagy, 1980; Miller and Chihuly, 1987; McLellan, 1990).

The presence of food acts as a strong attractant for bears, especially in areas and times when natural high quality foods are scarce. Bears are very adaptable and quickly learn to exploit human food resources, so they could easily be attracted to work areas by food left in vehicles, or around work areas or camps. Furthermore, sometimes their inquisitive nature can induce bears to visit camps or work areas for curiosity's sake. However, individual bears vary in the degree of habituation-tolerance to human presence, and some will continue to avoid areas where humans are present (Olson and Gilbert, 1994). The attraction of grizzly bears to garbage and/or food odors at field camps and other facilities has led to the loss of bears in the past (Schallenberger, 1980). Once bears become conditioned to the availability of human sources of food, measures to reduce this availability by improved garbage handling are not always effective (McCarthy and Seavoy, 1994). Bears will make an extra effort to get to the food sources that they are conditioned to having. Cubs of female bears conditioned to anthropogenic food source and habituated to human presence have a higher survival rates as cubs but have a high mortality rate after they are weaned (Shideler and Hechtel, 2000). These young-habituated bears are more vulnerable to human-bear encounters near settlements; people often will not accept the risk of bear attacks, and these encounters often lead to the loss of bears (Archibald, Ellis, and Hamilton, 1987).

Visits to camps and work areas could result in bear attacks on people or damaged equipment or vehicles, and any bears that attack humans are likely to be killed.

Habitat Alteration

Potential effects of oil development activities include low-grade habitat loss from gravel mining, facility, and pipeline construction. Other habitat impacts could include reduced access caused by physical or behavioral barriers created by roads, pipelines, and facilities (Clough et al., 1987, as cited by Winters and Shideler, 1990; Garner and Reynolds, 1986).

Pipeline Construction

Pipelines would be constructed during winter when bears hibernate, and would either be buried or elevated above the tundra. Grizzly bears are not known to be adversely impacted by the presence of pipelines.

Oil Spills

Small Oil Spills

Small petroleum spills should have no noticeable effects on grizzly bears. Small spills from the LDPI would not contact onshore grizzly bear habitat. Small offshore and onshore pipeline spills could be contacted by grizzlies under a limited set of conditions (May through October timeframe, in the area when a spill occurred, etc.) but are unlikely to affect grizzly bears on a population level.

Large Oil Spills

GLSs 160 (Ledyard Brown Bears), and 163 (Kasegaluk Brown Bears) were identified as important grizzly bear habitat; however, both have contact probabilities less than 5 percent so they will not be analyzed further. General OSRA analysis shows Land (ERA 0) could be contacted, potentially exposing some grizzly bears to spilled materials. Table 4-28 shows conditional probabilities of contact from a large spill in summer and winter. A winter spill (October 1 through June 30) could contact bears if the materials persist in the environment or if the spill occurred before/after hibernation.

Table 4-28 Conditional Probabilities of a Large Spill Contacting a Grizzly Bear Habitat or ERA

ID	Environmental Resource Area Name	1 day		3 days		10 days		30 days		90 days		360 days	
		LI	PL	LI	PL	LI	PL	LI	PL	LI	PL	LI	PL
0	Land (1 July–30 Sep)	25	53	54	74	74	85	85	91	88	93	88	93
0	Land (1 Oct–30 Jun)	22	51	51	72	72	84	84	90	88	93	88	93
0	Land (1 Jan–31 Dec)	22	51	52	72	72	84	84	90	88	93	88	93

LI = Liberty Development and Production Island PL = Proposed Pipeline

The information contained in Table 4-28 indicates that should a large spill occur at the proposed LDPI, there is a 22 percent to 88 percent probability that it would contact a coastal area within 360 days of release, and a 51 percent to 93 percent probability of a spill originating from the proposed pipeline contacting land.

A large spill from onshore segments of the proposed pipeline is unlikely to adversely impact grizzly bears, since the spill would contaminate a comparatively small area of habitat where the soil is underlain with permafrost that prevents oil from infiltrating deeply into the soil. The small area contaminated by a large onshore spill would only occur within the home range of a single bear and it is unlikely the bear would be drawn to such an area. For this reason the level of effects to grizzly bears from a large onshore spill would be negligible.

A large offshore spill originating from pipeline or the LDPI has the potential to contact sections of coastline where some grizzly bears may scavenge for food; however, it is unlikely more than one or two bears would visit a contaminated coastal area at any given time, since grizzlies are so thinly distributed across the ACP of Alaska. Any bear that did contact oil could inhale, or possibly ingest oil from feeding on contaminated beach castings or carrion, or from grooming a pelt that was covered in oil. The quantity of oil ingested/contacted, and the individual health of a bear, would determine how severe the effects on a grizzly bear would be, such that some bears exposed to oil might remain unimpacted, while others could die. If bears fed on contaminated prey, such as dead caribou that were oiled, the worst effects of a spill on grizzly bears could be manifested.

Assuming the most extreme result of contact did occur, a small number of bears might die after being exposed to oil, which meets the criteria for a moderate level of effects. If a spill response plan were in place and implemented, and if any contaminated food items were removed, the effects grizzly bears would be reduced.

Oil Spill Response

Cleaning up a large oil spill also would potentially disturb a few grizzly bears. The presence of large numbers of humans, boats, and several aircraft operating to clean up the area probably could displace bears.

The effect of onshore oil spills would be local and would only contaminate tundra in the immediate vicinity of the pipeline; these spills would not be expected to contaminate or alter grizzly bear range within the pipeline corridors.

Alternative 2 (No Action)

The No Action alternative would not impact grizzly bears. Local grizzly populations would continue with current population trends.

Alternative 3 (Alternate LDPI Locations)

The impacts and levels of effect from Alternative 3 would be the same for grizzly bears as described for the Proposed Action because the level of onshore activity and aircraft traffic is anticipated to be similar.

Alternative 4 (Alternate Processing Locations)

In this alternative, oil and gas processing would be relocated from the proposed LDPI to an onshore processing facility either at 1) Endicott (an existing facility) or 2) a new onshore facility. Most impacts to grizzlies from Alternative 4 would be the same as impacts associated with the Proposed Action.

Relocating to the Endicott as a processing location would no produce additional effects on grizzly bears because Endicott is an existing facility with ongoing activity and traffic patterns already in place.

Relocation to build a new processing facility at an onshore location would require additional construction onshore that would result in habitat losses and disturbances, and would introduce the year-round presence of people, increasing the risk of human-grizzly encounters. It is possible though not likely this could result in a bear killed in defense of life; however, if bear avoidance measures are implemented, as is done elsewhere in the Prudhoe Bay oilfield, those effects would likely be mitigated.

Alternative 5 (Alternate Gravel Sources)

The impacts and levels of effect from Alternative 5 on grizzly bears would be the same as described for the Proposed Action because the alternate mine sites would be located in similar habitat as the proposed mine sites. The alternative gravel pits would operate under the same construction schedule and would impact approximately the same amount of bear habitat.

4.3.6.3.4 Arctic Fox

The Proposed Action

Aircraft Operations

No known adverse effects of aircraft operations on Arctic foxes have been documented. In other parts of Alaska, such as Shemya Island, Arctic foxes regularly approach aircraft on runways and appear unimpacted by aircraft take-offs or landings. Low altitude helicopter flights might frighten or disturb some Arctic foxes; however such events would likely be rare.

Vehicle Operations

Vehicles could potentially strike and kill foxes and rodents. Though some individual foxes could die, the overall population numbers and trends would not be impacted. Due to the high fecundity of Arctic foxes, any losses in the local population should recuperate within one or two years.

Heavy Equipment

Arctic foxes are unlikely to be impacted by the presence and operations of heavy equipment at the proposed LDPI, on ice roads, or along the pipeline corridor, as foxes can easily avoid this type of activity.

Gravel Mining

A few Arctic foxes may approach the gravel mine site out of curiosity, which could put them at risk for becoming habituated to people. Gravel mining operations will occur in substrate that foxes may use for denning. The overall size of disturbance associated with the proposed mine site is approximately 50 acres, which could result in local impacts to a few individuals; however, this would not result in the removal of enough potential denning habitat to create widespread or lasting impacts to Arctic foxes.

Onshore Ice Roads

Arctic foxes show no avoidance of roads or ice roads throughout the Prudhoe Bay Oilfield. It is reasonable to assume some would periodically wander onto ice roads in both onshore and offshore areas. There is potential for vehicles to hit and kill Arctic foxes on ice roads. Speed limits of 25 mph and avoidance protocols for drivers and workers on the ice roads would mitigate this potential impact.

Wildlife-Human Interactions

Arctic foxes are widely known to approach people, seeking scraps of food. This has the potential to increase the overwintering survival rates of Arctic foxes in the area of the Proposed Action, both onshore, and during winter at the proposed LDPI site, if they can access food at those areas. Potentially such added food resources, and the increased survival rates, could lead to artificially elevated numbers of Arctic foxes in the area, which would have a corresponding increase in predation on their prey species (Burgess and Banyas, 1993; Burgess et al. 1993).

Habitat Alteration

Arctic foxes could benefit from onshore facilities and pipeline development. Crawlspaces under buildings, culverts, and pipes provide sometimes foxes with shelter for resting and, in some cases, artificial dens (Eberhardt et al., 1982; Burgess and Banyas, 1993). Oil development has not harmed the fox population around Prudhoe Bay, Alaska (Eberhardt et al., 1982). Arctic fox numbers and productivity are higher in the Prudhoe Bay area compared to adjacent undeveloped areas (Burgess et al., 1993).

Pipeline Construction

Onshore pipeline construction could have some adverse effects on Arctic foxes if fox dens were to be disturbed or damaged. If the pipeline route was surveyed before construction, the destruction of fox dens could be avoided.

Oil Spills

Small Oil Spills

Some tundra vegetation in the pipeline corridor would become contaminated from these spills. If a pipeline spill occurred, it is likely that control and cleanup operations (ground vehicles, air traffic, and personnel) at the spill site would frighten Arctic foxes away from the spill area and prevent any Arctic foxes from contact with the spill. If small offshore pipeline spills were to occur during winter, much of the spill would remain under the sea ice and unreachable to Arctic foxes. Though sea ice melts and portions of an under ice spill could eventually reach the coast after the spring and summer melt, such spill materials would be weathered, and disperse slowly in tandem with the rate of ice melt.

Large Oil Spills

If a large offshore spill were to occur, areas of the coastline could become contaminated. Because Arctic foxes often scavenge along coastlines, they could be contacted by large spills during the open-water season. During winter a large offshore spill would mostly occur under ice, making it unreachable by foxes until the spring thaw. As with small spills, such a release of icebound spill materials would occur gradually, allowing dispersal and weathering to occur. A large onshore spill from a ruptured pipeline would be unlikely to impact Arctic foxes, since workers would be cleaning the spill up, and the presence of cleanup activities would discourage foxes from approaching the areas where they could become contaminated.

No ERAs or GLSs identifying particularly important Arctic fox habitat have been described so a general OSRA analysis shows Land (ERA 0) the following conditional probabilities of contact from a large spill in summer and winter (Table 4-29).

Table 4-29 Chance of a Large Spill on LDPI or Pipeline Contacting an Arctic Fox Habitat or ERA

ID	Environmental Resource Area Name	1 day		3 days		10 days		30 days		90 days		360 days	
		LI	PL	LI	PL	LI	PL	LI	PL	LI	PL	LI	PL
0	Land (1 July–30 Sep)	25	53	54	74	74	85	85	91	88	93	88	93
0	Land (1 Oct–30 Jun)	22	51	51	72	72	84	84	90	88	93	88	93
0	Land (1 Jan–31 Dec)	22	51	52	72	72	84	84	90	88	93	88	93

The information contained in Table 4-29 indicates that should a large spill occur at the proposed LDPI, there is a 22 percent to 88 percent probability that it would contact a coastal area within 360 days of release, and a 51 percent to 93 percent probability of a spill originating from the proposed pipeline contacting land.

Oil Spill Response

Cleaning up a large oil spill also would disturb some Arctic foxes. The presence of humans, boats, and aircraft operating to clean up the area probably would displace some Arctic foxes. An oil spill could also result in the loss of small numbers of Arctic foxes through ingestion of contaminated prey or carrion, or from grooming contaminated fur.

For the most part, the effect of onshore oil spills would be very local and would contaminate tundra in the immediate vicinity of the pipeline; these spills would not be expected to significantly contaminate or alter Arctic fox range within the pipeline corridors.

Alternative 2 (No Action)

The No Action alternative would not impact Arctic foxes. Local populations of Arctic fox would continue with current population trends.

Alternative 3 (Alternate LDPI Locations)

The effects from Alternative 3 would be the same for Arctic foxes as described for the Proposed Action because the level of onshore activity and aircraft traffic would be anticipated to be the same.

Alternative 4 (Alternate Processing Locations)

In this alternative, oil and gas processing would be relocated from the proposed LDPI to an onshore processing facility either at Endicott (an existing facility) or a new onshore facility.

Relocating to Endicott as a processing location would not produce additional effects on Arctic foxes because Endicott is an existing facility with traffic patterns already in place.

Relocation to build a new processing facility at an onshore location would require additional construction onshore that would result in habitat losses and disturbances, and would introduce the year-round presence of people.

Arctic foxes may den in gravel pads and other man-made protected areas with good drainage. Consequently, the loss in natural habitat from construction of an onshore processing facility could be compensated for by creating denning habitat for Arctic foxes with a gravel pad, though this could also attract red foxes to the area. Red foxes have come to the Prudhoe Bay Oilfield in recent decades, and typically outcompete or kill Arctic foxes. Due to this, the overall impacts to Arctic foxes from Alternative 4 would be moderate.

Alternative 5 (Alternate Gravel Sources)

The impacts from Alternative 5 would be the same for Arctic foxes as described for the Proposed Action. The alternative gravel pits would operate under the same construction schedule and would impact approximately the same amount of Arctic fox habitat.

4.3.6.4 Overall Conclusions for Terrestrial Mammals

Overall, impacts from the Proposed Action would have a negligible level of effect on Terrestrial Mammals. Vehicular traffic would most likely affect caribou more than it would grizzly bears and foxes because caribou adults/calves occur in large numbers in the onshore area of the Proposed Action. The most likely effects from the Proposed Action would be behavioral responses that could range from aversion to flight or aggression, and possibly slight reduction in habitat, depending upon the species and circumstances.

4.3.7 Vegetation, Wetlands, and Substrate

This section identifies and discusses impacts associated with the Proposed Action and action alternatives that could impact vegetation and wetlands. As defined by the U.S. Army Corps of

Engineers (USACE), wetlands are: "*Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.*" Wetlands considered "waters of the United States" (WOUS) are under the jurisdiction of the USACE. A complete definition of WOUS is at 40 CFR 230.3. Section 404 of the CWA requires that a Department of the Army permit be obtained for the placement or discharge of dredged and/or fill material into WOUS, including jurisdictional wetlands (33 U.S.C. 1344).

BOEM has provided the Liberty Development Wetland Delineation Report, Foggy Island Bay, Alaska, performed by ASRC Energy Services, Alaska, Inc. (AES) (2015) on the Liberty Project website at https://www.boem.gov/liberty/. This wetland and WOUS delineation was performed in accordance with the USACE Wetlands Delineation Manual (Environmental Laboratory 1987) and the Regional Supplement to the USACE Wetland Delineation Manual: Alaska Region (Version 2.0) (USACE, 2007).

4.3.7.1 The Proposed Action

4.3.7.1.1 Aquatic Site Assessment and Substrates

Most impacts to wetlands/WOUS from the Proposed Action would occur during construction of the ice roads and pads, gravel mine site development, excavation and backfill for the construction of the offshore pipeline, construction of the landward end of the Liberty pipeline, and construction of the proposed LDPI for the offshore production facilities.

Wetlands discharge activities under USACE jurisdiction are summarized in Table 4-30. The following activities are subject to Section 404 of the CWA:

- Marine water pipeline construction (buried in a trench) in the territorial seas (discharge of fill below mean high tide in Beaufort Sea navigable waters
- Onshore pipeline construction of 1.5 miles of elevated pipeline with VSMs every 51 feet (discharge of fill into jurisdictional wetlands)
- Construction of a 350-foot by 150-foot trench (approximately 1.2 acres) to accommodate thermosiphons near the pipeline landfall (discharge of fill into jurisdictional wetlands)
- Gravel pad construction (0.71-acre) at the Liberty/Badami pipeline junction (discharge of fill into jurisdictional wetlands)
- Pipeline/road crossing pad construction (0.15-acre) for a permanent ice road crossing site (discharge of fill into jurisdictional wetlands)
- Development of a 21-acre gravel mine site (discharge of fill into jurisdictional wetlands)

The following proposed activities are subject to Section 10 of the Rivers and Harbors Act or Section 404 of the CWA:

Table 4-30 Summary of Proposed Impacted Areas under USACE Jurisdiction

Feature	Acres Covered	Discharge (cy)	Wetlands?	Authority*
LDPI	24	927,000	No	10
Offshore Pipeline	33 (60 feet x 4.5 miles)	394,000	No	404 and 10
Offshore Pipeline	8 (60 feet x 1.1 miles)	97,000	No	10
Transition Pipeline to Shore	1.4 (350 feet x 150 feet)	5,000	Yes	404
Pipeline VSM (170 total)	0.03 (3-foot diameter x 170**)	890	Yes	404
Onshore Road Crossing	0.15 (80 feet x 80 feet)	1500	Yes	404
Badami Tie-in Pad	0.71 (193 feet x 160 feet)	3500	Yes	404

Note: * 10 indicates Section 10 of the Rivers and Harbor Act and 404 indicates Section 404 of the Clean Water Act. Section 10 applies to state waters (territorial seas) and Section 404 applies to OCS waters.

** VSMs are emplaced every 50 feet at a depth of 20 feet.

Ice Roads and Ice Pads

A complete discussion of ice road construction can be found in Section 2.1.1. The Proposed Action includes the construction of a 250-foot ice pad perimeter around the 21-acre gravel mine that would be used to hold overburden and vegetation for the single year mining season. The ice pad would temporarily impact existing vegetation; crushed vegetation is expected to recover within two growing seasons. Damming of drainages during the spring melt or breakup could interrupt natural sediment flow, and, with a possible concentration of flow, would enhance erosive potential to wetland vegetation and subsequently destabilize substrates. Ice roads and pads may cause delayed plant development (phenology) increasing plant stress, freezing of plant tissues, changed soil chemistry, impacts to soil invertebrates, soil thaw characteristics, and small-scale changes in hydrology and depth of thaw. Yokel et al. (2007) found only minimal evidence of additive impacts from ice roads built over the same route in two subsequent years, and no statistically significant differences in depth of thaw. Guyer and Keating (2005), however, found that long-term vegetation modifications causing repeated delays in vegetation phenology may occur when consecutive season ice roads are built annually.

Vegetation growing near ice roads could be changed by altered hydrology, with desiccated or flooded nearby habitats. Tussock tundra vegetation could be damaged by annual ice roads which could decrease the wetland's soil temperature regulation leading to thermokarst features (irregular depressions caused by warming, melting, and heaving of frozen ground) that could remove vegetation. Invasive species introduction is possible if imported Proposed Action equipment has not been thoroughly washed.

Effects of ice roads and pads on vegetation and wetlands would be of short duration, local, and limited in extent and is considered to be minor.

Gravel Mine

A complete discussion of the proposed construction of the gravel mine site is provided in Section 2.1.2. Vegetation and overburden would be removed and stockpiled on a 250-foot perimeter ice pad (discussed above) adjacent to the proposed gravel mine site. The footprint of the gravel mine site would be approximately 21 acres and the gravel mined from the site would be hauled directly to the construction sites during the first construction winter.

Excavation of the gravel mine site would remove or disturb wet sedge, moist sedge, dwarf shrub and wet graminoids. All are common in the area.

Gravel mine sites fill with water over time and require dewatering before further use. Water discharged mechanically to nearby areas generally does not have an effect on vegetation/wetlands unless discharge rates are uncontrolled, which could result in vegetation loss through erosion.

Onshore Gravel Pads and Related Construction

The Proposed Action would result in the discharge of approximately 10,000 cy of gravel fill material into approximately two acres of wetlands and would be a permanent impact.

The habitat most affected by onshore gravel pads and related construction would be dwarf shrub vegetated wetlands with a mix of water regimes: permanently flooded, seasonally flooded, and saturated. Approximately 1.2 acres of moist sedge, dwarf shrub and wet graminoid complex would be lost, and 0.2 acres of other WOUS would be disturbed during construction of the pipeline transition trench.

All of the wetlands north of the Badami Pipeline and the Badami seasonal ice road are pristine, undisturbed, and high functioning (AES, 2015). They are not rare or unique, used for science, or under threat from upstream sediments or toxins. However, these are high value wetlands because they control erosion, alter flood flows, and provide valuable wildlife habitat, especially for waterfowl and caribou (AES, 2015).

4.3.7.1.2 Accidental Oil Spills and Gas Releases

Accidental spills may include gas releases, crude oil spills from the pipeline, or diesel spills from storage tanks, construction equipment, or vehicles and may occur during any of the action alternatives. Gas releases would not impact vegetation and wetlands. The degree of oil spill impacts on vascular plants depends upon a number of abiotic and biotic factors including the type and amount of oil, the plant species and extent of oil coverage, the season of the spill, weather conditions at the time of the spill, and soil composition. Soil organic matter content is a primary factor controlling the effects of oil spills on wetlands. Large crude oil spills generally can cause widespread impacts to coastal wetland plants, such as reduced plant photosynthesis, transpiration, shoot height, stem density, and biomass, as well as impaired growth and re-growth, and even complete mortality, especially if plant roots are smothered with crude oil.

Small Oil Spills

BOEM assumes about 70 small spills (less than 1,000 bbl) would occur over the course of the Proposed Action. The majority of small spills would occur on and be contained on the LDPI or landfast ice (during winter) and not impact the vegetation and wetlands. Coastal habitats in Foggy Island Bay are not likely to be contaminated by small offshore spills because these spills would disperse quickly during the summer open-water season when coastal vegetation-wetlands might be exposed to the spills.

Small refined oil spills in wetlands and vegetation during summer would likely be from vehicles. Small oil spills of refined products, depending on oil type and amount, may not require extensive cleanup, however, refined oils are toxic if they contact any part of a plant. Small refined oil spills are expected to have negligible to minor local and temporary impacts.

Onshore crude oil spilled from a pipeline rupture impact would vary depending upon various factors, including spill duration, spill volume, contents of spill, size of rupture, control of or lack of flow control, pipeline pressure, winds, and season. A crude oil spill in winter from a buried pipeline and confined to a relatively small area would impact less than an acre of soil. Vegetation affected by a small pipeline spill could be removed and replaced once the contaminated soil was removed and remediated. A crude oil spill under high pressure from an above ground pipeline during windy conditions could kill many acres of vegetation and wetlands during summer, especially if the mixture is under high pressure and sprays over a large area.

Large Oil Spills

BOEM has analyzed the impacts of one large spill during the course of the Proposed Action (see Section 4.1.1.3 for spill assumptions). Large onshore oil spills would impact soils and vegetation, though they are easier to confine and clean up than offshore spills.

Heavy oiling of wet and moist tundra vegetation, wetlands, and other WOUS would kill some plants through fouling, smothering, asphyxiation, and poisoning at the plant roots from direct contact with the oil. Diesel fuel is more toxic than crude oil, but would evaporate more quickly and be less persistent than crude oil in the vegetated wetlands and other WOUS. Effects on coastal vegetation-wetland habitat would occur if an offshore spill occurred during summer open water or during spring meltout or if an onshore spill occurred near a riverine system. During winter, bottomfast ice covers the lagoon and coastal shorelines, and snow buffers the tundra from the oil.

Various factors, including spill duration, spill volume, contents of spill, size of rupture, degree of flow control, pressure of pipeline contents, wind conditions, season, and above ground or buried pipeline would affect the adverse impacts to vegetation and wetlands from an onshore large crude oil spill. Moderately oiled wetlands of the Sagavanirktok River east to Mikkelsen Bay would take perhaps 10 years or longer to recover if the oil contaminated both plant surface and subsurface structures during the summer. A large onshore spill could oil up to 5 acres of vegetation along the pipeline landfall to the Badami tie in, causing some ecological harm. Wetland vegetation could also be affected similarly if an off-shore spill occurred and oil and pollutants washed ashore. Oiled vegetation should recover within a few years but may take more than 10 years to fully recover.

The Proposed Solid Ice Conditions (Section 2.5.1) would shift much of the risks associated with a large oil spill from summer months to winter months, but this would have no measureable impact on onshore wetlands. Restricting reservoir drilling to winter months would also extend the time period required to complete the overall drilling program but again this is unlikely to increase or decrease impacts to wetlands.

4.3.7.1.3 Decommissioning

Rehabilitation of Former Vegetated Wetlands

The minimum project operational life, which includes construction and decommissioning, is estimated to be 25 years. Decommissioning would occur over an 18-month period after production ends. Wetland restoration of areas that were filled during development is not likely, given the long-term impacts of the fill and excavation. Restoration would occur along the non-vegetated coast at the landward end of the subsea pipeline. Removal of the gravel pads at the onshore pipeline support at the Badami pipeline tie-in along with removal of VSMs would result in thermokarsting (development of very irregular surfaces of marshy hollows and small hummocks). Restoration of wetland plant communities after gravel removal may be possible in wet tundra areas within about 10 to 30 years from initial restoration efforts but it is unlikely that moist or dry tundra habitats could be restored to conditions similar to natural communities without a greater effort than needed for rehabilitation of wet tundra, if at all. A longer duration for impact recovery would be expected from rehabilitation of wetlands plant communities in mainly moist or dry tundra habitats.

Rehabilitation of Gravel Mine Site

Restoration of the gravel mine site to pre-project conditions is not expected. The topographical difference expected between the bottom of the gravel mine site and adjacent wetlands is so large there is no expectation that a vegetated wetland could be successfully established. Once the gravel for the Proposed Action has been removed (after Year 1), the overburden would be returned to the gravel mine site to be rehabilitated. The 15 acres of dwarf shrub vegetation and 4.1 acres of herbaceous vegetation in pre-construction wetlands would be decreased to relatively narrow fringe of wetland vegetation along all or part of the pond/lake shore. Depending upon the design of side-slopes, an emergent wetland fringe may be successfully established along the perimeter of the gravel pit. However, it is anticipated that the area would ultimately resemble an artificial lacustrine system.

4.3.7.2 Conclusion for the Proposed Action

Tundra habitats in the ACP have and will continue to undergo change in response to climatic conditions. Perhaps the most important changes to vegetation in the Arctic environment will be as a result of climate change, in the form of expanding and retreating lakes and wetlands. Much of the ACP is underlain with permafrost. As the current pattern of warming continues, some regions of the Arctic would see shifts in permafrost distribution and deepening of the active layer, accompanied by changes in vegetation and wetlands. Additionally, coastal wetlands are particularly vulnerable to sea level rise associated with increasing global temperature.

Appendix C (Sections C-1 to C-3) describes mitigation measures derived from lease stipulations, design features, and BMPs the operator committed to, and requirements and BMPs that other agencies typically require. BOEM’s impact conclusions assume implementation of, and compliance with, these mitigation measure. In particular, Section C-2 describes measures that HAK has agreed to implement to minimize impacts to vegetation and wetlands.

The amount of wetlands/WOUS lost during the entire project would be less than 30 acres. The types of wetlands that would be lost are common in the area. These impacts would be characterized as localized, but long-term. Overall, it is anticipated the impacts of Proposed Action would be result in minor impacts.

4.3.7.3 Alternative 2 (No Action)

Under this Alternative, the Proposed Action would not be approved and the actions described in the Liberty DPP would not take place. There would be no impacts to vegetation and wetlands.

4.3.7.4 Alternative 3 (Alternate LDPI Locations)

4.3.7.4.1 Alternative 3A: Relocate LDPI Approximately One Mile to the East

The impacts of this Alternative on vegetation and wetlands would be the same as the Proposed Action.

4.3.7.4.2 Alternative 3B: Relocate LDPI Approximately 1.5 Miles to the Southwest

The impacts of this Alternative on vegetation and wetlands would be the same as the Proposed Action.

4.3.7.5 Alternative 4 (Alternate Processing Locations)

4.3.7.5.1 Alternative 4A: Relocate Oil and Gas Processing to Endicott

The proposed LDPI in the Alternative would require less gravel than the Proposed Action and none of the proposed onshore pads would be needed. The only onshore construction activities needed would be the opening and operation of a new gravel mine site or expansion of an existing gravel mine site, presumably nearer the Endicott SDI. As a result of a smaller LDPI footprint and reduction in onshore pads, impacts to vegetation and wetlands in this Alternative would be reduced slightly from the Proposed Action but still minor.

4.3.7.5.2 Alternative 4B: Relocate Oil and Gas Processing to a New Onshore Facility

Additional or expanded gravel pads would be needed for construction of the onshore production facilities in this Alternative. Increased road construction and use would also result from providing access to onshore production facilities. The footprint of the gravel mine site would proportionally increase to provide for this additional construction, though adding additional losses of vegetation and wetlands would remain less than 10 to 15 additional acres. Rehabilitation of wetland plant communities after gravel and replacement of wetland habitat would have similar problems as discussed for the Proposed Action. Even with these increases in disturbance, the overall proportion of vegetation and wetlands in the Proposed Action Area that would be impacted by this Alternative remains relatively small. Thus, impacts to vegetation and wetlands from this alternative would be up to moderate.

4.3.7.6 Alternative 5 (Alternate Gravel Sources)

For Alternatives 5A and 5B, vegetation and wetland mapping was performed by AES (2016) and a wetland delineation map for each alternate gravel mine site can be found in Figure 4-26 and the Wetland report posted at www.boem.gov/liberty. Included in each map is the distribution of

Arctophila fulva, an herbaceous plant of particular interest to conservation agencies due to its importance as waterfowl habitat.

Table 4-31 presents the surveyed locations of the Proposed Action, Alternative 5A and Alternative 5B gravel mine sites, the amount of area surveyed, and the distribution of *Arctophila fulva* in each surveyed alternate gravel mine location.

Table 4-31 Comparison of Wetlands and *Arctophila fulva* within the Gravel Mine Site Alternatives

Category of Measure	GMS-01 MS-01) Proposed Action	GMS-02 MS-02n Alternative 5A	GMS-03 MS-03n Alternative 5B
Wetlands	Lake (6.79 ac) Lower Perennial (0.10 ac) Marine (1.30 ac) PEM (565.63 ac) Pond (20.85 ac)	Lake (9.89 ac) PEM (197.40 ac) Pond (6.53 ac)	Lake (2.55 ac) PEM (350.63 ac) Pond (6.47 ac)
Total Wetlands	594.67 ac	213.82 ac	359.65 ac
Arctophila fulva	Sparse (0.03 ac)	Relatively abundant (5.53 ac)	Sparse (0.07 ac)

Source: AES (2016).

4.3.7.6.1 Alternative 5A: East Kadleroshilik River Mine Site #2

The alternate gravel mine site for this Alternative would have two areas: one in similar wetland vegetation as the proposed gravel mine site’s wetlands, the other in the main river channels of the Kadleroshilik River. Additional wetlands losses beyond those expected for the Proposed Action would occur. Approximately 0.5 miles of additional ice road would be necessary for this Alternative to provide access from the gravel mine to the Badami ice road. Impacts to wetlands and vegetation from this Alternative are similar to those from the Proposed Action; slightly more acreage has the potential to be impacted, and *Arctophila fulva* is more abundant in the overall study site, but overall the level of impacts is expected to be minor.

4.3.7.6.2 Alternative 5B: East Kadleroshilik River Mine Site #3

The alternate gravel mine site for this Alternative has similar wetland vegetation as the Proposed Action. Permanent loss of wetlands would occur to construct a channel 4 to 5 times longer than what is needed to connect the proposed gravel mine site to an active flowing body of water. BOEM assumes approximately 1.5 miles of additional ice road would be added for access via the Badami ice road and result in additional temporary impacts by crushing more vegetation than the Proposed Action. Impacts to wetlands and vegetation from this alternative are similar to those from the Proposed Action and would be minor.

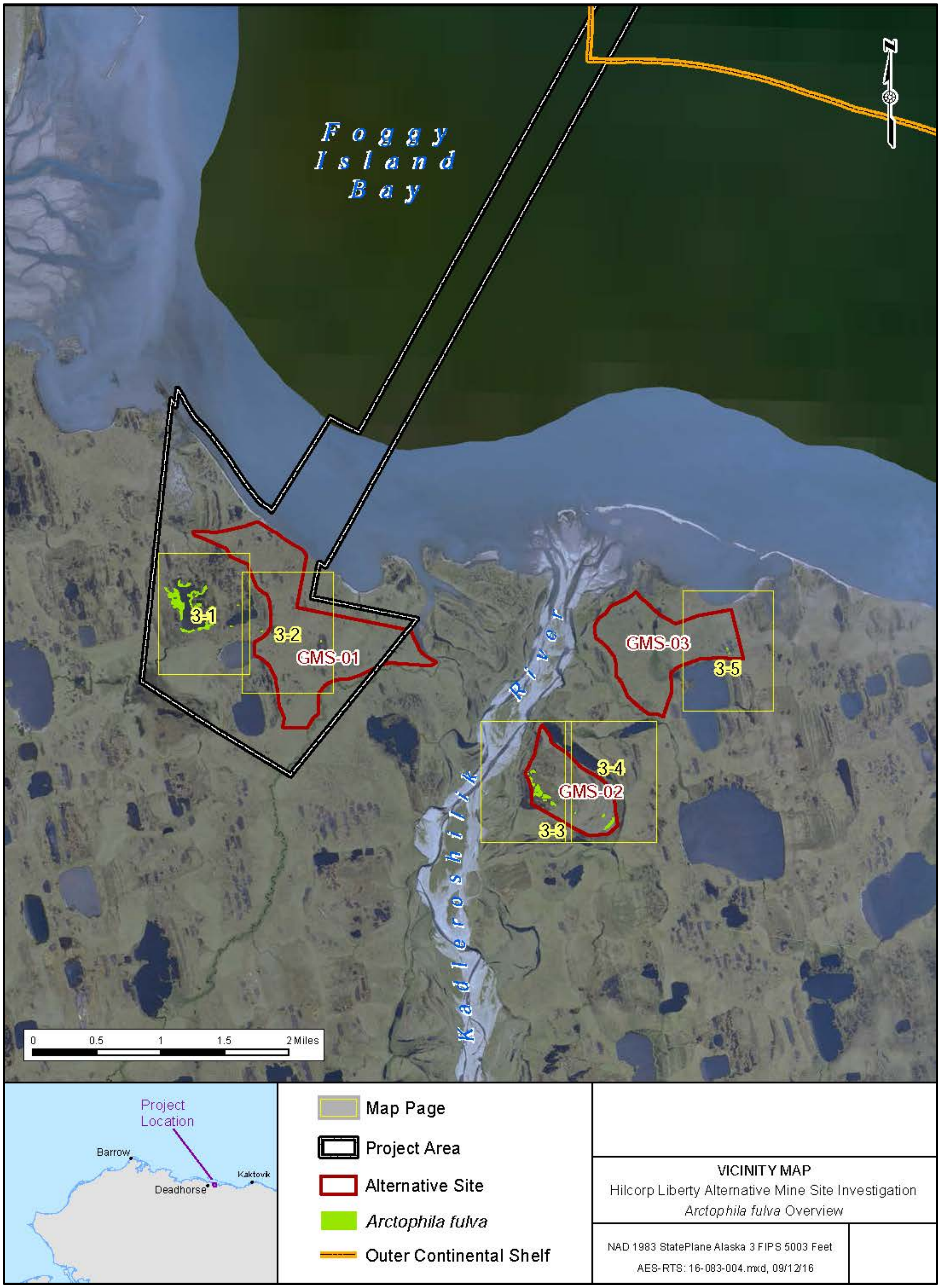

Figure 4-26 Wetlands Affected and Alternative Mine Sites (AES, 2016)

4.4 Sociocultural Systems

4.4.1 Sociocultural Systems

Subsistence is a central organizing element of Iñupiaq society (Section 3.3.3). The existing sociocultural system can be affected in a negative manner if the foundation of the system – subsistence – is disrupted. In the NSB, potential impacts to the sociocultural system are primarily assessed through examination of potential damage to subsistence resources and disruptions to subsistence activities and harvest patterns. Previous analyses in the Alaskan Arctic have described how substantial damage to subsistence resources or disruptions to subsistence activities could cause a breakdown in the sociocultural system and the subsistence-cash economy (NOAA, 2016; USDOI, BOEM, 2015; USDOI, MMS, 2002). Subsistence harvest practices and sharing networks are a vital part of the mixed economies and cultures of the ANS (Burnsilver et al., 2016; Kofinas et al., 2016).

Disruptions to bowhead whaling and losses of opportunities to harvest and share whales and other marine resources could have severe and thus major adverse impacts to sociocultural systems in the ANS (Pedersen et al., 2000). Harvesting and sharing bowhead whales is profoundly important to the maintenance of family ties, kinship networks, and community well-being. In NSB communities, task groups associated with bowhead whale harvests are important in defining social roles and relationships. The individuals one cooperates with help define extended family ties, and the distribution of specific tasks reflects and reinforces the roles of family members, friends, and others in their social network. Disruption of these task groups could damage the social bonds that hold the community together. Any moderate to major disruptions to bowhead harvests and sharing networks would have adverse impacts to the sociocultural system and could trigger fear, anger, and frustration, and a sense of loss and helplessness. Because of the social and psychological importance of whaling to social organization and sharing networks, potential threats to whaling activities are a major cause for anxieties about offshore oil and gas development for people in Nuiqsut, Kaktovik, and Utqiaġvik.

Sociocultural systems are analyzed with reference to three important components: social organization, cultural values, and institutions (Section 3.3.1.2; USDOI, BOEM, 2015). Social organization means how people are divided into social groups and networks. Cultural values reflect the norms and most desirable aspirations and behaviors of people in a society and tend to be widely shared by members of a social group. Institutions correspond to the structure and function of local governments, regional and village corporations, and nongovernmental organizations.

4.4.1.1 The Proposed Action

This section describes potential effects to sociocultural systems from activities associated with the Proposed Action for Nuiqsut, Kaktovik, and Utqiaġvik. Effects could be realized at both the community and borough levels; BOEM describes both here but focuses at the community level for potential effects related to subsistence, and the borough level for potential effects related to economy.

Impacts to subsistence harvest patterns and other practices, such as sharing subsistence foods, directly translates into impacts to sociocultural systems. This is because subsistence is directly related to social organization, cultural values, and local institutions. Therefore, any components of the Proposed Action that could affect subsistence activities and harvest patterns as described in Section 4.4.3 are relevant to the analysis of effects to the sociocultural system. A summary of potential effects to subsistence harvest patterns is provided in Table 4-32.

Table 4-32 Summary of Potential Impacts to Subsistence Practices from the Proposed Action for Nuiqsut, Kaktovik, and Utqiaġvik

Community	Source of Impact[1]	Whaling	Seal hunting	Caribou Hunting	Fishing	Waterfowl Hunting
Nuiqsut	Proposed Action	Moderate to Major	Minor	Negligible	Negligible	Minor
Nuiqsut	Small Spills	Minor to Major	Minor to Moderate	Negligible	Negligible[2]	Minor to Moderate
Nuiqsut	Large Spill	Major	Major	Moderate to Major	Moderate to Major	Major
Kaktovik	Proposed Action	Negligible	Minor	Negligible	Negligible	Minor
Kaktovik	Small Spills	Negligible	Minor to Moderate	Negligible	Negligible[2]	Minor to Moderate
Kaktovik	Large Spill	Moderate to Major	Minor to Moderate	Minor to Moderate	Moderate	Minor to Moderate
Utqiaġvik	Proposed Action	Negligible	Negligible	Negligible	Negligible	Negligible
Utqiaġvik	Small Spills	Negligible	Negligible	Negligible	Negligible[2]	Negligible
Utqiaġvik	Large Spill	Moderate to Major	Minor to Moderate	Minor to Moderate	Negligible	Minor to Moderate

Note: [1] The Proposed Action includes routine construction, development, production, and decommissioning; a number of small spills (i.e., <1,000 bbl) and one large spill (i.e., ≥1,000 bbl) is assumed to occur during the 25-year life of the Proposed Action.
[2] BOEM anticipates negligible impacts on subsistence fishing from small spills for Nuiqsut, Kaktovik, and Utqiaġvik. However, for subsistence fishers and community residents, stress over potential contamination of Arctic cisco, Arctic char, and broad whitefish could be minor to major depending on the location of small spills.

Subsistence harvesters recognize beneficial effects brought by energy development, but they also realize that not all potential beneficial effects become realities such as direct employment of NSB residents in industry (Lampe, 2001, p. 50; SRB&A, 2009). Beneficial impacts include corporate dividends, funding for the NSB, employment with the NSB, employment in activities that support industry, training sponsored by industry, use of oil company facilities, and logistical support to whaling crews or search and rescue assistance (Galginaitis, 2014c; Kruse et al., 1982; Northern Economics, 2006; SRB&A, 2009).

The sociocultural system could be affected in either positive or negative ways if regional revenue from property taxes occurs on a scale sufficient to create local changes in population, employment, prices of commodities, or community prosperity (Picou et al., 2009; Northern Economics, 2006). Potential regional effects to revenue that could follow from the Proposed Action as described in Section 4.4.2 and Table 4-40 for the NSB are pertinent to this analysis of potential impacts to sociocultural systems.

The Proposed Action could affect the sociocultural system for Nuiqsut, Kaktovik, and Utqiaġvik through the following means:

- Potential loss of opportunities for subsistence harvests (Section 4.4.3; Table 4-32)
- Potential revenue from property taxes (Section 4.4.2; Table 4-39)
- Accidental oil spills and spill response and cleanup activities (Section 4.4.4.2.6, Oil Spills and Spill Response)

4.4.1.1.1 Potential Loss of Subsistence Harvests

Section 4.4.3.1.2 describes potential effects to subsistence from the Proposed Action. BOEM provides a summary of potential effects in this section to provide context for the reader about potential impacts to subsistence that could adversely affect sociocultural systems. The summary is focused on whaling by crews from Nuiqsut because there is potential for moderate to major effects to that traditional activity from the Proposed Action (Table 4-32) (if not reduced or avoided through appropriate mitigation measures). Effects to Nuiqsut's subsistence whaling harvest would most likely only occur in August through September during the fall whaling season.

There is potential temporal and spatial overlap between subsistence whaling activities and the Proposed Action for Nuiqsut crews such as proposed LDPI slope protection and related construction activities scheduled for May through August (Table 4-42). Impacts to subsistence whaling from possible deflection of some whales seaward could be moderate. Impacts to Cross Island whaling related to the presence of and potential disturbances from support vessel traffic could be moderate.

Impacts due to whaler avoidance of the Proposed Action Area could be major. These impacts would most likely only occur during whaling seasons in which whalers needed to scout for whales south of Narwhal Island. It is important that the Proposed Action Area be available for scouting in case whales are not readily found where they are expected to be north and east of Cross Island. This is especially the case during times when ice and weather conditions prevent whalers' access to open water seaward of the barrier islands. Whalers tend not to approach closer than 2 to 3 miles of offshore developments (Galginaitis, 2014b, 2016). They would most likely avoid the Proposed Action Area for a number of reasons, including lack of desire to practice their most important harvest activity near the proposed LDPI and potential contamination of whales from operations at the site.

Effects of summer construction activities related to proposed LDPI slope protection work could be major. Nuiqsut whalers may avoid the Proposed Action Area for the entire whaling season due to noise and presence of construction activities if slope protection activities occur through the end of August. Whalers have observed that noises cause whales to change behavior patterns in ways that increase the difficulty of successful harvests such as moving farther out of the hunting area and skittish or aggressive behaviors.

Potential adverse effects to subsistence whaling activities for Nuiqsut from the Proposed Action could range from moderate to major (Section 4.4.3; Table 4-32) (if not reduced or avoided through appropriate mitigation measures). These effects are primarily based on the traditional ecological knowledge (TEK) and direct experiences of the whalers regarding noise and industrial developments in the marine environment. These potential effects are also based in social, cultural, and symbolic factors related to traditional beliefs about whaling practices and the Iñupiat people's relationship to the whale. These potential impacts to whaling are independent of potential biological impacts to bowhead whales.

The potential effects to Cross Island whaling from routine activities could possibly be reduced or eliminated by implementing carefully planned mitigation measures involving close coordination between Nuiqsut whalers and the operator (Appendix C; Kuukpik, 2015, 2017; NOAA, 2013, p. 4-211; SRB&A, 2013). However, potential major adverse effects to subsistence whaling could result from whaler avoidance of the Proposed Action Area, or a large accidental oil spill even if these measures are successfully implemented.

Over 93 percent of households in Nuiqsut use bowhead whale (Brown et al., 2016). Loss of opportunities to harvest bowhead whales (i.e., for a large part of one whaling season or more) due to possible deflection, vessel interference, whaler avoidance, or summer construction at the proposed LDPI (as summarized above) could result in long lasting, widespread and severe disruptions to sharing patterns, kinship ties, and cultural values. This could create social and psychological stressors, loss of identity, and food insecurity (Section 4.4.4.1). These in turn could erode or damage social organization and community health, which could stress local institutions such as health care systems, whaling crew relationships, and annual community feasts.

There are three Native allotments in the affected area used by three families and their heirs for subsistence activities. The allotment holders could experience adverse impacts if access to their allotments was prevented or restricted or if subsistence resources were diverted away from their allotments as a result of the Proposed Action. However, any potential effects at the level of the allotments would not result in adverse impacts to sociocultural systems at the borough level.

As described in Section 4.4.3 and summarized above, if potential adverse impacts to subsistence whaling were to occur (if not reduced or avoided through appropriate mitigation measures), the highest potential for adverse effects to the sociocultural system would be in the community of Nuiqsut. If moderate to major impacts to Cross Island whaling were realized (Section 4.4.3; Table 4-32), effects to Nuiqsut's sociocultural system could range from long lasting and widespread but less than severe to severe (i.e., moderate to major).

Impacts to subsistence harvest patterns for Kaktovik and Utqiaġvik are anticipated to be less for routine activities associated with the Proposed Action than are anticipated for Nuiqsut (Table 4-32). BOEM expects little to no impacts to the sociocultural systems for Kaktovik and Utqiaġvik as a result of routine activities associated with the Proposed Action. This is because there would primarily be only negligible to minor adverse effects to subsistence from the Proposed Action for these communities (Table 4-32).

4.4.1.1.2 Potential Revenue from Property Taxes

As discussed in Section 4.4.2, different types of revenue would occur as a result of the Proposed Action (Table 4-37). The NSB and SOA would both receive a share of revenues from property taxes assessed for onshore infrastructure associated with the Proposed Action such as the proposed onshore pipeline. BOEM provides a summary of potential economic effects in this section to provide context for the reader about how these could affect sociocultural systems. The summary is focused on revenue to the NSB because there is potential for a moderate beneficial effect to the economy of the NSB in terms of tax revenue from the Proposed Action (Section 4.4.2; Table 4-40).

The NSB would receive approximately $1.1 million in annual property tax revenues passed through from the SOA from the Proposed Action, and approximately $35.2 million total over the life of the project. Compared to the $340 million in property tax revenues on energy production infrastructure in the NSB in 2015, the incremental annual effect would be less than 1 percent. However, property tax payments by North Slope oil producers are the main source of revenue for the NSB (accounting for approximately 90 percent of the NSB operating budget in 2015), and these revenues directly support wages for NSB government jobs (Section 3.3.2.2).

Under the SOA's Community Revenue Sharing Program, the NSB receives revenues which would increase slightly from the larger number of oil and gas workers in the NSB because of the Proposed Action. These workers would be counted as permanent residents for purposes of calculating revenue sharing per capita payments to the NSB. These revenues would be provided through services and funding to NSB communities such as health and social services.

Although the incremental impact of annual NSB revenues associated with the Proposed Action would be less than 1 percent, these revenues directly support wages for NSB residents and indirectly support local services. The combination of these factors would most likely have moderate positive effects on the NSB economy (Table 4-40). If revenue from the Proposed Action created more employment in the form of borough jobs and cash income, NSB subsistence harvesters could experience beneficial effects. This could increase efficiency and success in subsistence harvest and strengthen social organization, cultural values, and institutions. If moderate positive effects on the local economy from increased revenue were to materialize over the 25-year life of the Proposed Action, long lasting and widespread beneficial effects to sociocultural systems could occur in the NSB.

However, many NSB residents living close to industrial infrastructure are concerned about adverse effects from both energy development and economic growth that tends to follow from increased tax revenue, including reliance on the cash economy, changes in traditional living, emergent social problems, and disagreement over economic benefits from development (SRB&A, 2009, 2013). Anticipated moderate economic effects from increased tax revenue to the NSB from the Proposed Action could affect the structure and function of institutions in adverse ways. For example, potential conflicts could occur between and within communities if institutions and organizations develop different views about the Proposed Action. Nuiqsut, Kaktovik, and Utqiaġvik are each governed by municipal and tribal councils. Despite close relationships and overlap among the members and leaders of the organizations, it is not uncommon for them to adopt divergent positions with respect to proposed energy development projects. Local leaders and other influential residents such as whaling captains and their wives could disagree about how to invest tax revenues from the Proposed Action. Disagreements could strain relationships and institutions in the NSB. These strains on formal institutions could cause social disorganization. Despite potential for disagreements and internal conflict, the NSB has historically been successful at providing local government jobs to residents in an equitable manner; sharing and avoiding conflict are cultural norms. These considerations taken together with a relatively low projected annual increase in revenue (i.e., less than 1 percent) and moderate beneficial effects to the sociocultural system would most likely result in little to no adverse effects to sociocultural systems from revenue generated by the Proposed Action.

In addition, the Proposed Action is not expected to have an impact on the population base (Section 4.4.2). There would most likely be little to no change in numbers of people becoming permanent residents of the NSB. BOEM does not anticipate substantial changes in the demographic makeup of the population in terms of non-Iñupiat moving in from outside the NSB and staying. Since little to no increase in population is expected to occur from the Proposed Action, BOEM expects little to no adverse effects to the sociocultural system from population growth related to moderate economic growth.

4.4.1.1.3 Accidental Oil Spills and Spill Response

Small oil spills have the potential to impact sociocultural systems by affecting subsistence harvest patterns (Section 4.4.3; Table 4-32). Subsistence harvesters could purposely reduce their harvests of a particular subsistence food resource or avoid hunting areas altogether due to potential contamination of habitats and wild foods. This in turn affects the cultural practice of harvesting and the social and nutritional practices of sharing and consuming wild foods. A small spill of crude or refined oil could have adverse effects on cultural values and social organization. If potential minor to major effects from small spills to subsistence harvest patterns were to occur, BOEM anticipates minor to major effects to the sociocultural system in Nuiqsut.

For small spills, BOEM anticipates little to no impacts to sociocultural systems for Utqiaġvik. For Kaktovik, however, small spills of crude or refined oil could have minor to moderate effects on subsistence seal hunting and waterfowl hunting (Table 4-32). If these impacts to subsistence harvests were realized due to a small spill, social organization and cultural values could be adversely affected in Kaktovik because of the importance of seals, geese, and eiders in traditional practices; impacts to the sociocultural system could be minor to moderate if hunters were present at the location of the spill when it occurred. The Proposed Action Area has historically been part of Kaktovik’s seal and bird hunting area, but it is not in their core area located closer to town. It would be unlikely hunters would be present at the time of small spills unless they traveled to Foggy island Bay to hunt because they could not find seals or birds close to home in the core area (Section 4.4.3.1).

Effects from a large oil spill on the sociocultural systems of local communities could come from oiling of habitats and subsistence resources, spill response and cleanup activities, changes in population, employment, and income, and social and psychological stress due to fears of potential contamination of food resources (Palinkas et al., 1993). Effects from a large spill could disrupt ongoing sociocultural systems by disturbing the cultural and nutritional practice of subsistence harvesting, sharing, and consumption for one or more seasons. This would impede sharing harvested resources with those residing in the community and those outside the community who rely on receiving subsistence foods to maintain their cultural values and identities. This is especially the case for many Iñupiat elders who no longer hunt and fish for themselves and at times of food insecurity.

For example, a community could experience food insecurity and a breakdown in sharing networks if a large offshore spill corresponded in time with a collapse of an onshore subsistence fishery or caribou hunt.

Effects from a large oil spill could result in a loss of or reduction in traditional whaling practices. If whaling areas are contaminated by an oil spill, or if hunters are unable to use traditional whaling areas, the sociocultural system could be severely impacted. In the summer season, July 1 through September 30, the Cross Island whaling area has a 25 percent chance of being contacted by a large oil spill (on the unlikely condition one occurred) starting from the proposed LDPI, and a 13 percent chance of being contacted by a large oil spill from the pipeline, 10 days after the spill occurs. These percent chances increase slightly to 26 percent and 14 percent, respectively, in summer 90 days after a large oil spill occurs (Appendix A, posted at www.boem.gov/liberty). In the unlikely event of a large accidental oil spill, severe and thus major impacts could occur to Cross Island whaling, which would translate to major impacts to the sociocultural system in Nuiqsut.

In the unlikely event of a large spill, moderate to major impacts are expected to occur for whaling for Kaktovik and Utqiaġvik crews (Table 4-32). In turn, a large spill could have moderate to major effects on the sociocultural systems of Kaktovik and Utqiaġvik depending on the extent of oiling of their whaling and seal hunting areas. If any part of the bowhead migration area outside their primary whaling areas was contacted by oil in the event of a large spill, impacts to sociocultural systems could be widespread and thus would be considered moderate for Kaktovik and Utqiaġvik, primarily due to avoidance because of potential contamination of bowhead whales as a food source. BOEM expects severe and thus major impacts to sociocultural systems lasting more than one year for Kaktovik and Utqiaġvik if their core bowhead whaling areas were directly contacted by oil in the event of a large spill. Effects to social organization, institutions, and the local economy can occur due to local employment in spill response and cleanup activities. A sudden employment increase could have adverse effects, including inflation and displacement of Alaska Native residents from subsistence harvest activities. Employment of local Iñupiat could alter subsistence practices and put stresses on day-to-day life in the communities by drawing local workers away from village service jobs (Palinkas et al., 1993). Over longer duration, a large spill and cleanup activities could cause social relations and cohesion in communities to deteriorate (Palinkas et al., 1993; USDOI, BOEM, 2015), especially if differential or inequitable increases in local income occur from temporary employment in OSR and cleanup (Wooley, 1995).

However, a large spill is expected to have a negligible impact to revenues (Section 4.4.2.1). The effects on the local economy would depend on the extent to which local residents are employed in cleanup work and would most likely be negligible to minor due to the temporary nature of spill response and cleanup jobs (Section 4.4.2.1). Local population effects are likely to be negligible due to the temporary nature of the jobs, physical separation of worker housing from community residents, and low likelihood of cleanup workers permanently relocating to the NSB (Section 4.4.2.1). BOEM expects spill response and cleanup to have a negligible to minor impact on sociocultural systems.

GIUEs (e.g., oil spill drills), which are infrequent, of short duration, (less than 8 hours), and utilize existing equipment, would not alter impact conclusions for sociocultural systems.

The Proposed Solid Ice Condition (Section 2.5.1) would shift much of the risks associated with a large oil spill from summer months to winter months. A large spill which occurred during the solid ice conditions of winter would likely have less impacts to sociocultural systems in terms of physical damage to the environment than a summer spill into open water, because a spill during solid ice conditions would disperse over a smaller area and be more easily cleaned up. This measure would not mitigate other impacts of a large spill, including hunter avoidance of the area, concerns about contamination, and potential disruptions to social organizations resulting from the loss of a subsistence season or seasons. Restricting reservoir drilling to winter months would also extend the time period required to complete the overall drilling program, and although this would mean drilling would occur when large spills are more easily contained and cleaned up, the additional few months to couple of years of drilling activity could still result in increased impacts to sociocultural systems for the reasons described above.

4.4.1.2 Conclusion for the Proposed Action

Appendix C describes mitigation measures derived from lease stipulations, design features and BMPs the operator committed to, and requirements and BMPs that other agencies typically require (Sections C-1 to C-3). BOEM’s conclusions regarding impacts assume implementation of and compliance with the mitigation measures described in Sections C-1 through C-3.

The primary subsistence activity that could be adversely affected by the Proposed Action is bowhead whaling conducted by crews from Nuiqsut (Table 4-32). If moderate to major impacts on Cross Island whaling were realized (Section 4.4.3), adverse effects to Nuiqsut’s established system of social organization, cultural values, and institutions could be moderate to major.

If moderate positive effects on the regional economy from increased revenue were to materialize over the 25-year life of the Proposed Action (Table 4-40), moderate beneficial effects to sociocultural systems could occur in the NSB from property tax revenue. There would most likely be negligible adverse effects to sociocultural systems in the NSB from revenue generated by the Proposed Action.

If minor to major effects from small spills to subsistence harvest patterns are realized, BOEM anticipates minor to major effects to occur to the sociocultural system for Nuiqsut. A large spill of crude or refined oil associated with the Proposed Action could have major adverse impacts to subsistence whaling, seal hunting, and waterfowl hunting for Nuiqsut (Table 4-32). If major impacts from a large spill occur to Cross Island whaling, BOEM expects severe and thus major impacts to occur for the sociocultural system in Nuiqsut.

Impacts to subsistence harvest patterns for Kaktovik and Utqiaġvik are anticipated to be less for routine activities and small spills associated with the Proposed Action than are anticipated for Nuiqsut. BOEM expects negligible impacts to the sociocultural systems for Kaktovik and Utqiaġvik as a result of routine activities associated with the Proposed Action. For small spills, BOEM anticipates negligible impacts to sociocultural systems for Utqiaġvik. For Kaktovik, however, small spills of crude or refined oil could have minor to moderate effects on subsistence seal hunting and waterfowl hunting (Table 4-32). If these impacts to subsistence harvests were realized due to a small spill, social organization and cultural values could be adversely affected in Kaktovik because of the importance of seals, geese, and eiders in traditional practices. Although unlikely, if hunters were present at the location of the spill when it occurred, impacts to the sociocultural system could be minor to moderate.

In the event of a large spill, moderate to major impacts are expected to occur for whaling for Kaktovik and Utqiaġvik crews (Table 4-32). In turn, a large spill could have moderate to major effects to the sociocultural systems of Kaktovik and Utqiaġvik depending on the extent of oiling of their whaling and seal hunting areas. The chance of contact of oil from a large spill for the whaling areas of Kaktovik and Utqiaġvik is less than 5 percent during January through December (Table 4-41 and Appendix A, (posted at www.boem.gov/liberty). If any part of the bowhead migration area outside their primary whaling areas was contacted by a large spill, impacts to sociocultural systems could be widespread and thus would be considered moderate for Kaktovik and Utqiaġvik, primarily due to avoidance of potentially contaminated bowhead whales as a food source. BOEM expects severe and thus major impacts to sociocultural systems lasting more than one year for Kaktovik and Utqiaġvik if their core bowhead whaling areas are directly contacted by oil from a large spill.

4.4.1.3 Alternative 2 (No Action)

Under Alternative 2, potential impacts to subsistence activities and harvest patterns from disruptions to hunting and fishing and the potential for contamination of subsistence foods associated with the Proposed Action would not occur. There would be no impacts on subsistence harvest patterns for Nuiqsut, Kaktovik, and Utqiaġvik. Therefore, there would be no adverse impacts to sociocultural systems under Alternative 2. There would be no new economic growth or tax revenue in the NSB from the Proposed Action under Alternative 2. The communities of Nuiqsut, Kaktovik, and Utqiaġvik would experience no beneficial effects to sociocultural systems from the Proposed Action under Alternative 2.

4.4.1.4 Alternative 3 (Alternate LDPI Locations)

In Alternative 3, the proposed LDPI would be relocated (Section 2.2.4). Alternative 3A would relocate the proposed LDPI one mile to the east into deeper water, and Alternative 3B would relocate the proposed LDPI 1.5 miles to the southwest into slightly shallower waters managed by the SOA.

For both Alternative 3A and 3B, the proposed LDPI would remain in the southern portion of Nuiqsut’s bowhead whaling area. Alternatives 3A and 3B would not change the potential likelihood or severity of whaler avoidance of the Proposed Action Area.

Alternative 3A could prolong potential impacts to the sociocultural system through loss of subsistence opportunities for Nuiqsut. Prolonged impacts could occur if construction activities were extended into the fall whaling season for Nuiqsut and into a second summer construction season and hence a second whaling season. Under 3A, effects to whaling for Nuiqsut from summer construction activities at the proposed LDPI would remain major (Section 4.4.3.3) but could be prolonged into a second whaling season, which could have severe and thus major impacts to the sociocultural system in Nuiqsut. This increase in summer construction time could also increase impacts on subsistence seal hunting from minor to moderate for Nuiqsut and Kaktovik, potentially increasing impacts to social organization and cultural identity in these villages. These impacts would be realized by disruptions to sharing practices and sharing networks and losses in opportunities to transmit TEK and practice from experienced harvesters to younger up-and-coming whalers and seal hunters.

If under Alternative 3B summer construction at the LDPI ceased August 25 or at the start of the Cross Island hunt (whichever occurs first), impacts to whaling for Nuiqsut from LDPI slope protection work could be reduced from major to moderate. If under Alternative 3B summer construction at the proposed LDPI ceased August 1, impacts to whaling for Nuiqsut from LDPI slope protection work could be reduced from major to minor. This change could also reduce potential impacts to subsistence seal hunting from minor to negligible for Nuiqsut and Kaktovik hunters.

Alternative 3B would move the proposed LDPI and operations into waters managed by the SOA, which would increase property taxes beyond what is projected from the Proposed Action (Section 4.4.2). Alternative 3B would result in an increase in property tax revenues to the SOA, a portion of which it would share with the NSB. BOEM estimates an annual average $6 million increment to the NSB (or less than a 2 percent increase) compared to the $340 million property tax revenue on the oil and gas infrastructure in the NSB in 2015. The effects of Alternative 3B on the NSB economy from tax revenues would largely be the same as for the Proposed Action, which is moderate (Section 4.4.2; Table 4-40).

Added revenue income to the NSB could benefit individual subsistence harvesters. Similar to the Proposed Action, increased revenue under Alternative 3B could have a long lasting and widespread beneficial effect to the sociocultural system.

4.4.1.5 Conclusion for Alternatives 3A and 3B

Most impacts of Alternative 3A on sociocultural systems would be the same as those for the Proposed Action (Section 4.4.1.1) with the exception of potential effects of summer construction on whaling and seal hunting. Potential effects to whaling for Nuiqsut from summer construction activities at the proposed LDPI would remain major but prolonged into a second whaling season, which could increase the duration and likelihood of severe impacts to the sociocultural system for Nuiqsut. Impacts to subsistence seal hunting from prolonged summer construction work (i.e., proposed LDPI slope protection) would extend potential impacts into a second seal hunting season, thereby increasing effects to seal hunting from minor to moderate, which could prolong impacts to the sociocultural system. If these impacts to subsistence were extended into a second open-water season under Alternative 3A, BOEM anticipates overall effects to the sociocultural system from losses of subsistence opportunities would most likely be moderate to major.

Most impacts of Alternative 3B on sociocultural systems would be the same as those for the Proposed Action (Section 4.4.1.1) with the exception of potential effects of summer construction on whaling and seal hunting. If summer construction at the proposed LDPI ceased August 25 or at the start of the Cross Island hunt (whichever occurs first), impacts to whaling for Nuiqsut from LDPI slope protection work could be reduced from major to moderate. If under Alternative 3B summer construction at the proposed LDPI ceased August 1, impacts to whaling for Nuiqsut from LDPI slope protection work could be reduced from major to minor. This change could also reduce potential impacts to subsistence seal hunting from minor to negligible for Nuiqsut and Kaktovik. Reducing summer construction time at the proposed LDPI would most likely reduce impacts to sociocultural systems, especially for Nuiqsut. Alternative 3B could have minor to moderate adverse impacts to the sociocultural system for Nuiqsut and Kaktovik.

Under Alternative 3B, if increased tax revenue was provided to the NSB as a result of moving the proposed LDPI into state-managed waters, subsistence harvesters in Nuiqsut, Kaktovik, and Utqiaġvik could experience beneficial effects. Similar to the Proposed Action, this would most likely have a long lasting and widespread, and thus moderate beneficial effect to the sociocultural system of the North Slope.

4.4.1.6 Alternative 4 (Alternate Processing Locations)

Under Alternative 4, oil and gas processing would be relocated to one of two alternate facilities (Section 2.2.5). Alternative 4A would relocate processing activities to Endicott located to the west of the Proposed Action Area. Alternative 4B would relocate processing to a new onshore facility that would need to be built near the Badami pipeline tie-in point.

Both Alternative 4A and 4B would reduce the construction time for the proposed LDPI, perhaps by as much as 20 days. Decreasing summer construction activities at the proposed LDPI related to LDPI slope protection could reduce impacts to whaling and thus sociocultural systems.

Alternatives 4A and 4B would most likely reduce the overall noise produced at the proposed LDPI. All power for both the onshore and offshore facilities would be generated onshore instead of on the island with fuel-powered turbines, which would most likely reduce some noises offshore at the proposed LDPI site. Overall, BOEM does not anticipate any added advantage or reduced impact to bowhead whales from this reduction in offshore noise because the reduction in noise would most likely be indiscernible from background levels caused by production. Production, which includes power generation, is comparatively quiet in comparison to other activities at the island. The noise produced during production is estimated to propagate 75 meters in open water, which is 0.04 percent of the distance in comparison to the loudest activities anticipated during construction (i.e., pile-driving; 17,500m) (SLR, 2017). For comparison, the noise generated from Northstar (during production, no vessel transits) fell between the 5 percent to 50 percent thresholds of the ambient sound levels in the Beaufort Sea at similar sound signatures (Blackwell and Greene, 2005).

However, despite not being able to measure the potential reduction in offshore noise under Alternative 4, any reduction of noise at the proposed LDPI would most likely reduce impacts to Cross Island whalers and other residents of Nuiqsut due to their TEK and experience of how noise in the marine environment decreases whaling success. Moving processing to Endicott or onshore at the Badami tie-in site would most likely decrease some noise in the marine environment that whalers have observed to deflect the whale migration and lower success in whaling. Reducing or eliminating noise in the marine environment would most likely bolster cultural identity, local cultural values, and community well-being and thus could benefit sociocultural systems, especially in Nuiqsut.

Both Alternatives 4A and 4B would increase tax revenue for the SOA and the NSB. If increased tax revenue was provided to the NSB as a result of moving the processing to Endicott or building a new processing facility at the Badami pipeline tie-in site, subsistence harvesters in Nuiqsut, Kaktovik, and Utqiaġvik could experience beneficial effects. The sociocultural system of the North Slope could experience long lasting and widespread beneficial effects from increased revenue that would be used to operate the NSB.

4.4.1.7 Conclusion for Alternatives 4A and 4B

Most impacts of Alternatives 4A and 4B on sociocultural systems would be the same as those for the Proposed Action (Section 4.4.1.1). However, decreasing the time needed for summer construction activities at the proposed LDPI for LDPI slope protection could reduce impacts to whaling for Nuiqsut, depending on when summer construction ceased. This change could also reduce potential impacts to subsistence seal hunting for Nuiqsut and Kaktovik hunters. These potential beneficial effects to subsistence would most likely reduce impacts to sociocultural systems. Moving processing to Endicott or onshore near the Badami tie-in point would most likely decrease noise near the proposed LDPI and potential deflection of the whale movements farther offshore. This would most likely improve overall community well-being by reducing stress associated with whalers' observations of how noise in the marine environment can lower whaling success. Increased tax revenue could result in moderate beneficial effects to sociocultural systems related to economic growth. Overall, BOEM anticipates Alternatives 4A and 4B would have moderate effects to the sociocultural system for Nuiqsut and Kaktovik because of reduced potential for loss of subsistence opportunities. BOEM anticipates moderate beneficial effects to the sociocultural system for the NSB from Alternatives 4A and 4B.

4.4.1.8 Alternative 5 (Alternate Gravel Sources)

Alternative 5 would relocate the proposed gravel mine (Section 2.2.6). There are two alternate mine sites Alternatives 5A and 5B, east of the Kadleroshilik.

BOEM anticipates that impacts from Alternatives 5A and 5B on sociocultural systems would be essentially the same as impacts described for the Proposed Action (Section 4.4.1.1).

4.4.1.9 Conclusion for Alternatives 5A and 5B

Impacts from Alternatives 5A and 5B to sociocultural systems would be the same as the Proposed Action, which for routine activities are moderate to major for Nuiqsut and negligible for Kaktovik and Utqiaġvik (Section 4.4.1.1).

4.4.2 Economy

4.4.2.1 The Proposed Action

The primary factors for calculating the economic effects of the Proposed Action are employment, labor income (wages), population, revenues, and oil spills. The effects analysis is relative to the baseline description of the existing economic conditions described in Section 3.3.2. All of the projections that BOEM presents in this section are approximate.

Increases in employment, labor income, and revenues are considered positive or beneficial effects. Increases in population are generally considered positive; however, there could be some adverse secondary considerations associated with large percentage population increases at the local level (e.g., inflation, strains on existing public and social infrastructure, etc.). Oil spills can have both beneficial and adverse impacts on employment, labor income, and revenues depending on the characteristics of the spill and the industries/sectors of the economy that are affected. The size of an oil spill is a key variable in determining potential economic impacts. BOEM uses three categories of spills, including small, large, and VLOS. Small spills of crude or refined oil (i.e., less than 1,000 bbl) are accidental events that have occurred with general routine frequency and are assumed to occur from the Proposed Action during its lifetime. Although an unlikely event, one large spill of crude or refined oil (i.e., more than or equal to 1,000 bbl) is assumed to occur during the development and production phase of the Proposed Action. The potential effects of small and large oil spills on the SOA and NSB economies are examined in this section, while the potential effects of a VLOS are examined in Appendix A (posted at www.boem.gov/liberty), Section A-7.

BOEM characterizes effects that would occur for a limited time during individual phases of the project (such as construction and development), or for a longer duration (such as the production phase or lifetime of the project) to better understand the relative magnitude and duration of the effects on the SOA and NSB economies. BOEM includes some relevant information on the effects of the Proposed Action at the Federal level for informational purposes even though the impact analysis focuses on the SOA and the NSB given the relative size of the Liberty project relative to the U.S. economy.

4.4.2.1.1 Methodology for Employment, Labor Income, and Revenues

Definitions

Section 3.3.2.1 describes baseline data and information on NSB and SOA employment and labor income (wage) data. The following definitions apply to the analysis of economic impacts:

- Direct employment includes those workers with jobs directly in oil and gas exploration, development, production, and decommissioning.
- Indirect employment includes those workers in industries that support the direct oil and gas activities (e.g., jobs in transportation, such as shuttling workers by air between Anchorage and the North Slope).
- Induced employment is the aggregate of workers associated with providing goods and services to direct and indirect workers.
- Labor income refers to wage compensation generated by direct, indirect, and induced employment.

The direct changes in employment, income, and expenditures resulting from the Proposed Action would initiate subsequent rounds of income creation, spending, and re-spending. Third-party contractors, vendors, and manufacturers receiving payment for goods and/or services required by the Proposed Action, in turn, would be able to pay others who support their businesses. In addition, persons directly and indirectly employed as a result of the Proposed Action would generate additional jobs and income in the economy as they purchase goods and services. These indirect and induced effects are also referred to as "multiplier effects."

Framework for Employment, Labor Income, and Revenue Analysis: MAG-PLAN Alaska Model

The following analysis incorporates results from MAG-PLAN Alaska. MAG-PLAN Alaska (Northern Economics, Inc. et al, 2012) is a two-stage, region-specific economic impact model used by BOEM to quantify potential economic impacts (direct, indirect, and induced) of oil and gas development in the Alaska OCS planning areas. Stage 1 estimates the level and allocation of direct expenditures as well as direct work force requirements and government revenues resulting from OCS oil and gas activities specified in an exploration and development (E&D) scenario. Stage 2 involves projecting the indirect and induced economic impacts of the OCS activities on potentially affected regions in Alaska, including the NSB. The model requires an E&D scenario for a specified modeling area or project as an input; model results are scenario-specific.

MAG-PLAN Alaska has evolved through the years in response to BOEM's analytical needs and in response to changing economic conditions and technological trends in oil and gas development. The current version (Northern Economics et al., 2012) contains the state of knowledge on new technologies, industry costs, and work force requirements for various offshore exploration, development, and production activities in the Beaufort Sea and Chukchi Sea Planning Areas of the Alaska OCS. The current version was modified and run with Liberty scenario-specific data, including information on proposed infrastructure, timing of activities, number of development and production wells, and production volumes. Summary of the MAG-PLAN output was provided to BOEM and was presented in the Liberty EIA (Hilcorp, 2015, Appendix A). The data presented in this section comes directly from the summary MAG-PLAN Alaska output.

Table 4-33 provides information on the direct, indirect, and total jobs supported by the Proposed Action in the NSB and SOA. Due to the small size of the project and resulting employment projections, BOEM chose not to round model output for presentation in tables and text. However, these estimates should be interpreted as a relative measure of jobs that would be needed to support the various project stages – not that the model has a level of precision indicated by the unrounded results.

The MAG-PLAN Alaska model output also includes estimates of potential royalty payments, lease payments, "TAPS effect," SOA corporate income taxes, and property taxes related to onshore infrastructure that would likely be generated by the Liberty Proposed Action scenario. Oil produced from the Proposed Action would help keep flow capacity up in TAPS and reduce the pipeline tariff, a situation that would increase revenue to the SOA from royalties and production tax (the "TAPS effect").

For purposes of this analysis, BOEM assumes a price of $100 per barrel of oil. Historically, oil prices are volatile: $132/bbl in June 2008; $40/bbl in December 2008; $125/bbl in March 2012; $30/bbl in January 2016; and $53/bbl in December 2016 (EIA, 2016). Despite the downturn in prices in 2015 and 2016, the U.S. Energy Information Administration in its Annual Energy Outlook 2017 projects a price of about $95/bbl in 2030 (in 2016 dollars) and a continued increase to $110/bbl prior to 2040 (EIA, 2017). The start of Liberty production is likely to begin around 2026 (see Table 4-33), making the $100/bbl assumption over a period of 25 years of production reasonable.

Total oil production from the Proposed Action is anticipated to be 90 to 130 million barrels for an estimated value of $9 to $13 billion (Hilcorp, 2015, Appendix A).

4.4.2.1.2 Employment and Labor Income

The Proposed Action would support direct jobs during project pre-development, development, production/operations, and abandonment phases. The projected number of workers needed is greatest during the 4-year development phase (construction and drilling) and fewer during the other phases (see Table 4-33 through Table 4-36). BOEM uses the projected peak annual number of jobs over the life of the project and associated labor income (wages) relative to the 2015 baseline in Section 3.3.2.1 to analyze the maximum likely effects of the Proposed Action in any given year; impacts at this level would be short-term. BOEM also considers the average annual employment and labor income associated with the production phase (approximately 25 years long) in evaluating the average longer-term impacts of the Proposed Action.

The nature of oil and gas employment is such that the MAG-PLAN employment estimates do not translate directly to the number of new workers needed. A portion of the estimates represent the continuation of existing jobs as previous projects are completed and workers cycle to the Liberty project, and in effect are not "new;" and a portion represent "new" part-time jobs but in effect would result in more work hours for already employed workers.

Table 4-33 Annual Average Employment (Number of Jobs)[1] by Project Phase

Liberty Scenario Phase	NSB Direct Employment	Other Alaska Direct Employment[1]	Other U.S. Direct Employment[1]	NSB Indirect and Induced Employment[1]	Other Alaska Indirect and Induced Employment[1]	NSB Total[2] Employment[1]	Other Alaska Total[2] Employment[1]
Pre-Development	0	137	169	0	75	0	212
Development	26	875	665	16	1,723	41	2,599
Production	6	129	132	6	350	12	479
Abandonment	9	108	421	4	113	14	221

Notes: Estimated annual average employment to support the Proposed Action by project phase.
[1] Jobs include part-time, seasonal, and full-time.
[2] NSB and other Alaska totals are the sum of direct, indirect and induced jobs presented in this table. Totals presented may differ due to rounding.
Source: MAG-PLAN Alaska summary output.

Table 4-34 Peak/Maximum Employment by Community and Project Phase

Liberty Scenario Phase	NSB Direct Employment	Other Alaska Direct Employment[1]	Other U.S. Direct Employment[1]	NSB Indirect and Induced Employment[1]	Other Alaska Indirect and Induced Employment[1]	NSB Total[2] Employment[1]	Other Alaska Total[2] Employment[1]
Pre-Development	0	314	411	0	172	0	486
Development	47	1,863	1,102	25	3,527	73	5,389
Production	6	235	253	7	882	14	1,117
Abandonment	9	108	421	4	113	14	221

Notes: Estimated Employment to Support the Proposed Action by Project Phase.
[1] Jobs include part-time, seasonal, and full-time.
[2] NSB and other Alaska totals are the sum of direct, indirect and induced jobs presented in this table. Totals presented may differ due to rounding.
Source: MAG-PLAN Alaska summary output provided to BOEM.

Table 4-35 Annual Average Employment Labor Income by Community and Project Phase[1]

Liberty Scenario Phase	NSB Direct	Other Alaska Direct	Other U.S. Direct	NSB Indirect and Induced	Other Alaska Indirect and Induced	NSB Total[2]	Other Alaska Total[2]
Pre-Development	0	13	16	0	3	0	16
Development	1	51	53	1	118	2	169
Production	1	12	12	1	24	2	37
Abandonment	0	8	10	0	8	1	16
Total Project Lifetime	18	593	610	18	1,140	37	1,733

Notes: [1] Estimated Annual Average Labor Income (Millions of 2015$) Associated with Employment by Community and Project Phase.
[2] Local and other Alaska totals are the sum of direct, indirect and induced presented in the table. Totals presented may differ due to rounding.
Labor income values were inflated from 2013$ to 2015$ using the U.S. Department of Labor, Bureau of Labor Statistics Consumer Price Index-urban (CPI-U) for Anchorage (USDOL, BLS, 2017a).
Source: MAG-PLAN Alaska summary output provided to BOEM.

Table 4-36 Peak/Maximum Employment Labor Income by Community and Project Phase[1]

Liberty Scenario Phase	NSB Direct	Other Alaska Direct	Other U.S. Direct	NSB Indirect and Induced	Other Alaska Indirect and Induced	NSB Total[2]	Other Alaska Total[2]
Pre-Development	0	20	39	0	8	0	37
Development	2	96	88	2	189	4	285
Production	1	14	14	1	60	1	74
Abandonment	0	8	10	0	8	1	16
Total Project Lifetime	18	593	610	18	1,140	37	1,733

Notes: [1] Estimated peak labor income (millions of 2015$) associated with employment by community and project phase.
[2] Local and other Alaska totals are the sum of direct, indirect and induced presented in the table. Totals presented may differ due to rounding.
Labor income values were inflated from 2013$ to 2015$ using the U.S. Department of Labor, Bureau of Labor Statistics CPI-U for Anchorage (USDOL, BLS, 2017a).
Source: MAG-PLAN Alaska summary output provided to BOEM.

State of Alaska Employment and Labor Income

BOEM estimates that the peak annual employment effects in other Alaska communities (not including the NSB) associated with the Proposed Action would occur during development with 5,389 total jobs (1,863 direct jobs and 3,527 indirect and induced jobs). The associated total peak annual labor income would be approximately $285 million in 2015 dollars. The incremental impact of the peak total annual jobs would represent less than 2 percent of total Alaska employment in 2015. Correspondingly, the incremental impact of the associated peak annual labor income in 2015 dollars would be approximately 2 percent of Alaska wages in 2015. However, these effects are very short-term. The average annual employment and labor income during the development phase would be much lower (2,599 jobs and $169 million). Once production begins, the average annual direct jobs in other Alaska communities are projected to be about 129 over a 25-year period; average annual total employment (direct, indirect, and induced) during this production phase is projected to be approximately 479 jobs. The relatively small number of long-term annual jobs and associated labor income associated with the Proposed Action would have little to no effect on the SOA economy.

However, it is worth noting that the Proposed Action would generate approximately $1.7 billion in labor income in the SOA and $1.2 billion in the U.S. over the life of the Proposed Action. A negligible impact finding does not diminish this potential contribution.

NSB Employment and Labor Income

BOEM estimates that the peak annual NSB employment effects associated with the Proposed Action would occur during development with approximately 73 total jobs (47 direct jobs and 25 indirect and induced jobs) and an associated labor income of $4 million. The incremental impact of the peak total annual jobs estimate and associated labor income would represent 2.2 percent and 2.6 percent of total NSB employment and NSB wages in 2015, respectively. However, for reasons discussed in the introduction to this section, fewer of these jobs are likely to represent new workers and the likely impact on NSB jobs and wages from the Proposed Action would be smaller. Once production begins, the average annual direct jobs in the NSB are projected to be about 6 over a 25-year period; average annual total employment (direct, indirect, and induced) during this production phase is projected to be approximately 12 jobs. Historically the oil industry employs few village residents; participation by Borough residents would likely remain comparatively low in oil industry-related jobs on the North Slope over the life of the Proposed Action.

The relatively small number of annual jobs and associated labor income over the pre-development, production, and abandonment stages of the Proposed Action would have little to no effect on the economy of the NSB. The somewhat larger (but still relatively small) number of annual jobs and associated labor income during development are also likely to have little effect on the economy of the NSB; however, more noticeable short-term positive effects could occur if more of the employment estimates for development represent new full-time jobs. Thus, the Proposed Action is expected to have a negligible to minor effect on the NSB economy over the life of the Proposed Action.

4.4.2.1.3 Revenues

Table 4-37 presents MAG-PLAN estimates of Federal, SOA, and NSB revenue streams likely to be generated by the Proposed Action. BOEM analyzes the potential incremental effects by comparing revenues generated from the Proposed Action relative to the current (baseline) SOA and NSB revenues described in Section 3.3.2.2.

Table 4-37 Federal, SOA, and NSB Revenues (Millions of 2015$)[1]

Revenue Source	Total	Annual Average
Total Federal Royalties and Lease Payments Collected	1,479.7	37.9
Federal Share of Royalties and Lease Payments	1,080.2	26.6
SOA Share of Federal Royalties and Lease Payments	399.5	9.8
TAPS Effect	116.0	3.0
State Corporate Income Tax	15.4	0.4
Total Property Tax Collected	38.0	1.0
SOA Share of Property Taxes	2.9	0.1
North Slope Borough Property Taxes	35.2	1.1

Notes: [1] Estimated Federal, SOA, and NSB Revenues Generated by the Proposed Action
Modeling was based on the following assumptions: total oil production of 117 million barrels from the Proposed Action; 12.5% royalty rate; 27% for Section 8(g) SOA share of royalty; 2% for property tax (20 mills); revenue values were inflated from 2013$ to 2015$ using the U.S. Dept. of Labor, Bureau of Labor Statistics consumer price index inflation calculator (USDOL, BLS, 2017b).

Source: MAG-PLAN Alaska summary output.

State of Alaska Revenues

On average, the SOA would receive $9.8 million annually associated with its share of royalties and lease payments. BOEM estimates that the sum of the average annual TAPS related effect, SOA corporate income taxes, and SOA property taxes (after transfer to the NSB) would be approximately $3.5 million. The oil and gas property taxes collected would be from new onshore infrastructure (landfall infrastructure and pipelines) associated with the project. The total average annual revenue to the SOA from the Proposed Action would be approximately $13.3 million which represents less than 2 percent of the $2.4 billion in 2015 total SOA oil and gas revenues (ADR, 2015). This also represents less than 1 percent of the $1.6 billion in 2016 and $1.7 billion in 2017 total SOA oil and gas revenues (ADR, 2015; ADR, 2016). The relatively small amount of annual SOA revenues associated with the Proposed Action would have little to no effect on the SOA economy, resulting in a negligible effect.

However, it is worth noting that the Proposed Action would generate approximately $533 million in revenues to the SOA and $1.1 billion to federal government over the life of the Proposed Action. The beneficial revenue effects could help offset declining oil production in the State to some degree. A negligible impact finding does not diminish these potential contributions.

NSB Revenues

The NSB would receive approximately $1.1 million in annual property tax revenues passed through from the SOA as a result of the Proposed Action, and approximately $35.2 million total over the life of the project. Compared to the $340 million in property tax revenues on the oil and gas infrastructure in the NSB in 2015, the incremental annual effect would be less than 1 percent. However, as noted above in Section 3.3.2.2, property tax payments by North Slope oil producers are the main source of revenue for the NSB (accounting for approximately 90 percent of the NSB operating budget in 2015), and these revenues directly support wages for NSB government jobs held by Borough residents.

In addition, under the SOA's Community Revenue Sharing Program, the NSB also receives revenues which would increase slightly as a result of the larger number of oil and gas workers in the NSB because of the Liberty project. These workers would be counted as permanent residents for purposes of calculating revenue sharing per capita payments to the NSB. These revenues would be provided through services and funding to NSB communities, such as education, public safety, and health and social services.

Although the incremental impact of annual NSB revenues associated with the Proposed Action would be less than 1 percent, these revenues directly support wages for NSB residents and indirectly support local services. The combination of these factors is likely to translate to moderate positive effects on the NSB economy.

4.4.2.1.4 Population

This section considers the relative impacts to the population base that could occur as a result of the direct jobs forecast in Table 4-33 and Table 4-34 if workers relocate as a result of the employment. The estimates presented in Table 4-33 and Table 4-34 are representative of where workers are likely to reside while employed on the project, not where the jobs will physically be located.

A portion of the other U.S. jobs would physically be located in the NSB but would be filled by long-distance commuters from other states. The percentage of workers in the Alaska oil and gas industry who are non-residents of the state rose from 30 percent in 2005 to 36 percent in 2015 (ADLWD, 2015f). However, non-resident workers would be housed in existing Liberty Development facilities away from local village communities in the area while they are working on the project. The physical separation of workers from established local communities makes it less likely that they would settle in communities of the NSB.

State of Alaska Population

Few workers are expected to permanently relocate to Alaska as a result of the Proposed Action. The estimated peak annual and long-term average jobs associated with the Proposed Action are small relative to the population base. Small population increases could occur but they would likely be in larger communities that already support oil- and gas-related activities (e.g., Anchorage) and would have little or no impact. Relative to the 2015 SOA population (737,200), the maximum population increase as a result of the Proposed Action would be less than 1 percent. Thus, the Proposed Action is likely to have little or no impact on the population base of the SOA, resulting in a negligible effect.

NSB Population

Few workers are expected to permanently relocate to the NSB as a result of the Proposed Action. Workers would be housed in existing Liberty Development facilities away from local village communities in the area. The physical separation of workers from established local communities makes it less likely that they would settle in communities of the NSB. Thus, the Proposed Action is likely to have little or no impact on the population base of the NSB, resulting in a negligible effect.

Monetized Impacts from GHG Emissions

Because BOEM estimated monetized impacts from changes in GHG emissions in the Draft EIS, it addresses those figures here and also provides an alternative method of monetizing GHG emissions. However, such monetization is of limited usefulness in the NEPA context and, as discussed further below, more appropriate in the rulemaking context, for which it was designed. Nonetheless, this subsection provides estimates of the monetary value of changes in GHG emissions that could result from selecting each alternative. In other words, this subsection assigns dollar values to the negative, climate change related impacts that would be caused by “Lifecycle GHG Emissions” identified in Table 4-7.

In the Draft EIS, values were estimated using the Social Cost of Carbon (SCC) protocol that BOEM considered when initially developing its analysis. The results of the Draft EIS analysis are provided for reference in Table 4-38, below.

Table 4-38 Previous Estimate – Social Cost of Carbon (in billions of dollars) at Various Discount Rates

Discount Rate	Proposed Action and Action Alternatives	No Action Alternative
5.0%	0.622	0.853
3.0%	2.548	3.513
2.5%	3.945	5.444
3.0% (95th percentile)	7.69	10.610

However, on March 28, 2017 the President issued Executive Order 13783, which disbanded the earlier Interagency Working Group (IWG) on Social Cost of Greenhouse Gases and withdrew the Technical Support Documents upon which the SCC protocol relied for the valuation of changes in GHG emissions. EO 13783 further directed agencies to ensure that any estimates of the value of GHG-related impacts provided in regulatory analyses "are based on the best available science and economics" and are consistent with the guidance contained in Office of Management and Budget (OMB) Circular A-4, "including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates." BOEM also received several public comments concerning the Draft EIS's estimate of the monetized costs of GHG emissions. These comments ranged from specific criticisms of the SCC protocol's methodologies to a more general statement that estimating costs from GHG emissions is unnecessary.

Having initiated estimates in the Draft EIS this Final EIS responds to public comments and provides new estimates of the monetary value associated with changes in GHG emissions associated with the Liberty DPP. Such analysis here should not be construed to mean a cost determination is necessary or, given current science and economics, appropriate in addressing potential impacts of GHGs associated with specific project alternatives. The estimates provided here follow prior estimates in the Draft EIS but use revised "interim" social cost estimates consistent with OMB Circular A-4. The OMB Circular A-4 methodology was subjected to peer review and public comment and has been widely accepted for more than a decade as embodying the best practices for conducting regulatory cost-benefit analysis. It utilizes a more appropriate range of discount rates: a 7 percent rate intended to represent the average before-tax return to private capital in the U.S. economy, and a 3 percent rate intended to reflect the rate at which society discounts future consumption. This method also focuses on monetizing domestic impacts of GHG emissions. Thus, while BOEM's NEPA analysis does address potential global impacts of GHG emissions, and quantifies emissions, this alternative method does not attempt to monetize effects outside of the United States. The results of this analysis are provided in Table 4-39, below.

Table 4-39 Revised Estimate – Domestic Costs of Marginal Changes in GHG Emissions (in millions of 2016 dollars) at Two Discount Rates

Discount Rate	Proposed Action and Action Alternatives	No Action Alternative
7.0%	36	49
3.0%	510	704

BOEM's efforts to monetize impacts from changes in GHG emissions are not to be misconstrued as part of a "cost-benefit analysis." Cost-benefit analyses are not required under NEPA (when, as here, the agency is not required to prepare one and is not preparing one for another purpose) and are not an appropriate means of assessing potential impacts in this Final EIS. The defining characteristic of a cost-benefit analysis is a direct comparison of all the costs and all the benefits of particular courses of action. To facilitate a meaningful comparison, the cost-benefit analysis must quantify and monetize all costs and all benefits of each proposed course of action. A comprehensive comparison of all costs and all benefits is not necessary in a NEPA document, the primary purpose of which is to analyze and compare the impacts of alternatives. Moreover, cost-benefit analyses do not capture qualitative considerations that may be important in weighing alternatives and identifying mitigation measures. The monetized value estimates in this subsection do not constitute part of any cost-benefit analysis and cannot be objectively compared on an “apples-to-apples” basis with other impacts described in the Final EIS.

4.4.2.1.5 Oil Spills

The NSB is a mixed cash-subsistence economy. This section discusses economic impacts from potential oil spills in terms of traditional measures of population, employment, income, and revenues. For analysis of potential impacts to subsistence-harvest patterns and sociocultural systems, please see Sections 4.4.3 and 4.4.1, respectively.

This discussion of employment, income, and revenues for OSR is based on the most relevant historical experience of a spill in Alaskan waters, the EVOS of 1989. That spill was 240,000 bbl. It generated substantial employment of up to 10,000 workers doing cleanup work in relatively remote locations. Smaller numbers of cleanup workers returned in the warmer months of each year following 1989 until 1992. The EVOS also had adverse effects on jobs and income associated with commercial and recreational fishing. During the EVOS, numerous local residents quit their jobs to work on the cleanup, often at significantly higher wages. This generated additional adverse effects in the form of sudden and significant inflation in the local economy (Cohen, 1993). Similar adverse effects on the NSB as a result of a large spill would be mitigated due to the likelihood that cleanup activities, including administrative personnel and spill cleanup workers, would likely be located in existing enclave-support facilities. This physical separation of workers from communities of permanent residents of the NSB would make it less likely that incoming non-resident cleanup workers would settle in the NSB, minimizing population impacts.

In the event of small or large oil spills, the number of workers employed for cleanup would depend on several factors. These include the procedures called for in the OSRP, how well prepared with equipment and training the entities responsible for cleanup are, how efficiently the cleanup is executed, and how well coordination of the cleanup is executed among numerous responsible entities.

Small Oil Spills

Small spills of crude or refined oil (i.e., less than 1,000 bbl) are accidental events that have occurred with general routine frequency and are assumed to occur from the Proposed Action during its lifetime. In general, small oil spills tend to be contained at the initial spill site. BOEM estimates that it would require less than 100 annual jobs to respond, clean up and contain the small spills that may occur over the life of the project and that no additional onshore infrastructure would be needed to support the cleanup efforts. Consequently, small oil spills would have little measurable impact on population, employment, income, and revenues and impacts to the U.S., SOA, and NSB economies would be considered negligible.

Large Oil Spills

A large oil spill between 1,000 and 5,100 barrels could generate several hundred direct and indirect jobs and thousands of dollars in personal income associated with OSR and cleanup in the short-term. As context, a spill size of 5,100 is approximately 2.1 percent of the EVOS spill size; taking 2.1 percent of the 10,000 workers who cleaned up the EVOS would translate to approximately 210 workers. A large spill is expected to have little adverse effects on employment and wages in other sectors of the SOA or NSB economies. The relatively small number of jobs and associated labor income associated with the cleanup efforts would likely have little to no effect on the SOA economy. The effects on the NSB economy would depend on the extent to which Borough residents are employed in the cleanup efforts, but are likely to be negligible to minor due to the temporary nature of the jobs.

Potential positive revenue impacts would include property tax revenues accruing to NSB from any additional onshore infrastructure built to house the influx of workers and to support cleanup efforts.

However, extra ships staged offshore would likely be the primary source of additional infrastructure used to support the response and cleanup efforts. Thus, a large spill is expected to have little to no impact on NSB revenues, resulting in a negligible effect on the NSB economy.

The associated SOA and NSB population effects are not likely to be measureable due to the temporary nature of the jobs, physical separation of worker housing, and low likelihood of workers permanently relocating to the NSB or the rest of Alaska.

The Proposed Solid Ice Condition (Section 2.5.1) would shift much of the risks associated with a large oil spill from summer months to winter months. A large spill which occurred during the solid ice conditions of winter would likely have fewer negative or positive impacts to the economy because a spill during solid ice conditions that does not disperse into open water would not result in as large or long-term of a clean-up operation. Restricting reservoir drilling to winter months would also extend the time period required to complete the overall drilling program, but the additional few months to couple of years of drilling activity are unlikely to contribute in a meaningful way to impacts to the economy.

4.4.2.2 Conclusion for the Proposed Action

Table 4-40 provides summary information on the various economic measures used to support the overall impact conclusion of the Proposed Action on the SOA and NSB economies.

Table 4-40 Summary of Effects by Economic Measure

Economic Measure	SOA Routine Activities	NSB Routine Activities	SOA Small Oil Spills	NSB Small Oil Spills	SOA Large Oil Spill	NSB Large Oil Spill
Employment / Wages	Negligible	Negligible to Minor	Negligible	Negligible	Negligible	Negligible to Minor
Revenue	Negligible	Moderate	Negligible	Negligible	Negligible	Negligible
Population	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

The Proposed Action is expected to have negligible beneficial effects on SOA employment, labor income, and revenues. The beneficial impacts on NSB employment and income are likely to range from negligible to minor, while the beneficial impacts on NSB revenues are expected to translate to moderate impacts on the NSB economy. The Proposed Action is likely to have little to no impact on the population base of the SOA or the NSB.

Overall, the Proposed Action is expected to have a negligible beneficial impact on the SOA economy and a negligible to moderate beneficial impact on the NSB economy.

As described in Chapter 3, global climate change could alter current conditions in the Proposed Action Area during the life of the Proposed Action. BOEM does not anticipate, in this relatively short timeframe, climate change would alter the impacts of the Proposed Action to the SOA and NSB economy.

4.4.2.3 Alternative 2 (No Action)

Under Alternative 2, the economic benefits including jobs, labor income, and revenues at the NSB and SOA levels would not occur. Any beneficial or adverse impacts from employment-related population changes and oil spills would also not occur.

4.4.2.4 Alternative 3 (Alternate LDPI Locations)

Section 2.2 and the summary in Table 2-9 describe the differences in the project aspects among alternatives. Although there may be small differences in employment needed to construct and decommission the project's various supporting infrastructure (ice roads, gravel mine, LDPI, pipeline, and processing facilities) under the different alternatives, the peak annual and longer-term average employment effects are likely to be comparable to those of the Proposed Action. Thus the associated labor income and population effects are also expected to be similar to those of the Proposed Action. Most of the revenue effects would also be similar to those of the Proposed Action, with the exception of the noted differences in property taxes collected on oil- and gas-related infrastructure.

Under Alternative 3, the proposed LDPI would be relocated (Section 2.2.4). Alternative 3A would relocate the proposed LDPI one mile to the east into deeper water, and Alternative 3B would relocate the proposed LDPI 1.5 miles to the southwest into slightly shallower waters managed by the SOA. Alternative 3B would result in an increase in property tax revenues to the SOA, a portion of which it would share with the NSB. BOEM estimates an annual average $6 million increment to the NSB (or less than a 2 percent increase) compared to the $340 million property tax revenue on the oil and gas infrastructure in the NSB in 2015. The increment to the SOA would be less than 1 percent.

4.4.2.5 Conclusion for Alternatives 3A and 3B

The effects of Alternative 3A and Alternative 3B on SOA and NSB employment, labor income, population, and revenues would be largely the same as those for the Proposed Action. The incremental increase in property tax revenues to the NSB and SOA and would be negligible and thus would result in the same impact conclusions as the Proposed Action (Table 4-40).

4.4.2.6 Alternative 4 (Alternate Processing Locations)

As stated above, Section 2.2 and the summary in Table 2-9 describe the differences in the project aspects among alternatives. Associated labor income and population effects are also expected to be similar to those of the Proposed Action. Most of the revenue effects would also be similar to those of the Proposed Action, with the exception of the noted differences in the property taxes collected on oil- and gas-related infrastructure.

Under Alternative 4, processing would be relocated to one of two alternate facilities (Section 2.2.5). Alternative 4A would relocate processing activities to an existing facility at Endicott located to the west of the Proposed Action Area. Alternative 4A would extend the useful life of the existing gas processing facility, and thus allow for continued property tax revenues over the life of the Proposed Action. Alternative 4B would relocate processing to a new onshore facility that would need to be built near the Badami pipeline tie-in point. Both Alternatives 4A and 4B would increase property tax revenues for the SOA and the NSB.

4.4.2.7 Conclusion for Alternatives 4A and 4B

The effects of Alternative 4A and Alternative 4B on SOA and NSB employment, labor income, population, and revenues would be largely the same as those for the Proposed Action. While there would be increased property tax revenues to the SOA and the NSB as a result of relocating the processing facilities, the incremental increase in annual revenues would be relatively small and thus would result in the same impact conclusions as the Proposed Action (Table 4-40).

4.4.2.8 Alternative 5 (Alternate Gravel Sources)

Section 2.2 and the summary in Table 2-9 describe the differences in the project aspects among alternatives. Alternative 5 would not result in additional property tax revenues over the Proposed Action. Effects of Alternative 5 on all aspects of local and state economies would be the same as those for the Proposed Action.

4.4.2.9 Conclusion for Alternatives 5A and 5B

Impacts from Alternatives 5A and 5B on the SOA and NSB economy would essentially be the same as the impacts described for the Proposed Action (Table 4-40).

4.4.3 Subsistence Activities and Harvest Patterns

4.4.3.1 The Proposed Action

This section reports the impacts analysis for the Proposed Action on subsistence activities and harvest patterns for Nuiqsut, Kaktovik, and Utqiaġvik. As described in Chapter 3, subsistence ways of life and harvest practices are fundamental to Alaska Native communities in the North Slope Borough (NSB) and provide important food resources and the foundation of community values and cultural identities. For impacts to subsistence activities and harvest patterns, BOEM considered the fundamental importance of subsistence to Iñupiaq cultural, individual and community health, and well-being. Due to these unique characteristics of subsistence practices, impacts to subsistence activities and harvest patterns are considered severe and thus major if they would disrupt subsistence activities, make subsistence resources unavailable or undesirable for use, or only available in greatly reduced numbers for a substantial portion of a subsistence season or more.

Nuiqsut is approximately 80 miles west of the proposed LDPI, and Kaktovik is approximately 94 miles east of the proposed LDPI. Utqiaġvik is located approximately 220 miles west of the proposed LDPI. The Proposed Action Area overlaps with lands and waters traditionally and contemporarily used for subsistence harvests by residents of Nuiqsut and Kaktovik (Figure 3-32; Galginaitis, 2014a, 2014b; 2016; NSB, 2014; Pedersen, 1979, 1990; SRB&A, 2010). The Proposed Action Area is shown in Figure 2-1. Figure 3-1 shows a wider area surrounding the Proposed Action Area. Both are important for subsistence activities practiced by residents of Nuiqsut and, to a lesser extent, Kaktovik.

The primary subsistence activity that could be affected by the Proposed Action is bowhead whaling conducted by crews from Nuiqsut near Cross Island (Galginaitis, 2014b; Hilcorp, 2015, Appendix A). Cross Island is located approximately 18 miles northwest of the proposed LDPI. Most other contemporary subsistence harvests in the Proposed Action Area are incidental to coastal travel for other purposes and opportunistic. The Proposed Action Area has historically been used by Iñupiat harvesters from Nuiqsut and Kaktovik (Pedersen, 1979). The Proposed Action Area could become a more regularly used and important harvest area at times during the 25-year life of the Proposed Action. Local people could foreseeably travel to the Proposed Action Area to intentionally look for seals, caribou, fish, or migratory waterfowl (if and when these become unavailable) at more highly preferred harvest areas closer to Nuiqsut and Kaktovik.

NPDES-permitted discharges are anticipated to have no impact on subsistence activities or harvest patterns under the Proposed Action and alternatives.

As described in Chapter 3, global climate change could alter current conditions in the Proposed Action Area during the 25-year life of the Proposed Action. BOEM does not anticipate, in this relatively short timeframe, that climate change would alter the impacts of the Proposed Action to subsistence harvest patterns as described in Chapter 4.

A primary source of information for this section is Galginaitis (2014b) adopted from the 2015 Liberty EIA (Hilcorp, 2015, Appendix A). Further discussions are found in OCS EIS/EA MMS 2002-019, Final Environmental Impact Statement for Liberty Development and Production Plan (USDOI, MMS, 2002); Final Environmental Impact Statement for Beaufort Sea Oil and Gas Development/Northstar Project (USACE, 1999); OCS Study MMS 2009-003 (SRB&A, 2010); OCS Study BOEM 2013-212 (SRB&A, 2013); and OCS Study BOEM 2013-218 (Galginaitis, 2014a, 2016).

In accordance with lease stipulations pertaining to the protection of subsistence activities, HAK has consulted with potentially affected subsistence communities, the NSB, and the AWEC during development of the Proposed Action to discuss potential conflicts between operations and subsistence activities and harvest patterns, and to identify measures to prevent unreasonable conflicts. Similar coordination is required in order for HAK to obtain an Incidental Take Authorization under the MMPA. A list of measures that HAK would implement in order to reduce potential impacts on subsistence is provided in Appendix C (Section C-3). Implementation of these measures (e.g., establishment of preferred vessel routes and minimum flight altitudes) is assumed in the following effects analysis. It is acknowledged that HAK has committed to taking part in the Conflict Avoidance Agreement (CAA) with the AEWC. HAK has committed to abide by the CAA each year that marine operations are conducted in support of the Proposed Action. Past CAAs have included various measures (e.g., minimum flight altitudes, vessel routing, other seasonal restrictions) designed to manage interactions between subsistence activities and offshore oil and gas activities. It is possible that measures incorporated into future CAAs would serve to reduce potential impacts from the Proposed Action. However, since the CAA is renegotiated every year, it is not possible to know what specific provisions would be contained in each CAA going forward. This section, therefore, analyzes potential effects from the Proposed Action as it is described in the DPP and does not assume the implementation of any additional mitigation measures that may or may not be included in future CAAs.

4.4.3.1.1 Overlap of the Proposed Action and Subsistence Activities

BOEM examined temporal and spatial overlap between specific subsistence hunting and fishing activities and the Proposed Action (Table 4-41). Temporal overlap (i.e., time) indicates that the timing of proposed actions overlaps with peak subsistence seasons; spatial overlap (i.e., area) indicates that a subsistence area(s) currently overlaps with the Proposed Action Area or has overlapped with the Proposed Action Area in the past.

The Proposed Action is comprised of several sub-activities scheduled to occur at set times and durations (Figure 2-1). BOEM found some temporal overlap between specific components of the Proposed Action and specific subsistence activities for Nuiqsut, Kaktovik, and Utqiaġvik (Table 4-41). BOEM also found potential spatial overlap between specific components of the Proposed Action and specific subsistence activities for Nuiqsut and Kaktovik (Table 4-42).

Table 4-41 Primary Subsistence Hunting and Fishing Activities for Nuiqsut, Kaktovik, and Utqiaġvik

Community	Bowhead Whales	Seals	Caribou	Fish	Waterfowl	Overlap with Proposed Action[1]
Nuiqsut	Late August-Sept.; launched from Cross Island 100 miles east of community; all strikes in an area along the coast extending from Northstar unit in the west to Bullen Point in the east, 30-50 miles off the coast	June- Sept. along coast and up to 40 miles offshore between Harrison Bay and Flaxman Island; most hunts near Thetis Island	June-Sept. on the coast and barrier islands by boat between Atigaru Point and Oliktok Point and Colville River Delta; Oct.-Feb. with snowmachines	Arctic cisco: Sept.-Dec. in Colville River Delta; Arctic char: August-Sept. in the Colville River; Broad whitefish: June-August and Oct. in Colville River Delta and Fish Creek	Geese: April-June in Fish Creek and Colville River Delta; Eiders: May-Sept. up to 10 miles offshore of Colville River Delta and east to Thetis and Cross Islands	Some temporal overlap with Proposed Action; could be some spatial overlap between summer construction activities at proposed LDPI and whale scouting, seal hunting, and eider hunting
Kaktovik	Late August-Sept. up to 50 miles off the coast in an area between Camden Bay in the west and Nuvagapak Lagoon in the east	June-Sept. along the coast and up to 30 miles offshore; between Canning River and Pokok Lagoon	June-Sept. on the coast and barrier islands by boat between Bullen Point (sometimes to Foggy Island) and Canada; Nov.-April with snowmachines	Arctic cisco: July-August in coastal areas; Arctic char: July-August in inland rivers and coastal areas; Broad whitefish: July-August in coastal areas and river mouths	Geese: May-Sept. in coastal areas and inland rivers; Eiders: May-Sept. in coastal areas and inland rivers	Some temporal overlap with Proposed Action; could be spatial overlap between winter construction activities and caribou hunting and summer construction at proposed LDPI and caribou, seal, and waterfowl hunting

Community	Bowhead Whales	Seals	Caribou	Fish	Waterfowl	Overlap with Proposed Action[1]
Utqiaġvik	Two hunts: April-May from the ice west of Point Barrow and close to shore and September-October, 20 or more miles off the coast between Skull Cliff in the west and Smith Bay in the east	June-August, some seals taken year round; along coast and over 20 miles offshore between Skull Cliff and Point Barrow	July-September by boat along the coast and inland rivers between Icy Cape and Prudhoe bay	Arctic cisco: July-November near town or by trip to Nuiqsut; Arctic char: July-August in Kugrua River; Broad whitefish: July-October south of town in rivers feeding Dease Inlet	Geese; May-June south of town in rivers feeding Dease Inlet and offshore; Eiders; May-August offshore north and west of town	Some temporal overlap with summer island construction activities and gravel mine reclamation; no spatial overlap with Proposed Action

Note: [1] Temporal means the timing of proposed actions overlaps with subsistence seasons; spatial means the Proposed Action Area overlaps with current or historic subsistence hunting and fishing areas.

Table 4-42 Proposed Action Temporal and Spatial Overlap with Primary Subsistence Activities

Proposed Action	Timing	Duration	Location[1]	Overlap with subsistence[2]
Ice road construction and maintenance	December-April	20 months; 4 construction seasons; years 1-5	2 onshore; 3 offshore[3]	Temporal with winter caribou hunting (N and K); could be spatial with winter caribou hunting (K)
Gravel mine site development, mining, and hauling	January-April	4 months; year 1	0.5 mile south of Foggy Island Bay; west of Kadleroshilik River; between mine and LDPI	Temporal with winter caribou hunting (N and K); could be spatial with winter caribou hunting (K)
Gravel mine reclamation	May-September	5 months; year 1	0.5 mile south of Foggy Island Bay; west of Kadleroshilik River	Temporal with summer caribou hunting, fishing, and waterfowl hunting (N, K, Utqiaġvik); could be spatial with summer caribou hunting and waterfowl hunting (K)
LDPI slope protection (grading, sheet pile driving, and armament installation)	May-August	4 months; year 2	LDPI	Could be temporal with Cross Island bowhead scouting (N); could be spatial with scouting for whales (N); temporal with summer caribou hunting and fishing (N, K, and Utqiaġvik); temporal with seal hunting (N, K, and Utqiaġvik); could be spatial with seal hunting (N and K); temporal with waterfowl hunting (N, K, and Utqiaġvik); could be spatial with eider hunting (N); could be spatial with eider and geese hunting (K)
Onshore and offshore pipeline construction and installation	January-May	5 months; year 3	Between Badami pipeline tie-in and LDPI	Temporal with winter caribou hunting (N and K); could be spatial with winter caribou hunting (K)
Facilities construction	October-April	19 months; years 2-4	LDPI	Temporal with winter caribou hunting and fishing (N and K)
Hovercraft hangar, boat dock, fuel tank construction	February-April	3 months; year 2	SDI	Temporal with winter caribou hunting (N and K)
Drilling	Year round	27 months; years 3-5	LDPI	Temporal with all subsistence activities
Production	Year round	years 4-20	LDPI	Temporal with all subsistence activities
Decommissioning	October-May	18 months over 2 winter seasons	LDPI and onshore pipeline	Temporal with all winter subsistence activities; could be spatial with winter caribou hunting (K) for onshore pipeline

Notes: [1] LDPI = Liberty Drilling and Production Island site SDI = Satellite Drilling Island at Endicott;
[2] N = Nuiqsut K = Kaktovik
[3] Two onshore ice roads and three offshore ice roads.

BOEM analyzed potential effects to specific subsistence activities in cases where those activities were found to have potential for both temporal and spatial overlap with the Proposed Action and its component activities. Subsistence activities that may overlap in both time and space with the

Proposed Action include 1) bowhead whaling for Nuiqsut, 2) seal hunting for Nuiqsut and Kaktovik, 3) winter and summer caribou hunting for Kaktovik, and 4) waterfowl hunting for Nuiqsut (i.e., eiders) and Kaktovik (i.e., eiders and geese).

BOEM found no spatial overlap between the Proposed Action and areas used by residents of Utqiaġvik for subsistence harvests. Utqiaġvik is included in this analysis because there is concern about potential contamination of and disruptions to subsistence species that travel or migrate through or near the Proposed Action Area, including bowhead whales harvested in fall near Utqiaġvik and Kaktovik and Arctic cisco harvested in the Colville River Delta. Moreover, crude and refined oil spills could potentially occur during the 25-year life of operations and could adversely affect subsistence activities and harvest patterns outside the immediate Proposed Action Area.

4.4.3.1.2 Effects on Subsistence Harvests

Bowhead Whaling Practices

The Proposed Action Area is near the fall migratory route of bowhead whales (Clarke et al., 2015a; Quakenbush et al., 2010). Bowhead whales are a highly important animal and subsistence resource for residents of Nuiqsut, Kaktovik, and Utqiaġvik (Section 3.3.3; Galginaitis, 2014a; SRB&A, 2010; USDOI, MMS, 2002). This section focuses on whaling by crews from Nuiqsut. The potential impacts described herein exist independent of potential negligible biological impacts to bowhead whales described in Section 4.3.4.3.1. Whales provide themselves to hunters when specific rules and conditions are met (some of which exist in a spiritual realm, a critical component of subsistence whaling); there is potential for certain aspects of the Proposed Action (e.g., physical presence, noise, small spills) to alter the rules and conditions that control successful subsistence whaling as practiced by Nuiqsut whalers. Potential effects to subsistence whaling practices and harvest patterns and potential effects to the community of Nuiqsut supported by these whalers (and their sharing networks) are largely independent of potential negligible biological impacts to the bowhead population and its migration route. The bowhead population/migratory range and subsistence whaling by Nuiqsut exist at substantially different spatial and temporal scales in relation to the physical, acoustical, and biological footprint of the Proposed Action. Moreover, the social, cultural, psychological, and symbolic contexts of Cross Island whaling exist independently from potential negligible biological impacts to bowhead whales.

The Nuiqsut subsistence bowhead hunt is launched from a base camp about 100 miles away from the village on Cross Island. The Proposed Action Area is located 18 statute miles to the southeast of Cross Island (Galginaitis, 2014b). BOEM focused this analysis on potential effects of the Proposed Action on Nuiqsut’s bowhead whale hunt because it overlaps with the Proposed Action in time and could overlap with the Proposed Action in space, particularly if construction activities occur at the proposed LDPI during summer and early fall (i.e., August-September). If bowhead whales were to increase their use of areas coastward closer to the proposed LDPI during the 25-year life of operations, Nuiqsut’s whaling practices could potentially overlap more closely in space with the Proposed Action.

Whaling conducted by crews from Kaktovik and Utqiaġvik does not spatially overlap with the Proposed Action Area. With the exception of a large oil spill, effects on bowhead whaling practices for Kaktovik and Utqiaġvik are expected to be negligible during the development and production life of the Proposed Action. Communities in the NSB that have sharing relationships with Nuiqsut could experience adverse sociocultural and health effects if the overall success rate of the Cross Island bowhead whale hunt was adversely affected to the degree that Nuiqsut was not able to share bowhead whale with them for one or more seasons.

Historically, the Nuiqsut bowhead hunt occurred around the start of September through mid-October. Whaling seasons in 2001 through 2013 have begun in late August and lasted through mid-September.

In 2015, the Cross Island whaling season extended over 19 days from August 25 through September 12 (Galginaitis, 2016). In 2016, Nuiqsut whalers landed their entire quota between August 25 and August 27 (Suydam, 2016). Nuiqsut crews go whaling immediately north of the Proposed Action Area, and in some years have scouted for whales directly in the Proposed Action Area (Galginaitis, 2014a, 2014b). All of Nuiqsut's documented whale strikes have been within an area extending from about the Northstar unit in the west to Bullen Point, in the east near Cross Island, and 30to 50 miles off the coast (Figure 3-35; Galginaitis, 2009, 2014a, 2014b, 2016; SRB&A, 2010).

Construction and support activities conducted during the open-water season; regular drilling, production, and processing operations; and oil spills could contribute to potential adverse effects on whaling conducted by crews from Nuiqsut (Galginaitis, 2014b). Effects on Cross Island whaling practices would most likely only occur in August through September during the open-water season. Thus, winter activities other than oil spills such as gravel mining, proposed LDPI construction, and ice road construction and maintenance are expected to have negligible impacts on subsistence whaling.

The Proposed Action could cause adverse effects to subsistence whaling activities launched from Cross Island, including 1) deflection of whale movements farther offshore, 2) interference from support vessels, 3) avoidance of the Proposed Action Area by Nuiqsut whalers due to the presence of the proposed LDPI and production facilities and potentially contaminated resources, 4) whaling conflicts with summer construction activities such as sheet pile driving (i.e., LDPI slope protection), and 5) oil spills (Galginaitis, 2014b).

Deflection of Bowhead Whales

Iñupiat people on the North Slope are concerned about the potential of offshore oil and gas activities to interfere with subsistence whaling practices (Galginaitis, 2014a, 2014b, 2016; ICAS, 2012; NOAA, 2013; SRB&A, 2009, 2013). Noise in the marine environment has been observed to lower whaling success (Long, 1996). Local concerns include deflection of migrating whales due to noise from seismic exploration, construction of offshore structures, drilling, pipeline monitoring, support vessel and aircraft traffic, and other industrial activities (Burns and Bennett, 1987; EDAW AECOM, 2008; Huntington, 2013; Lefevre, 2013; NRC, 2003, p. 102; NOAA, 2013, p. 4-199; Nukapigak, 2011; SRB&A, 2009; USACE, 1999). Other local concerns are related to potential discharge of wastes, changes in ocean currents, and sedimentation due to artificial island construction. In its comments regarding BOEM's 2012-2017 OCS oil and gas program, the Iñupiat Community of the Arctic Slope (ICAS) (2012) wrote:

> "We are also gravely concerned about a host of other impacts associated with offshore drilling. In the past, our whaling captains have experienced firsthand how underwater noises associated with drilling… have interfered with the bowhead whale hunt at Cross Island. When whales are deflected from their normal migration route, our whaling captains are forced to travel great distances in dangerous conditions to obtain the food that feeds our people. Our traditional knowledge tells us that bowhead whales are very sensitive to underwater noise…"

Cross Island whalers report that areas near barrier islands, both seaward and coastward, can be important for migrating whales (Huntington, 2013). The area south of Narwhal Island is important for the migration of smaller whales; the whalers have observed that smaller whales avoid the deeper water north of Cross Island (Galginaitis, 2014b). Nuiqsut whalers, as a group, prefer to target smaller rather than larger whales when they are available, but some whaling captains have a reputation for taking larger whales (Galginaitis, 2014c). Subsistence whaling activities and harvest patterns could be adversely affected by noise in the marine environment associated with routine activities of the Proposed Action.

Based on their observations, Nuiqsut whalers believe noise and other disturbances from the Proposed Action over the 25-year life of the operation would deflect some whales seaward, which could increase the distance whalers need to travel to find and strike whales. Anticipation of greater travel distances on the part of the whalers could cause long-lasting and widespread stress. Increased travel results in increased fuel expenses and increased risk to human safety and greater potential for meat spoilage (USACE, 1999). Nuiqsut whalers do not prefer to look for whales greater than 20 miles from Cross Island because striking whales farther than that away from camp can cause harvested whales to spoil during long tows back to camp. Based on their observations, Nuiqsut whalers expect that deflected whales would be disturbed, harried, exhibit more wary or skittish behavior, and thus become more difficult to approach for a strike (Galginaitis, 2014b; Huntington, 2013). Cross Island whalers did not observe or report skittishness in bowheads during the 2015 season (Galginaitis, 2016).

Nuiqsut whalers report that the presence of the proposed LDPI may change sea current patterns (Galginaitis, 2014b). Since migrating bowhead whales commonly follow currents, the presence of the proposed LDPI is a concern for whalers that could cause long lasting and widespread stress for whaling crews and residents of Nuiqsut. This is because the proposed LDPI would most likely be viewed as a physical source of disturbance to ocean currents, which also is believed to alter movement patterns of bowhead whales.

If bowhead whale movement patterns in the fall are diverted farther out to sea due to the Proposed Action, Cross Island whalers would experience adverse, long lasting and widespread impacts. These impacts could result in more dangerous and costly scouting trips and lower than normal success in landing whales during the Cross Island hunt. Impacts of having to scout farther out to sea for skittish whales could be long lasting and widespread and thus moderate. These impacts would most likely affect all whaling crews from Nuiqsut during the 25-year life of the Proposed Action. This finding is specific to the behaviors of whaling crews engaged in subsistence harvest of bowhead whales; it is independent of the biological finding of negligible effects from noise to bowhead whales produced by the Proposed Action (Section 4.3.4.1).

Support Vessel Traffic

Subsistence whalers using Cross Island as a base camp have a great sensitivity to vessel and aircraft traffic and associated noises as disruptive factors to their hunt because of recent personal experience (Galginaitis, 2014b; NOAA, 2013, p. 4-199; NOAA, 2016, p. 4-212 and 4-213). The Cross Island whaling season is relatively short, taking place within a window of about 4 weeks when the whales are present, temperatures are cool, and weather and other conditions are most likely to be favorable for scouting for whales. The Cross Island whalers prefer a season length of 2 to 3 weeks (Galginaitis, 2014a). The number of scouting days available to look for whales is limited, especially if there are some days when weather or ice conditions prevent the whalers from looking for whales, which has been the case for most recent seasons since 2001 (Galginaitis, 2014a, 2016). Scouting is a term used by whalers that means being on the water looking for whales to strike and may be used interchangeably with whale hunting or whaling in this section.

Three or four whales generally provide enough for the needs of Nuiqsut and those communities with which they share. Their target is about 120 feet of whale, roughly 4 whales of 30 feet each; Nuiqsut whaling captains typically say that a 30- to 35-foot whale (or two 25-footers) meets the requirements for a Nalukataq celebration in June (Galginaitis, 2016, p. 24). For the period 2001 to 2013, Cross Island whalers were able to meet their needs for bowhead harvest in all but the 2005 and 2009 seasons. Nuiqsut only harvested one whale in 2005 and two whales in 2009 (Galginaitis, 2016, p.11). While interference from commercial vessel traffic (unrelated to the petroleum industry) was only one factor in their lack of success, at the time it was the most prominent factor from the whalers' perspective regarding their lower success (Galginaitis, 2014b). Adverse ice conditions in 2005, poor visibility and weather conditions for whaling in 2005 and 2009, and mechanical problems in both years were other factors leading to lower than normal success (Galginaitis 2014a).

In the 2015 season, the Cross Island whalers did not use their full quota. Galginaitis (2016) reported that the whalers did not attribute their inability to fill their quota to interference from commercial vessel traffic or the skittishness of the whales. They did report that whales were swimming faster than expected. The whalers explained their inability to fill their quota in 2015 as a factor of poor weather conditions; difficult hunting due to ice in the water combined with fog on several days and rough seas in open water; and relatively large travel distances from Cross Island to located whales.

Interference from industrial and commercial vessel traffic such as barges in their whaling area is currently one of their primary concerns regarding the success of whaling from Cross Island (Galginaitis, 2016). Whaling crews may be impacted when they encounter unexpected boats or aircraft in the Cross Island area while on the water looking for whales. Bowhead whales may react to approaching vessels by interrupting their normal behaviors and rapidly swimming away from vessels (Richardson, 1996, p. 107). During the open-water season, Hilcorp proposes to use barges, hovercraft, and tug boats to transport equipment, personnel, and supplies to the proposed LDPI; barge traffic related to the Proposed Action is expected to be most frequent during Execute Year 2 to support proposed LDPI construction (Hilcorp, 2015, pp. 35, 129). Physical interference with whaling operations and altered behaviors of whales from industrial vessel traffic could occur. The opportunity to strike a whale may be relatively infrequent during a given season, and from the whalers' perspective, anything that may interfere with a possible strike opportunity should be avoided at all costs (Galginaitis, 2014b). Disturbance from vessel traffic to whaling could be long-lasting and widespread, and thus moderate. BOEM anticipates no impacts to whaling practices or any other subsistence activities and harvest patterns from discharges from support vessels under the Proposed Action or alternatives.

Whaler Avoidance

Whalers and other subsistence hunters often report that they avoid areas of industrial development while they are hunting (Galginaitis, 2014b, 2016). If Liberty is developed, the Cross Island whalers may avoid the Proposed Action Area due to the presence of the proposed LDPI. They most likely would not approach the immediate vicinity of the LDPI, remaining 2 to 3 miles away. Avoidance behavior on the part of Nuiqsut whalers has been documented for the Northstar development, but it is unclear to what extent their avoidance of Northstar has affected whaling success for hunts now launched from Cross Island. Nuiqsut whalers landed a whale in the Northstar area in 1997 before it was developed. During the fall migration, bowhead whales approached Cross Island from the east, and Northstar is located to the west of Cross Island. Nuiqsut whalers tend to head northeast or east, and less frequently north and northwest from Cross Island when looking for whales. They normally encounter bowhead whales before the whales pass the Northstar unit. On those few occasions when whaling boats do approach Northstar, they turn away from it at a distance of 2 to 3 miles (Galginaitis, 2014b). It is reasonable to assume they would behave similarly if the LDPI were present.

Cross Island whalers currently have a strong preference to scout for whales northeast of Cross Island (Galginaitis, 2014b). When adverse ice conditions in 2005 and 2006 prevented them from looking for whales to the northeast of Cross Island, the whalers still avoided approaching closer than 2 to 3 miles from Northstar. In seasons where ice is not a problem, whalers do not approach closer than about 6 miles from Northstar when scouting. The whalers have said they moved their whaling operations farther east to Cross Island to avoid disturbances from exploration work at Northstar and other oil and gas exploration and development activities occurring west of Cross Island (Galginaitis, 2014b). Until 1986, Cross Island was only one of several possible locations for Nuiqsut whalers, although it was probably the most promising site (Galginaitis, 2014c). Pingok Island had been a whaling site in the past as well as other barrier islands and shore-based camps west of Northstar (Galginaitis, 2014c).

Since development of Northstar, Nuiqsut whalers report that they rarely scout for whales in that area (Galginaitis, 2016, p. 28). It is probable that Nuiqsut whalers have largely been displaced from whaling in the Northstar area due to the presence of industrial development.

Cross Island whalers could avoid approaching the proposed LDPI as they now avoid the Northstar development. The immediate LDPI area would most likely be permanently avoided by whalers despite any seasonal restrictions and mitigation measures because people will not practice the most important of subsistence activities in an industrialized oil production area (Kuukpik, 2017, p. 12). In all whaling seasons documented since 2001, avoiding the immediate LDPI area probably would have had a negligible adverse effect on the harvest success of those hunts (Galginaitis, 2014b). The Proposed Action Area was only part of the whale search area during 2005 and 2006, and no whales were struck or landed near the proposed LDPI. Whales were seen and heard in or near the Proposed Action Area during those two seasons but could not be approached close enough to make a strike. In 2005 and 2006, access to open water outside the barrier islands was restricted by ice and weather. In 2005, this was the case for the entire season except one day and for the first half of the 2006 season (Galginaitis, 2016, p. 11). In 2005, Nuiqsut only used one strike and landed one whale. In 2006, they filled the full quota of four whales; all four whales were landed seaward of the barrier islands once conditions in open water had improved.

Nuiqsut whalers could stop scouting for whales near the proposed LDPI. However, in seasons with adverse weather or ice conditions that prevent scouting northeast and east of Cross Island, the whalers may be required to look for whales coastward in or near the Proposed Action Area. The proposed LDPI is about 8.5 miles south of Narwhal Island (Galginaitis, 2014b). Cross Island whalers rarely scout for whales south of Narwhal Island. However, they have travelled through the Proposed Action Area while scouting for whales in the past, and in both 2005 and 2006 whaling took place south of Narwhal Island and north of the proposed LDPI on several days and represented a substantial portion of the whaling effort for those seasons. No whales were struck in this area, but several whale sightings were reported. If Cross Island whalers were displaced from scouting in the Proposed Action Area (i.e., near the proposed LDPI and between it and Narwhal Island) due to avoidance or other reasons related to the presence of the proposed LDPI such as support vessel traffic, impacts to subsistence whaling for the community of Nuiqsut could be severe and thus major. These impacts would most likely only occur during whaling seasons in which whalers needed to scout for whales in the Proposed Action Area south of Narwhal Island. For example, during adverse ice and weather conditions, the Proposed Action Area may become critically important to Cross Island whalers for scouting (Galginaitis, 2014c, 2016). To adapt to variable conditions and be able to locate and access whales, the whaling crews from Nuiqsut have a vital need for an expanded search area beyond where they usually expect to find whales (Galginaitis, 2016, p. 24). This expanded search area would most likely include the Proposed Action Area for certain whaling seasons during the 25-year life of the Proposed Action. If their limit of approach to the LDPI were 2 to 3 miles as assumed, the Nuiqsut whalers would have about 5 miles between Narwhal Island and their limit of approach in which to scout.

The relationship between whaler avoidance of developed areas and interference from vessel traffic can be complicated by ice and weather conditions. The adverse ice and weather conditions that restricted the whalers' boating activities also affected commercial vessel traffic. In both 2005 and 2006, the whalers reported interference to their hunts by vessels transiting the area (Galginaitis, 2014b). Whaling and non-whaling vessels can become crowded inside the barrier islands during times of adverse ice and weather conditions. In years with conditions that prevent whalers and other vessels access to open water beyond the barrier islands, the Nuiqsut whalers could be limited to scouting coastward of the barrier islands closer to the proposed LDPI and in the Proposed Action Area. At times during the 25-year life of the Proposed Action, the area inside the barrier islands may be the only area where whales are available to Nuiqsut whalers. If they were deterred from using it by the presence of the proposed LDPI and non-whaling vessels, their opportunities to strike whales could be severely reduced for one or more seasons depending on ice and weather conditions, resulting in major impacts to subsistence whaling for Nuiqsut. Whalers would be stressed and frustrated due to a decrease in the quality of the hunt because of closer proximity to the Proposed Action. The avoidance effect is expected to be limited to the Nuiqsut bowhead hunt and is not expected to directly affect whaling for Kaktovik and Utqiaġvik.

Whalers may also choose to avoid the Proposed Action Area due to potentially contaminated subsistence resources because of oil spills, waste discharges, or other observed reasons related to the Proposed Action (Galginaitis, 2014b). Subsistence harvesters are highly sensitive to animals that exhibit lesions or other imperfections, and avoid taking animals they think may be contaminated or sick (Galginaitis, 2014b; USDOI, MMS, 2002). For several years after the EVOS, subsistence harvesters reduced their harvest effort of subsistence resources, and frequently testified about avoiding tainted resources at public hearings (Fall, 1991; Fall and Field, 1996; NOAA, 2013). Memories of times when people avoided harvesting marine resources due to potential contamination tend to linger in the minds of subsistence harvesters and could last for the lifetime of the Proposed Action. This could result in long-lasting, widespread, and severe levels of stress and uncertainty over food safety and security throughout the communities of Nuiqsut and Kaktovik as was seen in communities affected by the EVOS and *Selendang Ayu* spill (Gill et al., 2011; Impact Assessment, Inc., 2011). Due to potential contamination of whales, whalers might avoid the Proposed Action Area. Whaler avoidance could reduce or eliminate scouting for one or more seasons during the life of the Proposed Action. If this were the case, adverse impacts to subsistence whaling for Nuiqsut would be severe and thus major.

LDPI Slope Protection

The Cross Island whalers would most likely prefer to avoid the immediate Proposed Action Area during construction and operations. The whalers would also prefer no construction activities and support vessel and aircraft traffic occur during the whaling season. Slope protection work is proposed as a part of construction of the proposed LDPI. This includes cutting a moat in the sea ice around the proposed LDPI, grading the LDPI with a crane and drag line, installing sheet piling, and installing concrete armament around the perimeter of the LDPI (Hilcorp, 2015). The slope protection activities are scheduled for 4 months during Execute Year 2 beginning in May and extending through August (Table 4-1; Hilcorp, 2015, p.16). Whale scouting by Nuiqsut crews now occurs in late August and early September and would be most at risk from impacts caused by slope protection work in summer, especially sheet pile driving.

Noise and disturbances from pile driving are expected to adversely affect whaling crews and whaling practices to a greater extent than whales. The assumed functional hearing range of bowhead whales includes the frequencies and decibel levels of sounds produced by pile driving (Table 4-16 and Table 4-17). It is possible that a few bowhead whales leaving early on their westward fall migration could be impacted by noise from pile driving; the fall migration occurs closer to shore than does the spring migration, especially in years of low sea ice (Section 3.2.4.1). Bowhead whales generally do not migrate inside of the barrier islands; however, individuals have been occasionally observed shoreward of the islands and at lagoon entrances (Section 3.2.4.1), and whalers sometimes scout for whales inside the barrier islands. Sound from proposed LDPI summer construction activities would be unlikely to affect most whales in lagoon entrances or inside the barrier islands due to shallow water. However, noise from sheet pile driving could cause whalers to avoid scouting inside the barrier islands.

The whaling season for Nuiqsut would most likely start mid to late August. Noises and disturbances from slope protection work and support vessel traffic and helicopter overflights could cause severe and thus major impacts to subsistence whaling in the Cross Island area, especially if slope protection work at the proposed LDPI extends into August. Based on observations and experiences, the whalers predict deflection of bowhead whales further offshore because of noise and disturbance from summer construction activities and vessel traffic at the proposed LDPI. See Section 4.3.4.1 for a discussion of potential biological impacts to bowhead whales. Subsistence whalers could completely avoid the Proposed Action Area due to summer construction activities, thereby potentially reducing whaling opportunities during construction years. See section above on Whaler Avoidance for more information about conditions that can limit spatial opportunities for whale scouting.

Oil Spills and Spill Response

Although accidental and unlikely events, residents of Nuiqsut, Kaktovik, and Utqiaġvik have expressed substantial concerns over large oil spills in the Beaufort Sea, especially effects to subsistence resources and industry's inability to clean up spilled oil in ice covered offshore waters (Goodyear and Clusen, 2012; SRB&A, 2009; USDOI, MMS, 2002, p. III-72).

The size of an oil spill is a key variable in determining potential impacts. BOEM uses three categories of spills, including small, large, and VLOS. Small spills of crude or refined oil (i.e., less than 1,000 bbl) are accidental events that have occurred with general routine frequency and are assumed to occur from the Proposed Action during its lifetime. Although an unlikely event, one large spill of crude or refined oil (i.e., greater than or equal to 1,000 bbl) is assumed to occur during the development and production phase of the Proposed Action. The potential effects of small and large oil spills on subsistence whaling are examined in this section. Potential effects of a VLOS on subsistence harvest patterns are examined in Appendix A, (posted at www.boem.gov/liberty) Section A-7.

BOEM assumes about 70 small spills could occur during the lifetime of the Proposed Action, at any time of the year (an average of 2-3 small spills per year). Bowhead whales have been reported in the Proposed Action Area by Cross Island whalers in August and September (Galginaitis, 2007, 2008). Small spills are unlikely to affect individual bowhead whales, because small spills cover a small area and are less likely to persist in the environment (NOAA, 2016, p. 4-128; USDOI, MMS, 2002). Small spills would most likely not reach the main bowhead whale migration route due to rapid dispersal and evaporation within hours to a few days. BOEM expects the number of bowhead whales potentially affected by small spills as a result of the Proposed Action to be negligible. If contact between oil and whales is made, the ensuing effects would most likely be nonlethal, although mortalities among individual whales would be possible depending upon the spill size, severity, weathering processes, and the duration of exposure. However, because of the low number of whales in the area where small spills may occur and dissipate, it is unlikely mortality would occur (Section 4.3.4.2).

Small spills occurring in the open-water season during August through September would have the greatest potential to affect migrating bowhead whales and subsistence whaling for Nuiqsut and Kaktovik. If small spills contacted the shoreline of Cross Island during the whaling season, impacts to subsistence whaling could be severe and thus major because whalers would not be able or willing to haul harvested whales onto oiled beaches for processing for one or more seasons. However, a small spill in the Proposed Action Area would most likely not reach Cross Island or Kaktovik beaches due to relatively fast dispersion and evaporation.

If small spills occurred during the whaling season in the Proposed Action Area, whalers from Nuiqsut would most likely be concerned that whales traveling through or harvested near the Proposed Action Area could be contaminated as a food source. Avoidance of bowhead whales due to potential contamination from small spills in the immediate area around the Proposed LDPI could be long lasting and widespread and thus moderate.

Impacts from a large spill of crude or refined oil are expected to be more substantial than potential effects of small spills. A large spill may originate at the proposed LDPI, offshore pipeline, or onshore pipeline (i.e., launch points). In Appendix A, (posted at www.boem.gov/liberty) Section A-4, BOEM presents the percent chance (i.e., probability) that a large oil spill starting at the proposed LDPI or pipeline launch points would contact subsistence use areas and other important natural resources. These probabilities are calculated on both an annual and seasonal basis. Annually, January through December, the Cross Island whaling area currently used by whalers from Nuiqsut has a 10 percent chance of being contacted by a large oil spill starting from the proposed LDPI and a 5 percent chance of being contacted by a large oil spill starting from the pipeline, 10 to 30 days after a large spill occurs. In the summer season, July 1 through September 30, the Cross Island whaling area has a 25 percent chance of being contacted by a large oil spill starting from the proposed LDPI and a 13 percent chance of being contacted by a large oil spill from the pipeline, 10 days after the spill occurs. These percent chances increase slightly to 26 percent and 14 percent, respectively, in summer 90 days after a large oil spill occurs.

The impacts from a large oil spill could be felt by communities far removed from launch points in the Proposed Action Area (Galginaitis, 2014b; USDOI, MMS, 2002). Important subsistence species such as bowhead whales migrating through oiled waters are harvested by communities located far from the Proposed Action Area. Concerns about reduced subsistence harvests and potentially contaminated subsistence foods due to a possible large spill would most likely be shared by all communities in the NSB that hunt bowhead whales. Such concerns would most likely be accompanied by long-lasting and widespread stress and worry in bowhead whaling communities across Alaska. If the Cross Island whaling area were contacted by a large spill, these psychological effects would be severe and thus major for most residents of Nuiqsut.

Bowhead whales hunted by Nuiqsut from their basecamp on Cross Island could suffer irritation and illnesses as a result of a large oil spill. Some individual whales could directly encounter and contact oil in the Beaufort Sea if a large spill occurred and contacted bowhead habitat during the fall migration (Neff, 1990; USDOI, MMS, 2002). It is likely that some of these whales would experience temporary and nonlethal effects. Potential harm to bowhead whales from contact with spilled oil is a concern because bowheads have extensive baleen that could be fouled by spilled oil, roughened areas of skin that may be sensitive to oil, extensive conjunctival sacs around the eyes that could be irritated, and a narrow channel connecting stomach chambers that could be blocked by ingested oil. Spilled oil could adversely affect the health of individual whales, especially along the edge of the sea ice or in ice leads where bowheads could contact spilled oil for longer durations or in higher concentrations than in open water conditions (Burns and Bennett, 1987; Geraci and St. Aubin, 1990; National Research Council, 2003, p. 102; USACE, 1999). The health and nutritional well-being of individual whales could be compromised if large amounts of oil or contaminated prey were ingested while feeding. Prolonged exposure of large numbers of feeding bowhead whales concentrated in high prey density could be exposed to prolonged oil contact and experience moderate effects, including mortality of some individuals, and impaired physiological function and reproductive capacity (Section 4.3.4.2).

Bowhead whales could be unavailable for harvest for one or more seasons if contaminated by spilled oil (USDOI, MMS, 2002). Concerns about potential contamination in communities nearest the spill event could substantially curtail traditional practices of harvesting, sharing, and processing bowheads for one or more seasons. Severe loss of opportunity to practice traditional subsistence whaling would threaten the foundations of Iñupiaq culture, identity, and social organization in the affected communities and could result in major impacts to Cross Island whaling.

There also is concern that the International Whaling Commission, which sets the quota for the subsistence harvest of bowhead whales, would reduce the harvest quota following a major oil spill as a precaution to ensure that overall population mortality did not increase (Galginaitis, 2014b; USACE, 1999; USDOI, MMS, 2002). Depending on the size of the reduction, a lower bowhead quota could have moderate to major impacts on food security, social organization, and cultural identity for

Iñupiaq whaling communities. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale products with impacted villages when successful.

Oil contamination of beaches used for whaling in fall or sea ice used for whaling in spring could have a major impact on whaling because even if bowhead whales were not directly contacted and contaminated, subsistence whalers would not be able or willing to bring them ashore and butcher them on oiled beaches or sea ice (Galginaitis, 2014b). This would most likely persist for one or more seasons or until beaches were adequately cleaned and restored and could result in major impacts.

The duration of avoidance of bowhead whales by subsistence whalers would vary depending on the volume of the spill, persistence of oil in the environment, degree of impacts on resources, time necessary for spill response and recovery, and the confidence that resources were once again safe to harvest, share, and eat. All whaling communities would share concerns over the safety of bowhead food products and the health of the whale stock in the event of a large crude or refined oil spill.

If a large spill occurred in Nuiqsut's whaling territory, effects on bowhead whaling could be severe and thus major for the Cross Island whalers. This is especially the case for the open-water season during August through September.

Impacts of a large spill on subsistence bowhead whaling for Kaktovik could be moderate to major depending on the trajectory of the spill. However, for the summer season, July 1 through September 30, the percent chance of oil contacting Kaktovik's whaling area is only 1 percent from launch points on the proposed LDPI, 30 days after the spill. Ninety days after a large spill occurred, the percent chance of Kaktovik's whaling area being oiled from proposed LDPI and pipeline sources remains 1 percent.

For Utqiaġvik, impacts of a large spill on subsistence bowhead whaling could be moderate to major depending on the trajectory and timing of the spill. For the summer season, July 1 through September 30, the percent chance of oil contacting the eastern portion of Utqiaġvik's whaling area is 4 percent from launch points on the island, 90 days after the spill and 2 percent from launch points at the pipeline. Effects on whaling from a large spill for Utqiaġvik crews would most likely only occur during the fall season.

Spill response and cleanup activities could include mechanical recovery methods and in-situ burning of spilled materials. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill cleanup operations.

If cleanup operations include sections of beaches, access to butchering sites and areas could be temporarily restricted.

Subsistence harvest patterns could be adversely affected by spill response and cleanup activities that involved volunteer or paid employment of local subsistence harvesters, by diverting time, effort, and equipment away from subsistence activities such as whaling to OSR and cleanup. Earning cash from paid work in spill response and cleanup may allow some subsistence harvesters to purchase newer equipment and fuel needed to effectively pursue subsistence activities.

Depending on the size of the spill and whether or not it contacted onshore and offshore subsistence resources, response and cleanup duration and impacts could be short-term and localized or long lasting and widespread.

Mechanical methods used to recover spilled oil offshore could affect whaling practices and other subsistence harvest patterns. The use of in-situ burning would most likely result in fears of potential contamination of subsistence resources that could last for one harvest season or longer. The potential for contamination of resources could result in cessation of subsistence harvest of marine resources including bowhead whales.

Impacts to subsistence harvest patterns caused by spill response and cleanup activities are expected to be minor to moderate depending on the extent and location of the spill. Minor to moderate effects from spill response and cleanup are not expected to change the overall impact conclusions for a large spill.

The Proposed Solid Ice Condition (Section 2.5.1) would shift much of the risks associated with a large oil spill from summer months to winter months. A large spill which occurred during the solid ice conditions of winter would likely have less impacts to subsistence whaling in terms of physical damage to the environment than a summer spill into open water, because a spill during solid ice conditions would disperse over a smaller area and be more easily cleaned up. This measure would not mitigate other impacts of a large spill, including hunter avoidance of the area, concerns about contamination, possible reduction in quota, and potential loss of a subsistence season or seasons. Restricting reservoir drilling to winter months would also extend the time period required to complete the overall drilling program, and although this would mean drilling would occur when large spills are more easily contained and cleaned up, the additional few months to couple of years of drilling activity could still result in increased impacts to subsistence whaling for the reasons described above.

Government initiated unannounced exercises (e.g., oil spill drills), which are infrequent, of short duration, (less than 8 hours), and utilize existing equipment, would not alter impact conclusions for subsistence activities and harvest patterns.

Summary of Effects for Whaling

BOEM found potential temporal and spatial overlap between subsistence whaling activities and the Proposed Action for Nuiqsut crews, particularly proposed LDPI slope protection and related construction activities scheduled for May through August (Table 4-42).

Impacts to subsistence whaling from possible deflection of some whales seaward are expected to be moderate.

Impacts to Cross Island whaling related to the presence of and potential disturbances from support vessel traffic are expected to be moderate.

Impacts due to whaler avoidance of the Proposed Action Area are expected to be major. These impacts would most likely only occur during whaling seasons in which whalers needed to scout for whales south of Narwhal Island (see above section, Whaler Avoidance). It is important that the Proposed Action Area be available for scouting in case whales are not readily found where they are expected to be north and east of Cross Island. This is especially the case during times when ice and weather conditions prevent whalers' access to the open water seaward of the barrier islands. Whalers may avoid the Proposed Action Area because of potential contamination as a result of operations.

Effects of summer construction activities related to LDPI slope protection are expected to be major. Nuiqsut whalers may avoid the Proposed Action Area for the entire whaling season due to noise and presence of construction activities if slope protection activities occur through the end of August.

Impacts to Cross Island whaling from small spills of crude or refined oil are expected to be minor to major. Moderate impacts to subsistence whaling practices could result from potential contamination of whales as a result of small spills. Although unlikely, major impacts could occur if a small spill contacted the shore of Cross Island during a whaling season.

Effects to subsistence whaling for Nuiqsut crews from large oil spills are expected to be major. A large spill that affects any part of the migration route of bowhead whales could injure and contaminate whales, which are culturally paramount to the Iñupiat people of the NSB. Even if whales were available for the spring and fall hunts, concerns about potential contamination could leave bowheads less desirable and disrupt or stop subsistence whaling practices for one or more seasons, resulting in severe and thus major impacts to subsistence whaling practices in these communities.

Depending on the extent of the oil spill and degree of response and cleanup activities, a large oil spill could adversely affect all Alaskan whaling communities.

Conclusions for Whaling Practices

Appendix C describes mitigation measures derived from lease stipulations, design features and BMPs the operator committed to, and requirements and BMPs that other agencies typically require (Sections C-1 to C-3). BOEM's conclusions regarding impacts assume implementation and compliance with the mitigation measures described in Sections C-1 through C-3.

Potential impacts to subsistence whaling for Nuiqsut are related to possible alteration of movement patterns of some whales; stress and worry over alteration of whale movement patterns on the part of whalers; support vessel traffic; summer construction activities such as sheet pile driving; and whaler avoidance of the Proposed Action Area. Overall, potential adverse effects to Cross Island subsistence whaling activities and harvest practices from routine activities could range from moderate to major primarily due to potential social, cultural, and psychological impacts related to whaling practices, beliefs, and traditional knowledge and observations of whalers regarding noise and industrial development in the marine environment. These potential impacts to the human environment are independent of potential negligible biological impacts to bowhead whales. (See Section 4.3.4.2 for a discussion of potential biological effects.) These potential impacts to the human environment are related to the relationship of people with that environment and the relationship of the Iñupiat people with the whale.

Effects to Cross Island subsistence whaling activities and harvest practices would primarily occur in August through September during the open-water season at times corresponding to the fall whaling season. Winter activities other than oil spills, such as gravel mining, proposed LDPI construction in winter, pipeline construction, and ice road construction and maintenance, are expected to have little to no impacts to subsistence whaling practices.

Although Kaktovik would most likely be whaling in late August and early September, their crews' core whaling area does not spatially overlap with the Proposed Action Area. BOEM expects negligible impacts to Kaktovik's whaling activities and harvest patterns from proposed LDPI construction, pipeline construction, facilities construction, drilling, production, and decommissioning. Small spills are expected to have negligible impacts on Kaktovik's whaling season. Large oil spills could have moderate to major impacts on bowhead whaling practices conducted by Kaktovik whaling crews.

BOEM found no spatial overlap between the Proposed Action and spring or fall bowhead whaling conducted by crews living in Utqiaġvik. The Proposed Action is not expected to have direct effects on Utqiaġvik's subsistence whaling activities and thus impacts would most likely be negligible. Small oil spills are expected to have negligible impacts on Utqiaġvik's whaling seasons. A large oil spill could have moderate to major impacts on the fall bowhead whaling hunt conducted by Utqiaġvik crews.

Most of the potential effects to Cross Island whaling from routine activities could possibly be reduced or eliminated by implementing carefully planned mitigation measures involving close coordination between Nuiqsut whalers and industry (Appendix C; Kuukpik, 2015, 2017; NOAA, 2013, p. 4-211; SRB&A, 2013). However, potential major adverse effects to subsistence whaling could result from whaler avoidance of the Proposed Action Area and large accidental oil spills even if these measures are successfully implemented.

Kuukpik (2015, pp. 29-30) identified several types of cessation in activities related to the Proposed Action, including but not limited to cessation periods for marine vessel traffic and operating selected equipment on the LDPI used for construction or other purposes during the fall bowhead whale migration (i.e., noise producing equipment). Most marine vessel traffic in this offshore area has been suspended to accommodate whaling and the bowhead migration beginning in the latter half of August each year in accordance with the process used to avoid conflicts. This timeframe has generally worked well in the past, but the proposed LDPI would be located upstream of where Nuiqsut crews go whaling. The upstream location would require an earlier cessation date such as August 1 or earlier (Kuukpik, 2015). These activities would be allowed to resume after the Nuiqsut bowhead whale quota of four whales is met or after the whalers officially end their whaling activities for the season.

If support vessel traffic and LDPI slope protection and related construction activities (e.g., pipe-/pile-driving), which produce noise, cease August 1, potential adverse effects to subsistence whaling from vessel traffic could be reduced from moderate to minor, and potential effects from summer construction at the LDPI could be reduced from major to minor. If support vessel traffic and summer construction activities for LDPI slope protection (e.g., pipe-/pile-driving) cease August 25 or at the start of the Cross Island hunt (whichever occurs first), potential impacts from vessel traffic would most likely remain moderate, and potential impacts from summer construction activities such as pipe-/pile-driving to subsistence whaling would most likely be reduced from major to moderate.

For additional mitigation measures, BOEM proposed that marine vessel traffic and pipe-/pile-driving not be allowed during the fall bowhead whale hunt by Nuiqsut; these would be allowed to resume after the Nuiqsut bowhead whale quota of four whales is met or after the whalers officially end their whaling activities for the season.

It is likely the whalers would prefer to avoid the LDPI during construction and operations (Galginaitis, 2014b). However, in years with more difficult hunting conditions due to ice and weather, it would be probable that the Cross Island whalers would, while avoiding the LDPI, still use the northern part of the area between Narwhal Island and the LDPI as a search area, and would be especially sensitive to vessel traffic associated with the Proposed Action (Galginaitis, 2014b). To avoid major effects to subsistence whaling in years when the Cross Island whalers cannot search for whales northeast of Cross Island, more stringent mitigation measures would be necessary than in years with more normal conditions. In other words, additional mitigation measures beyond the typical requirements of the agreement between industry and the whalers may be required to minimize disruptions during these more difficult seasons.

As part of typical agreements, communication centers are established and subsistence advisors or representatives are hired to reduce potential conflicts between whaling crews’ scouting efforts and support vessels and aircraft traffic during August through September. An improved communications system in conjunction with stipulations minimizing industrial activities known to interfere with whaling can positively affect whaling success (Galginaitis, 2014c, p. 15). Subsistence advisors and communication centers could reduce impacts related to support vessel traffic from moderate to minor. Consultation between the operator and the communities, communication centers, and subsistence advisors would most likely reduce impacts related to whaler avoidance from major to moderate.

To further avoid and reduce potential adverse effects of the Proposed Action to subsistence whaling, the Kuukpik Corporation has requested a protection zone in their whaling territory to include the following measures (Kuukpik, 2016, p. 4):

- Establish quiet periods during the whale migration and harvest season for industry vessels and exploration activities.
- Designate communication channels and practices by which whalers and industry communicate every 6 hours to preemptively avoid potential conflicts.
- Require industry vessels to use their best efforts to avoid encountering bowhead whales or whalers.
- Ensure vessels employ best practices to minimize impacts when vessels inadvertently approach a whale.
- Establish a dispute resolution process.

- Another proposed mitigation measure that may help reduce impacts to subsistence whaling is to require monitoring of factors that may interfere with the bowhead hunt or reduce the desirability of whales, such as noise impacts or water quality contamination. The results from a monitoring program could help assure stakeholders and regulators that negative impacts are not occurring and/or alert these parties to any unforeseen impacts which do occur.

Seal Hunting

Hunting for bearded and ringed seals is a primary subsistence activity for residents of Nuiqsut, Kaktovik, and Utqiaġvik (Section 3.3.3; Table 4-41; SRB&A, 2010). In general, NSB seal hunters prefer bearded seals to ringed seals, but both species are important for their subsistence ways of life. These two types of seals tend to be hunted in the same areas and during the same timeframe off the central Beaufort coast. Most seal hunting activity is done by boat and starts in June, peaks in July, and continues through September in open water as seals follow the ice.

Overlap with the Proposed Action

BOEM found potential for both temporal and spatial overlap of seal hunting activities and the Proposed Action for Nuiqsut and Kaktovik (Table 4-42). This is the case for summer construction activities proposed to protect the LDPI slope scheduled for May through August during Execute Year 2. For Utqiaġvik, there is temporal overlap between proposed LDPI slope protection work and seal hunting, but no spatial overlap; therefore, no adverse effects from summer construction activities are expected to occur for Utqiaġvik's seal hunting practices. BOEM anticipates routine activities, development, production, and decommission for the Proposed Action to have little to negligible impacts on seal hunting practices for residents of Utqiaġvik.

During 1996 through 2006, Nuiqsut hunters reported hunting seals between Harrison Bay and Flaxman Island, which broadly overlaps with the Proposed Action Area (SRB&A, 2010). The prime seal hunting area for Nuiqsut is just north of the Colville River Delta and centered on Thetis Island. For Kaktovik hunters, the core seal hunting area is Pokok Lagoon in the east to the Canning River in the west, which is 62 miles east of Foggy Island Bay and the Proposed Action Area. During 1996 through 2006, Kaktovik residents reported hunting bearded seals along the coast as far west as Prudhoe Bay, which broadly overlaps with the Proposed Action Area (SRB&A, 2010).

Although Nuiqsut and Kaktovik have hunted seals in and near the Proposed Action Area, their current core seal hunting areas are substantial distances from the Proposed Action Area. Moreover, hunters tend to look for seals farther off shore than the Proposed Action Area (Section 3.3.3; SRB&A, 2010). During the 25-year lifetime of the Proposed Action, seal hunting in and closer to the Proposed Action Area may become more popular than it is today if and when seals become unavailable at the core hunting areas closer to Nuiqsut and Kaktovik.

LDPI Slope Protection

Slope protection is proposed as part of summer construction for the proposed LDPI. This includes cutting a moat in the sea ice around the proposed LDPI, grading the LDPI with a crane and drag line, and installing sheet piling and concrete armament around the proposed LDPI's perimeter (Hilcorp, 2015). The slope protection activities are scheduled for May through August during Year 2 (Figure 2-1; Hilcorp, 2015, p.16). Seal hunting seasons for Nuiqsut and Kaktovik primarily occur June through September (Table 4-41) and would be most at risk from potential impacts caused by slope protection work in summer. The potential effects could be disturbance of seal hunters due to construction noises, conflicts between seal hunting boats and support vessels, disturbances from helicopter overflights, and avoidance of the Proposed Action Area due to summer construction activities. This may potentially reduce seal hunting opportunities for the Execute Year 3 open-water season. However, seals would not become unavailable for one or more seasons, and hunters would have continued opportunities to go hunting for seals in areas closer to Nuiqsut and Kaktovik at the core seal hunting areas. Noises and disturbances from slope protection work and associated support vessel and aircraft traffic could result in short-term and localized, and thus minor impacts to subsistence seal hunting for Nuiqsut and Kaktovik. This would especially be the case if hunters need to look for seals in the Proposed Action Area in July and August 2018 if seals were not available closer to home.

Oil Spills and Spill Response

Small spills are unlikely to affect individual seals, because small spills cover a small area and are less likely to persist in the environment (Section 4.1.1.3; USDOI, MMS, 2002). Small spills starting at the proposed LDPI or the pipeline would most likely not reach the main ice habitat areas of bearded and ringed seals due to rapid dispersal and evaporation within hours to a few days. BOEM expects the number of seals potentially affected by small spills as a result of the Proposed Action to be negligible.

If small spills occurred during the main seal hunting season, June through September, seal hunters from Nuiqsut and Kaktovik could experience worry about potential contamination of seals. Seal hunters would most likely be concerned that any seals traveling through the Proposed Action Area could be contaminated as a food source due to small spills. If small spills contacted the shoreline of Thetis Island during the seal hunting season, subsistence seal hunting at the island could be temporarily disrupted because hunters would be unable or unwilling to camp and hunt seals there due to the fear of contaminated resources and oiled beaches. The impacts to subsistence seal hunting would be short-term and localized, and thus minor, and hunters would be able to pursue seals at different areas. The effects of stress over potentially contaminated seals would most likely be longer lasting and widespread, and thus moderate. However, small spills originating in the Proposed Action Area would most likely not reach Thetis Island due to relatively fast dispersion and evaporation.

BOEM anticipates that small spills would have a negligible impact on seal hunting for Utqiaġvik hunters because there is no spatial overlap between the Proposed Action Area and the core seal hunting area for Utqiaġvik.

Although an unlikely event, BOEM assumes that one large spill of crude or refined oil could occur during the life of the Proposed Action. Appendix A (posted at www.boem.gov/liberty) shows the percent chance of oil contacting subsistence resource areas from a large spill starting at the proposed LDPI and the pipeline. Nuiqsut's main seal hunting area, Thetis Island north of the Colville River Delta, would have a chance of being contacted by a large spill. Thirty days after a large spill launched from the proposed LDPI, Thetis Island has a 10 percent chance of being oiled both annually and for the summer season July 1 through September 30. For a large spill starting at the pipeline, Thetis Island has a 4 percent chance of being contacted 30 days after a large spill occurs both annually and during summer.

If a large spill reached the Thetis Island area and contacted the shoreline of the island, the impacts to subsistence seal hunting could be severe and thus major for Nuiqsut because this is their core seal hunting area. Individual seals could be killed if contacted by oil, but large-scale mortality of seals is unlikely (Geraci and St. Aubin, 1990, p. 255). The seal hunters would most likely stop hunting seals at Thetis Island for one or more seasons due to oiled beaches and the potential for contamination of seals and other resources. However, seals would not be completely unavailable. Hunters would be able to pursue seals farther to the west in Harrison Bay or to the east towards Flaxman Island. They could look for seals in the Cross Island area as well but most likely would not do so in late August and early September to avoid disturbing whaling crews. It is possible that a large spill physically affecting Thetis Island would also contact these alternative seal hunting areas, thereby further limiting seal hunting opportunities. Worry about potentially contaminated seals would most likely be long lasting and severe due to a large spill for the entirety of Nuiqsut's seal hunting territory.

Kaktovik's core seal hunting area is less likely to be contacted by a large spill originating at the Proposed Action Area. The Canning River Delta and Kaktovik's core offshore seal hunting and whaling areas only have a 1 percent chance of contact in the event of a large spill starting at the proposed LDPI in summer. In the event of a large spill, Kaktovik hunters would most likely avoid the western portion of their seal hunting area between Prudhoe Bay and Flaxman Island, which would limit their seal hunting opportunities closer to town in the core area; the effects of which are expected to be short-term and localized, and thus minor. However, a large spill could cause long lasting and widespread, and thus moderate, impacts related to psychological stress related to the potential for contamination of seals as a food source for one or more hunting seasons.

For the summer season July 1 through September 30, the eastern portion of Utqiaġvik's core seal hunting area has a 4 percent chance of being contacted by a large spill starting at the proposed LDPI and a 2 percent chance of contact from a large spill starting at the pipeline, 90 days after the event. The western portion of their core seal hunting area has no chance of contact from a large spill originating at the Proposed Action Area. In the event of a large spill, some Utqiaġvik seal hunters may temporarily avoid the eastern part of their territory for one or more seasons, but they would continue to have seal hunting opportunities to the west and south in the Peard Bay area and farther seaward to the north off Point Barrow. Many hunters would most likely look for seals east of Point Barrow unless a large spill physically contacted that area. For seal hunting conducted by Utqiaġvik hunters, BOEM expects short-term and localized, and thus minor impacts from a large spill. However, a large spill could cause long lasting and widespread effects, and thus moderate impacts related to psychological stress for Utqiaġvik seal hunters regarding potential contamination of seals as a food source for one or more hunting seasons.

Seal hunting practices could be adversely affected by spill response and cleanup activities that involved volunteer or paid employment of local subsistence hunters by diverting time, effort, and equipment away from seal hunting to OSR and cleanup for one or more seasons. Earning cash from paid work in spill response and cleanup could allow some subsistence sealers to purchase newer equipment and fuel needed to effectively pursue seals and other subsistence activities.

Depending on the size of the spill and whether or not it contacted onshore and offshore subsistence resources, response and cleanup duration and impacts could be short-term and localized or long lasting and widespread.

Mechanical methods used to recover spilled oil offshore could impact seal hunting practices at Thetis Island or other important seal hunting areas. The use of in-situ burning would most likely result in worry over environmental contamination and potentially contaminated seals that could last for one harvest season or longer. The potential for contamination of seals due to spill response and cleanup could result in cessation of seal hunting or avoidance of hunting areas for one or more seasons.

Impacts to subsistence seal hunting caused by spill response and cleanup activities are expected to be minor to moderate depending on the extent and location of the spill. Minor to moderate effects from spill response and cleanup are not expected to change the overall impact conclusions for a large spill.

Conclusions for Seal Hunting

Overall, LDPI slope protection work at the Proposed Action Area is expected to have minor impacts on seal hunting for Nuiqsut and Kaktovik and negligible impacts on seal hunting for Utqiaġvik. Other routine activities associated with the Proposed Action are not expected to have adverse effects on seal hunting for any North Slope community.

If Hilcorp ends summer construction activities and related support vessel traffic at the proposed LDPI site July 25 instead of extending the LDPI slope protection work through August, impacts to seal hunting for Nuiqsut and Kaktovik would most likely be reduced from minor to negligible. If Hilcorp ended construction for LDPI slope protection August 25, the impacts to seal hunting would most likely remain minor.

Small spills associated with the Proposed Action are expected to have minor to moderate impacts on seal hunting for Nuiqsut and Kaktovik. For Utqiaġvik seal hunters, impacts from small spills at the Proposed Action Area would be negligible.

A large spill could result in major impacts to seal hunting for Nuiqsut. For Kaktovik and Utqiaġvik, a large spill is expected to have minor to moderate impacts on subsistence seal hunting.

Caribou Hunting

Caribou are an important subsistence resource for the residents of Nuiqsut, Kaktovik, and Utqiaġvik and provide a large amount of subsistence foods and other materials year-round (Section 3.3.3; Table 4-26; Braem et al., 2011; Galginaitis, 2014b; SRB&A, 2010). For these communities, caribou hunting generally peaks in July and August and tapers off in September (SRB&A, 2010). June is also an important month for caribou hunting for Utqiaġvik and Nuiqsut (Braem et al., 2011; SRB&A, 2010). In summer, caribou are generally hunted by boat in river deltas and along the coastline or shores of barrier islands where caribou congregate for relief from insects and heat. In winter, caribou are primarily hunted inland near communities using snowmachines, but at times coastal areas have been used in winter for caribou, especially by Kaktovik hunters (Pedersen, 1990b; SRB&A, 2010).

Overlap with the Proposed Action

BOEM found temporal overlap between subsistence caribou hunting and the Proposed Action for Nuiqsut, Kaktovik, and Utqiaġvik (Table 4-26). With exception of an unlikely large oil spill, BOEM did not find spatial overlap between caribou hunting activities and the Proposed Action for Nuiqsut and Utqiaġvik (Braem et al., 2011; SRB&A, 2010). For routine construction, development, production, and decommissioning activities, BOEM anticipates little to no and thus negligible impacts to subsistence caribou hunting for Nuiqsut and Utqiaġvik.

Kaktovik hunters harvest caribou year-round; most in July and August. They tend not to harvest caribou in June during calving and October during rut (Pedersen, 1990b; SRB&A, 2010). The timing of winter and summer construction activities for the Proposed Action potentially overlap with both winter and summer caribou hunting. Kaktovik hunters use coastal areas in both winter and summer for caribou hunting.

BOEM found the Proposed Action Area potentially overlaps spatially with the western portions of Kaktovik's historical caribou hunting area (Table 4-26). Kaktovik residents reported hunting caribou along the coast and barrier islands as far west as Prudhoe Bay with some caribou use areas as far west as the Ikpikpuk River and around the shores of Teshekpuk Lake (NSB, 2014; SRB&A, 2010). Caribou hunters from Kaktovik sometimes hunt in coastal areas during summer months near Flaxman Island and occasionally farther west to the Shaviovik River and Foggy Island inside the Proposed Action Area (LGL Alaska et al., 1998; NSB, 2014; SRB&A, 2010).

Hunters from Kaktovik seldom expect to use this entire area, and they prefer to avoid areas of industrial development to the west of Flaxman Island while hunting caribou. However, during the 25-year life of the Proposed Action, they could foreseeably use the western portions of their historical caribou hunting area located in the Proposed Action Area if and when caribou are not present near the community or in the core hunting area. The core caribou hunting area for Kaktovik is a smaller area along the coast between Bullen Point in the west and the US-Canada border in the east (Table 4-26; Galginaitis, 2014b; SRB&A, 2010). Bullen Point is approximately 2 miles east of the Proposed Action Area.

Effects on Caribou Resources

Disturbance can displace and divert caribou away from habitats or routes that would normally be used by caribou and subsistence harvesters (Section 4.3.6.3.1; Hilcorp, 2015, Appendix A; SRB&A, 2009). Construction of the gravel mine and proposed LDPI and installation of the offshore and onshore segments of the pipeline during winter should minimize potential disturbance impacts because fewer caribou are present in the Proposed Action Area in winter and fewer hunters use coastal areas in winter for caribou hunting (Section 4.4.3.1). Noise disturbance would be greatest during gravel mine construction with blasting only occurring during one winter. However, most caribou leave the coastal plain by late September to migrate to wintering areas in or south of the Brooks Range. The most likely response from caribou to active gravel mining would be avoidance by around 1.5 miles during times of active gravel extraction. The temporary and non-injurious impacts of gravel mining would have a negligible effect on caribou (Section 4.3.6.3.1).

During winter construction, transportation would generally require vehicles on ice roads or helicopters. Trucks would use ice roads to access Foggy Island Bay, the pipeline, gravel mine site, fresh water sources, and the proposed LDPI site. Approximately 400 trips by vehicles of various types and function are proposed during the winter construction season to haul gravel to build the proposed LDPI (Hilcorp, 2015). Construction of the tie-in gravel pad and installation of the onshore portion of the pipeline would create onshore winter traffic. These activities could potentially cause short-term and localized noise disturbance and displacement of small numbers of caribou wintering in the Proposed Action Area. Disturbance can cause flight reactions and decreased foraging for caribou, resulting in increased energy expenditures that would most likely cause minor impacts to individual caribou but would not be expected to affect overwinter survival of caribou.

The greatest potential for disturbance to caribou from the Proposed Action would be the increase in air and vehicle traffic from Deadhorse and on the Endicott Road. Low-level helicopter overflights for routine maintenance and surveillance of the pipelines may cause caribou to flee the area, especially for maternal caribou and large groups of caribou; this disturbance would cause the animals to expend extra energy (Hilcorp, 2015, Appendix A). Potential summer construction activity at the Endicott SDI would create increased traffic on the Endicott Road during gravel hauling. Increased summer traffic may lead to an increase in disturbance to caribou moving through the Sagavanirktok River Delta.

Most ground and air traffic from Deadhorse to the proposed LDPI would cross through the middle of the Sagavanirktok River Delta; the potential for disturbance to animals using the delta would be present during all seasons, but it would be greatest during spring and summer. Caribou are most sensitive to disturbance and displacement from preferred habitats early during the calving period (late May and early June). Helicopter overflights could cross caribou calving concentrations between the Sagavanirktok and Canning rivers, but Hilcorp (2015, Appendix A) expects that this would be unlikely and most calving locations would be expected to be east of this potential overflight area.

Effects on Summer Caribou Hunting

For summer caribou hunting by residents of Kaktovik, potential impacts of the Proposed Action include disturbance to or displacement of groups of caribou and hunters in coastal areas due to helicopter overflights. Helicopters would be used in support of LDPI slope protection work scheduled for May through August during Execute Year 2. Work activities just south of Foggy Island Bay for the reclamation of the gravel mine in May through September of Execute Year 1 could also disturb or displace caribou and hunters from Kaktovik. Support vessel traffic coastward of the barrier islands could conflict with boat travel by caribou hunters from Kaktovik in Foggy Island Bay.

Potential impacts to caribou hunting would most likely occur in July and August in coastal areas between Prudhoe Bay and Mikkelsen Bay and would most likely result from helicopter operations. Hovercraft would access the proposed LDPI year-round (Hilcorp, 2015). Hilcorp (2015a) proposed year-round helicopter access to the proposed LDPI with air operations limited by weather conditions and visibility. Air access to the island would be used for routine movements of personnel, equipment, supplies such as food, and pipeline surveillance and maintenance. Air traffic is proposed to take direct routes from West Dock, SDI, or Deadhorse to the proposed LDPI. During construction, Hilcorp (2015a) proposed 1 to 2 helicopter and 3 hovercraft round-trips per day, 2 helicopter and 2 hovercraft round-trips per day during drilling, and 1 to 2 helicopter and 2 hovercraft round-trips per day during production. Hilcorp has proposed to adjust routes and flight altitudes to accommodate weather, air traffic, and subsistence activities.

If during the 25-year life of the Proposed Action, caribou hunters from Kaktovik travel to Foggy Island Bay or Prudhoe Bay by boat and encounter helicopter overflights, the impacts to the hunt could be minor or moderate depending on the number of hunters affected and to what extent they associate their success or lack thereof with the aircraft encounter. If caribou are observed but no caribou are harvested because they were driven away by a helicopter, impacts could be long lasting and widespread, especially after travelling such a great distance by boat in search of meat for the community. If the same scenario occurred with only one boat travelling through the Proposed Action Area for other purposes or if no caribou were present when the encounter occurred, the effects would most likely be short-term and localized.

The likelihood of Kaktovik hunters travelling to the Proposed Action Area to intentionally hunt caribou is low during the life of the Proposed Action. BOEM anticipates that Kaktovik caribou hunters would have opportunities to find and successfully harvest caribou in the core area to the east of the Proposed Action Area and would only rarely travel west of Flaxman Island or to shores of Foggy Island Bay to harvest caribou during the life of the Proposed Action. Caribou should not be unavailable as a result of the Proposed Action for one or more seasons. BOEM expects little to no effects to summer caribou hunting as a result of LDPI slope protection activities, gravel mine reclamation, and support vessel traffic. Overall, BOEM expects impacts from the Proposed Action on summer caribou hunting for Kaktovik to be negligible.

Effects on Winter Caribou Hunting

For winter caribou hunting by residents of Kaktovik, potential impacts of the Proposed Action could result from ice road construction and maintenance; gravel mining and hauling; helicopter support flights for proposed LDPI construction and offshore pipeline installation; onshore pipeline construction; and decommissioning of the onshore pipeline and gravel pads. These work activities are proposed between December and April when Kaktovik hunters go for caribou using snowmachines. Hunters can cover about 200 miles a day on snowmachine while hunting and tend to do most of the caribou hunting during day trips where they return to town each day (NSB, 2014; SRB&A, 2010). Kaktovik hunters prefer to hunt close to home, but they will spend time and resources to travel farther when necessary.

Groups of caribou and hunters would most likely be temporarily displaced from the Proposed Action Area during these construction activities. During the 25-year life of the Proposed Action, it is possible that caribou hunters from Kaktovik would need to travel to the Foggy Island Bay area by snowmachine. If those hunters were to encounter helicopter overflights or trucks hauling gravel, the impacts to the hunt could be minor or moderate, depending on the number of hunters affected and to what extent they associate their success or lack thereof with disturbances from winter construction activities and support vehicles or aircraft. If caribou are observed but not harvested because they were driven away from hunters by a helicopter or support vehicle, impacts could be long lasting and widespread, especially after travelling substantial distances by snowmachine in search of meat for the community.

Caribou that overwinter on the coastal plain sometimes use the coast and near shore sea ice as a salt lick. Potential impacts to subsistence hunting would be limited to coastal areas in the far western portions of Kaktovik's caribou hunting area, which would most likely only be used if caribou were not found closer to town in the core hunting area or at inland areas that are more popular for hunting caribou in the winter. BOEM does not expect that caribou would be unavailable to Kaktovik hunters for an entire winter season or more because of winter construction activities and support vehicle and helicopter traffic. Therefore, BOEM expects little to no and thus negligible impacts to winter caribou hunting for Kaktovik as a result of the Proposed Action.

Oil Spills and Spill Response

Small spills occurring offshore are unlikely to affect individual caribou unless a small spill contacted shorelines and barrier islands in July and August when caribou are present for insect relief. Small spills are not expected to contact beaches or shorelines of barrier islands because they cover a small area and are less likely to persist in the environment (USDOI, MMS, 2002).

Small spills that occur onshore are not expected to affect individual caribou or groups of caribou because caribou most likely would avoid construction and development areas while work is ongoing. After construction has ceased, caribou may use elevated gravel pads to get into the wind to avoid biting insects and could potentially contact a small spill from a pipeline. Caribou hunters from Nuiqsut and Kaktovik would most likely avoid the construction and development areas during all times of year unless they had no other options to take caribou, which is unlikely. BOEM expects the number of caribou potentially affected by small spills as a result of the Proposed Action to be negligible. In the event that individual caribou were contacted by a small spill, the impacts on caribou are expected to be short-term and localized, and thus minor.

If small spills occurred during the main caribou season, June through August, caribou hunters from Nuiqsut and Kaktovik could experience worry about potentially contaminated caribou. Hunters would most likely be concerned that caribou traveling through or using the Proposed Action Area could be contaminated as a food source due to small spills. The effects of worrying about potentially contaminated caribou could be long lasting and widespread and thus moderate. However, the overall impacts to subsistence caribou hunting for Nuiqsut and Kaktovik from small spills would most likely be negligible as hunters would be able to pursue caribou at different areas outside the Proposed Action Area.

BOEM anticipates small spills would have a negligible impact on caribou hunting for Utqiaġvik hunters because there is no spatial overlap between the Proposed Action Area and the core caribou hunting area for Utqiaġvik (Braem et al., 2011; SRB&A, 2010).

Although an unlikely event, BOEM assumes that one large spill of crude or refined oil could occur during the life of the Proposed Action. Nuiqsut's main caribou hunting area, the Colville River Delta, would have a small chance of being contacted by a large spill. The Colville River Delta has a 3 percent chance of being contacted within 90 days after a large oil spill occurred at any point during the year (January 1 through December 31). If a large oil spill occurred during the winter (October 1 through June 30), there is a 2 percent chance that Colville River Delta would be contacted within 90 days. If a large spill, originating from the proposed LDPI, were to occur in the summer (July 1 through September 30), the Colville River Delta has a 6 percent chance of being oiled within 30 days. For a large spill originating at the pipeline during the summer, the Colville River Delta has a 3 percent chance of being oiled within 30 days.

In July and August, the Colville River Delta is important for Nuiqsut caribou hunting. Although unlikely, if a large spilled contacted the Colville River Delta in summer while caribou were present or if a large spill diverted caribou away from the delta in summer, the impacts to caribou hunting for Nuiqsut could be severe and thus major. A large spill in this area could severely disrupt subsistence caribou hunting or make caribou unavailable or undesirable for one or more seasons. Stress over potentially contaminated caribou as a food source would most likely result in long lasting and widespread and thus moderate psychological stress in Nuiqsut.

There is a higher percent chance of contact from a large spill of crude or refined oil for the larger insect relief and calving area along the coast used by the Central Arctic Caribou Herd (CAH), which overlaps with portions of the caribou subsistence use areas for Nuiqsut and Kaktovik (Appendix A, posted at www.boem.gov/liberty). The extent of this caribou use area (GLS-174) is large, extending from the Colville River Delta in the west to the Canning River Delta in the east. If a large spill originating from the proposed LDPI occurred in the summer (July through September), there is a 42 percent chance that oil could contact this stretch of coastline within 30 days. The chance of contact from a large spill starting from the pipeline in summer increases to 47 percent 30 days after a large spill. If the location and time of contact of oil spilled offshore corresponded to the time and location of caribou presence there could be moderate effects to individual caribou, especially if individuals were directly oiled. A large spill originating from the onshore pipeline could have short-term and localized effects on individual caribou and caribou hunting. In the event that individual caribou were oiled, effects to caribou could be moderate but less than severe because the entire herd would not be at risk of decline from loss of habitat or large-scale mortality due to a large spill.

If contact of spilled oil corresponded in time and place with caribou hunting for Nuiqsut or Kaktovik hunting parties hunting with boats along the shoreline, there could be long lasting and widespread and thus moderate impacts to subsistence caribou hunting. Impacts to caribou hunting would most likely not be major because hunters from both Nuiqsut and Kaktovik would have alternate places to look for caribou; Nuiqsut could hunt to the west of the Colville River Delta and farther inland, and Kaktovik hunters could hunt in coastal areas east of the Canning River along the shores of Camden Bay. The effects of the potential for contamination of caribou in the CAH as a food source due to a large spill contacting important caribou habitat and forage would most likely be long lasting and widespread and thus moderate for hunters and other residents of Nuiqsut and Kaktovik.

Kaktovik’s core caribou hunting areas farther east of the Proposed Action Area are less likely to be contacted by a large spill originating at the Proposed Action Area. The Canning River Delta and the insect relief and overlapping subsistence use area for the Porcupine Caribou Herd only have a 1 percent chance of contact in the event of a large spill starting at the proposed LDPI in summer 30 days after a large spill. In the event of a large spill contacting the coastline or tundra in the Proposed Action Area, Kaktovik hunters would most likely avoid the western portion of their caribou hunting area between Prudhoe Bay and Flaxman Island. This would limit their caribou hunting opportunities closer to town in the core area; the effects of which are expected to be short-term and localized, and thus minor.

For a large spill occurring in the summer season (July 1 through September 30), the eastern portion of Utqiaġvik’s caribou hunting area has a 5 percent chance of being contacted by oil originating at the proposed LDPI. There is a 3 percent chance of it being contacted from a large spill starting at the pipeline within 90 days after the event. In the event of a large spill, some Utqiaġvik caribou hunters may temporarily avoid the eastern part of their territory for one or more seasons, but they would continue to have caribou hunting opportunities to the west and south along the Chukchi coast in the Peard Bay area. Many hunters would most likely look for caribou east of Utqiaġvik unless a large spill physically contacted that area. For caribou hunting conducted by Utqiaġvik hunters, BOEM expects short-term and localized and thus minor impacts from a large spill. However, a large spill could cause long lasting and widespread and thus moderate impacts related to psychological stress for Utqiaġvik caribou hunters and other residents regarding potential contamination of caribou as a food source for one or more hunting seasons.

Caribou hunting practices could be adversely affected by spill response and cleanup activities that involved volunteer or paid employment of local subsistence hunters by diverting time, effort, and equipment away from caribou hunting to OSR and cleanup for one or more seasons. However, earning cash from paid work in spill response and cleanup could allow some caribou hunters to purchase newer equipment and fuel needed to effectively pursue caribou and other subsistence activities.

Depending on the size of the spill and whether or not it contacted onshore and offshore subsistence resources, response and cleanup duration and impacts could be short-term and localized or long lasting and widespread.

Mechanical methods used to recover spilled oil offshore would most likely not affect caribou hunting. The use of in-situ burning would most likely not affect caribou hunting but could result in worry about environmental contamination of caribou and other food resources that could last for one harvest season or longer. Potential for contamination of caribou due to spill response and cleanup most likely would not result in complete cessation of caribou hunting or avoidance of all caribou hunting areas for one or more seasons. In the event of coastal or tundra oiling, shoreline and tundra cleanup and restoration activities could haze caribou away from oiled areas potentially reducing chances of caribou coming into direct contact with spilled crude or refined oil.

Impacts to subsistence caribou hunting from spill response and cleanup activities are expected to be minor to moderate depending on the extent and location of the spill. Minor to moderate effects from spill response and cleanup are not expected to change the overall impact conclusions for a large spill.

Conclusions for Caribou Hunting

Overall, BOEM expects negligible impacts to subsistence caribou hunting for Nuiqsut, Kaktovik, and Utqiaġvik from routine construction, development, production, and decommissioning activities associated with the Proposed Action.

Overall, BOEM expects minor impacts to individual caribou could occur as a result of the Proposed Action. Potential minor effects to caribou could result from helicopter overflights and winter construction activities.

If industry pilots maintain altitudes above 1,500 feet and do not approach groups of caribou and caribou hunters, minor and negligible impacts to from helicopter overflights to caribou and subsistence caribou hunting and minor impacts to individual caribou would most likely be eliminated.

The overall impacts to subsistence caribou hunting for Nuiqsut and Kaktovik from small spills would most likely be negligible as hunters would be able to pursue caribou at different areas outside the Proposed Action Area. BOEM anticipates small spills would have a negligible impact on caribou hunting for Utqiaġvik hunters because there is no spatial overlap between the Proposed Action Area and the core caribou hunting area for Utqiaġvik.

For a large spill of crude or refined oil resulting from the Proposed Action, BOEM anticipates moderate to major impacts to subsistence caribou hunting for Nuiqsut and minor to moderate impacts on caribou hunting for Kaktovik and Utqiaġvik.

Subsistence Fishing

Fishing is a major component of the annual subsistence rounds of Nuiqsut, Kaktovik, and Utqiaġvik. The primary species of importance for these communities include Arctic cisco, Arctic char, and broad whitefish (Section 3.3.3; Table 4-41; SRB&A, 2010).

Overlap with the Proposed Action

BOEM found some temporal overlap between subsistence fishing and the Proposed Action (Table 4-42). In general, winter construction and development activities would occur at the same time Utqiaġvik and Nuiqsut go fishing for Arctic cisco. Summer and fall construction and development activities would overlap in time with Kaktovik's main fishing seasons for Arctic cisco, Arctic char, and broad whitefish. Summer and fall construction and development activities would overlap in time with the Arctic char and broad whitefish seasons for Utqiaġvik and Nuiqsut.

BOEM found no spatial overlap between the Proposed Action Area and subsistence fishing areas for Arctic cisco, Arctic char, and broad whitefish for Nuiqsut, Kaktovik, and Utqiaġvik. The far western portion of Kaktovik's fishing area is along the coast near Flaxman Island and is about 35 miles east of the Proposed Action Area (SRB&A, 2010). Residents of Kaktovik harvest Arctic cisco, Arctic char, and broad whitefish in this area. Nuiqsut residents primarily fish for Arctic cisco in the main channels of the Colville River Delta north and west of town with the Nigliq Channel being of particular importance. Nuiqsut residents harvest Arctic cisco and most other fish species approximately 80 miles west of the Proposed Action Area. Utqiaġvik's subsistence fishing areas for these species are located approximately 200 miles west of the Proposed Action Area.

For Nuiqsut, Kaktovik, and Utqiaġvik, BOEM anticipates negligible impacts to subsistence fishing from routine construction, development, and production activities associated with the Proposed Action.

Potential Effects to Arctic Cisco

Human activities associated with oil and gas development in the nearshore and offshore Beaufort Sea and Colville River Delta have potential to affect Arctic cisco during critical life history stages (ARB, Inc. et al., 2007). Holdings of TEK who fish in the Colville River Delta concluded offshore oil and gas activities adversely affect the migration of juvenile Arctic ciscoes. They also concluded offshore drilling activities adversely affect feeding and growth of juvenile Arctic ciscoes and subadults in nearshore areas; and river channel crossings, ice bridges, and drilling in winter adversely impact overwintering Arctic ciscoes (ARB, Inc. et al., 2007).

Environmental factors such as salinity and wind direction appear to affect inter-annual variability in the Arctic cisco population in the Colville River to a greater extent than disturbances from industrial developments (ARB, Inc. et al., 2007). However, there is some evidence that industrial development activities in winter in the Colville River Delta negatively affected survival and catch rates of Arctic ciscoes (ARB, Inc. et al., 2007). This study found that over-wintering survival may have been reduced during the years with the most intense development activities in the Colville River Delta in particular winter construction activities. The study found no obvious effects of offshore seismic activity on total recruitment levels or catch rates for Arctic cisco. A number of residents expressed concerns about hydrocarbon pollutants in cisco; a study of fish tissues from Arctic ciscoes caught in the 2005 subsistence fishery found non-detectable levels of hydrocarbons in all samples (Moulton et al., 2006). ARB, Inc. et al. (2007) found no evidence of any effect of causeways on total recruitment, survival, or catch rates of Arctic cisco.

Winter development activities in the Colville River Delta have the potential to adversely affect Arctic cisco survival (ARB, Inc. et al., 2007). However, the winter construction and development activities planned for the Proposed Action in the Foggy island Bay area are not anticipated to affect the Colville River Delta because there is no spatial overlap between the two. The proposed LDPI is not expected to block the Arctic cisco migration in coastal waters or interfere with summer feeding for Arctic ciscoes (Section 4.3.2). BOEM expects negligible impacts from the Proposed Action to Arctic ciscoes used for subsistence purposes.

Oil Spills and Spill Response

BOEM anticipates negligible impacts on subsistence fishing from small spills associated with the Proposed Action for Nuiqsut, Kaktovik, and Utqiaġvik. Small spills would be too far away from the primary subsistence fisheries to have an adverse effect on these subsistence fisheries. Small spills would disperse and evaporate within hours to days before reaching the coastal fisheries or the mouth of the Colville River. Residents of Kaktovik and Nuiqsut would most likely become concerned about potential contamination of coastal fishes due to reports of small spills. For subsistence fishers and community residents, stress over potential contamination of subsistence foods such as Arctic cisco, Arctic char, and broad whitefish could be short-term and localized or long lasting and widespread depending on the location of the spill. However, BOEM does not anticipate that small spills would completely shut down any subsistence fishery for one or more seasons or render these subsistence fish inedible.

Nuiqsut's Arctic cisco subsistence fishery would be most vulnerable to a large spill of crude or refined oil during September through December. For the winter season, October 1 through June 30, the subsistence use area at the Colville River Delta has a 2 percent chance of being contacted by a large spill starting at the proposed LDPI within 90 days after the event. The chance of contact from a large spill originating at the pipeline in winter is 1 percent for the Colville River Delta 90 days after the spill. Nuiqsut's Arctic char and broad whitefish seasons would be most vulnerable during summer. The chance of contact from a large spill for the Colville River Delta is greater in summer than in winter. During July through September, there is a 6 percent chance of oil contacting the Colville River Delta within 30 days after a large spill starting at the proposed LDPI and a 3 percent chance of contact from a large spill originating at the pipeline.

In the unlikely event that a large spill contacted the Colville River Delta during the Arctic cisco fishing season from September through December, impacts to subsistence fishing could be severe and thus major. Oil on and under the ice would most likely deter residents of Nuiqsut from setting their nets under the ice for Arctic ciscoes for one or more seasons. The impacts to the community caused by the potential for contamination of fish in the Colville River Delta would be major. In summer, Nuiqsut harvesters go farther up river south of town for Arctic char and do not rely on the delta as much as they do for catching Arctic ciscoes in winter. If a large spill contacted the Colville River Delta in summer, effects to subsistence fishing could be long lasting and widespread and thus moderate. The impacts would primarily be associated with potentially contaminated whitefish and char as a food source. Nuiqsut fishers would be able to fish upstream for Arctic char and whitefishes and would most likely not miss an entire fishing season as a result of a large spill. Arctic char and broad whitefish would be available south of the delta and close to the town of Nuiqsut.

During summer, Kaktovik fishers primarily go for Arctic ciscoes, Arctic char, and broad whitefish along the coastline from Demarcation Bay in the east to Flaxman Island in the west; they also travel inland during winter by snowmachine to harvest Arctic char in the Hulahula River (SRB&A, 2010). During July 1 through September 30, there is less than 0.5 percent chance of Camden Bay, Barter Island, and Demarcation Bay being contacted by a large oil spill (Appendix A posted at www.boem.gov/liberty). For Flaxman Island during the summer season, there is a 4 percent chance of contact with oil starting from a spill on the proposed LDPI and a 2 percent chance of contact from a large spill originating from the pipeline within 30 days after the event. There is only a 1 percent chance of oil contacting the Canning River Delta within 30 days after a large spill starting from the proposed LDPI in summer.

In the unlikely event that a large oil spill contacted the coastal areas of Flaxman Island, the Canning River Delta, Camden Bay, Barter Island, or Demarcation Bay during July 1 through September 30, these subsistence fisheries could be moderately impacted for harvesters from Kaktovik. They would still be able to pursue Arctic char inland on the Hulahula and other rivers in the winter, but a large oil spill in these coastal areas would most likely close down portions of one or more summer fishing seasons, resulting in long lasting and widespread impacts to Kaktovik fishers. This area is large, so if the western part of Kaktovik's fishing grounds was contacted by a large spill, Kaktovik fishers could use the eastern portion closer to the community. These fish species would most likely be available to harvesters from Kaktovik unless the entire coast was oiled. BOEM expects that Kaktovik fishers would not completely lose one or more summer fishing seasons as a result of a large spill from the

Proposed Action. BOEM anticipates moderate impacts to subsistence fishing for Kaktovik if a large spill occurs, primarily due to oiled shorelines and potential contamination of some subsistence fish resources that are important for food and sharing.

Subsistence harvesters from Utqiaġvik primarily go fishing for Arctic cisco, Arctic char, and broad whitefish during June through November. With the exceptions of the northwest part of Smith Bay and Elson Lagoon just off Point Barrow, Utqiaġvik fishers tend to use inland rivers and lakes feeding Dease Inlet for these subsistence resources (SRB&A, 2010). BOEM does not anticipate that a large oil spill from the Proposed Action would affect the Meade, Inaru, and Chipp rivers that flow into Dease Inlet. For the coastal area of Point Barrow (i.e., Elson Lagoon), 90 days after a large spill event from the proposed LDPI there is only a 2 percent chance of oiling during July 1 through September 30; this drops to 1 percent for a large spill launched from the pipeline. In summer, 90 days after an event, Smith Bay has a 1 percent chance of being contacted from a large spill starting at the proposed LDPI. BOEM anticipates little to no effect and thus negligible impacts to subsistence fishing from a large spill for residents of Utqiaġvik.

Subsistence fishing for Arctic cisco, Arctic char, and broad whitefish could be adversely affected by spill response and cleanup activities that involved volunteer or paid employment of local subsistence fishers by diverting time, effort, and equipment away from fishing to OSR and cleanup for one or more seasons. However, earning cash from paid work in spill response and cleanup could allow some subsistence fishers to purchase newer boats, motors, and nets and fuel needed to effectively pursue fish in these subsistence fisheries.

Depending on the size of the spill and whether or not it contacted onshore and offshore subsistence resources, response and cleanup duration and impacts could be short-term and localized or long lasting and widespread.

Mechanical methods used to recover spilled oil offshore are not expected adversely affect subsistence fishing. Mechanical recovery and physical cleanup methods used on the shorelines and in nearshore waters in summer could disrupt subsistence fishing for Kaktovik. The use of in-situ burning would most likely result in worry over environmental contamination and potentially contaminated fishery resources that could last for one harvest season or longer. Potential contamination of fish due to spill response and cleanup could result in cessation of subsistence fishing in coastal areas or river deltas for one or more season.

Impacts to subsistence fishing for Nuiqsut and Kaktovik caused by spill response and cleanup activities are expected to be minor to moderate depending on the extent and location of the spill. BOEM anticipates that spill response and cleanup activities would have negligible effects on Utqiaġvik’s subsistence fisheries. Negligible to moderate effects from spill response and cleanup are not expected to change the overall impact conclusions for a large spill.

Conclusions for Subsistence Fishing

For Nuiqsut, Kaktovik, and Utqiaġvik, BOEM anticipates negligible impacts to subsistence fishing from routine construction, development, and production activities associated with the Proposed Action.

The winter construction and development activities planned for the Proposed Action in the Foggy Island Bay area are not anticipated to directly affect Arctic ciscoes overwintering in the Colville River Delta because there is no spatial overlap between the this area and the Proposed Action Area. The proposed LDPI is not expected to block the Arctic cisco migration in coastal waters or interfere with summer feeding for Arctic ciscoes (Section 4.3.2). BOEM expects negligible impacts from the Proposed Action to Arctic ciscoes used for subsistence purposes.

BOEM anticipates negligible impacts on subsistence fishing from small spills associated with the Proposed Action for Nuiqsut, Kaktovik, and Utqiaġvik. For subsistence fishers and community residents, stress and worry about contaminated subsistence foods such as Arctic cisco, Arctic char, and broad whitefish could be minor to major depending on the location of the small spill. If the small spill occurred where people fish, impacts of stress and worry over contamination could be major; if the spill is located away from where people fish, these types of effects could be minor. Actual contamination of subsistence fish resources resulting from small spills is not expected.

In the unlikely event that a large spill contacted the Colville River Delta during the Arctic cisco fishing season from September through December, impacts to subsistence fishing could be major for residents of Nuiqsut. If a large spill contacted the Colville River Delta in summer, effects to Nuiqsut's subsistence fishing are expected to be moderate. For Nuiqsut, BOEM anticipates a moderate to major impact to subsistence fishing from a large spill. BOEM anticipates moderate impacts to subsistence fishing for Kaktovik if a large spill occurs. BOEM anticipates negligible impacts to subsistence fishing from a large spill for residents of Utqiaġvik.

Subsistence Waterfowl Hunting

Geese and eiders are an important food resource on the North Slope (Section 3.3.3; Fuller and George, 1997; Huntington, 2009; SRB&A, 2010). Eiders specifically and waterfowl in general also hold substantial sociocultural importance for the Iñupiat people (Huntington, 2009).

Residents of Nuiqsut harvest geese April through June. The core goose hunting areas for Nuiqsut are located on Fish Creek, along the Colville River south of town, and to the north along Nigliq Channel. The core eider hunting area for Nuiqsut is an area up to 10 miles offshore of the Colville River Delta and east to Thetis and Cross Islands May through September.

Kaktovik residents hunt geese close to shore and along inland rivers during May through September. Kaktovik's core hunting area for geese is located between Collinson Point to the west and Pokok Lagoon to the east, inland along major rivers, and across from Barter Island. Residents of Kaktovik hunt eiders on the coast in the same locations and at the same times as geese and as far west as the Sagavanirktok River.

Utqiaġvik residents reported hunting geese as far east as Teshekpuk Lake, south of Wainwright, inland on the Meade and Chipp rivers, and substantial distances offshore west of Point Barrow. Residents of Utqiaġvik generally hunt for eiders May through August. Eider hunting occurs offshore north and west of town and on the Inaru and Meade rivers.

Overlap with the Proposed Action

The proposed summer construction activities for LDPI slope protection and the proposed reclamation of the gravel mine overlap in time with waterfowl hunting activities for Nuiqsut, Kaktovik, and Utqiaġvik.

There is potential spatial overlap between proposed LDPI slope protection activities proposed for May through August and eider hunting areas for Nuiqsut and eider and goose hunting areas for Kaktovik (Table 4-42; SRB&A, 2010). There also is potential for spatial overlap between Kaktovik's waterfowl hunting area and reclamation activities at the proposed gravel mine. Nuiqsut hunters sometimes go for eiders near Cross Island north of the Proposed Action Area and offshore of Foggy Island and Mikkelsen Bays. Kaktovik hunters pursue geese and eiders in the same places along the coast as far west as Prudhoe Bay, including the shorelines and nearshore waters of Foggy Island Bay. This is the far western extent of Kaktovik's waterfowl hunting area; their core waterfowl area is smaller, extending to the western edge of Camden Bay.

BOEM found no spatial overlap between the Proposed Action and subsistence goose hunting areas used by Nuiqsut hunters; BOEM anticipates negligible impacts to Nuiqsut's goose hunting season from routine construction, development, production, and decommissioning activities. BOEM found no spatial overlap between the Proposed Action and subsistence waterfowl hunting areas used by Utqiaġvik hunters. For routine construction, development, production, and decommissioning activities, BOEM anticipates negligible impacts to subsistence waterfowl hunting for harvesters from Utqiaġvik.

LDPI Slope Protection

LDPI slope protection activities are proposed as part of summer construction for the proposed LDPI to fortify the proposed LDPI's perimeter (Hilcorp, 2015). Slope protection activities are scheduled for May through August during Year 2 (Figure 2-1; Hilcorp, 2015, p.16). Eider hunting season for Nuiqsut and goose and eider hunting seasons for Kaktovik primarily occur May through July (Table 4-41) and would be most at risk from potential impacts caused by slope protection work in summer. The waterfowl hunting seasons for Nuiqsut and Kaktovik could be affected by LDPI slope protection work. The potential effects could be disturbance of birds due to construction noises, disturbance or diversion of waterfowl and hunters caused by helicopter overflights, conflicts between waterfowl hunting boats and support vessels, and avoidance of the Proposed Action Area due to summer construction activities thereby potentially reducing goose and eider hunting opportunities for the Execute Year 3 open-water season. However, waterfowl would not become unavailable for one or more seasons, and hunters would have continued opportunities to go hunting for eiders and geese in areas closer to Nuiqsut and Kaktovik. Noises and disturbances from slope protection work and associated support vessel and aircraft traffic could result in short-term and localized and thus minor impacts to subsistence waterfowl hunting for Nuiqsut and Kaktovik. This would especially be the case if hunters need to look for birds in the Proposed Action Area in May through August if eiders (and geese for Kaktovik) were not available closer to home.

Gravel Mine Reclamation

BOEM found potential for spatial overlap between reclamation activities at the gravel mine site in summer and waterfowl hunting for Kaktovik. After completion of gravel mining, the mine site would be closed and rehabilitated. Rehabilitation would likely include conversion of the pit to aquatic habitat and re-contouring excavated overburden. The rehabilitation plan would likely include creation of shallow-water benches, and reseeding and/or replanting with locally adapted plants. Rehabilitation activities such as revegetation and final surveying work would likely occur during the summer months of June through September, using helicopters to transport workers and materials (Hilcorp, 2015, Appendix A, p. 4-98; Jack Winters, ADF&G, personal communication). Re-contouring excavated earth would take place during winter months in January through April, using ice roads and bulldozers (Jack Winters, ADF&G, personal communication). Winter reclamation activities do not overlap with waterfowl hunting because the birds are not present.

The shoreline and coastal waters of Foggy Island Bay are part of Kaktovik's waterfowl hunting area. The proposed mine site is only one half mile inland from Foggy Island Bay, and reclamation would take five months in Execute Year 1. The waterfowl hunting season that year for Kaktovik could be affected by reclamation work during summer months at the proposed mine site. Potential effects could be disturbance of birds and hunters due to noises caused by reclamation activities, disturbance or diversion of waterfowl or hunters caused by helicopter overflights or vehicular travel on the tundra, and avoidance of the proposed mine site due to reclamation work thereby potentially reducing goose and eider hunting opportunities for Kaktovik. However, waterfowl would not become unavailable for one or more seasons, and hunters would have continued opportunities to go hunting for eiders and geese in areas closer to Kaktovik. Noises and disturbances from reclamation work and associated support vehicle and aircraft traffic could result in short-term and localized, and thus minor, impacts to subsistence waterfowl hunting for Kaktovik. This would especially be the case if hunters needed to look for birds in the Proposed Action Area May through September in Execute Year 1 if eiders and geese were not available closer to Kaktovik.

Oil Spills and Spill Response

Residents of Nuiqsut and Kaktovik have reported thousands of birds migrate into the Nuiqsut and Kaktovik areas during spring, and the entire Beaufort coast is important for a large variety of eiders, geese, and duck species for feeding and nesting in the warmer months (Section 3.2.3; SRB&A, 2011). Migratory waterfowl use the entire nearshore environment, including the coastline, barrier islands, and river deltas. The Proposed Action Area is located in the center of this important waterfowl habitat area. Small and large spills of crude and refined oil occurring May through September could adversely impact migratory waterfowl and subsistence bird hunting.

Small spills starting at the proposed LDPI and the far offshore portions of the pipeline are unlikely to affect individual birds, because small spills cover a small area and are less likely to persist in the environment (USDOI, MMS, 2002). The USFWS has concluded that listed eiders would not be killed as a result of small spills from the Liberty project (USFWS, 2009, p. 28). Small spills starting from the nearshore portion of the pipeline could reach birds' shoreline habitat. Waterfowl are particularly vulnerable to oiling due to oil's effects on their feathers. If a small spill happened close to shore or at the pipeline crossing from seabed to land, a small number of birds and their nesting areas could potentially be oiled as a result of the Proposed Action. In the event that individual birds were contacted by a small spill, the impacts on birds are expected to be short-term and localized and thus minor. A small number of individual birds could be oiled and become ill and/or die.

If small spills occurred during the main waterfowl hunting season, May through September, bird hunters from Nuiqsut and Kaktovik could experience worry over potentially contaminated waterfowl. Hunters would most likely be concerned that any birds traveling through the Proposed Action Area could be contaminated as a food source due to small spills. If small spills contacted the shoreline of barrier islands such as Cross Island, the shores of Foggy Island Bay, or the Sagavanirktok River Delta during the waterfowl hunting season, subsistence bird hunting at these locations could be temporarily disrupted because hunters would be unable or unwilling go there for fear of contaminated resources and oiled beaches. The impacts to subsistence waterfowl hunting would be short-term and localized, and thus minor, and hunters would be able to pursue geese and eiders at different areas. The effects of the potential for contamination of birds as a food source would most likely be longer lasting and more widespread, and thus moderate. However, small spills originating in the Proposed Action Area would most likely not reach important bird habitat due to relatively fast dispersion and evaporation unless a small spill originated at the shoreline from the pipeline.

BOEM anticipates that small spills would have a negligible impact on waterfowl hunting for Utqiaġvik hunters because there is no spatial overlap between the Proposed Action Area and the waterfowl hunting area for Utqiaġvik.

BOEM expects a large spill of crude or refined oil from the Proposed Action to have greater impacts to subsistence waterfowl hunting than small spills. Nuiqsut hunters primarily pursue geese in the western part of the Colville River Delta and along the eastern shores of Harrison Bay. This subsistence use area has a 6 percent chance of being contacted by a large spill originating from the proposed LDPI within 30 days after the event in July through September and a 3 percent chance of being oiled from a large spill starting at the pipeline. Thetis Island and up to 10 miles offshore of the Colville River Delta are used for eider hunting by Nuiqsut hunters. Within 30 days after a large spill starting at the proposed LDPI, the Thetis Island area has a 10 percent chance of being oiled in summer and a 4 percent chance of being contacted by a large spill starting at the pipeline. The other eider hunting area for Nuiqsut is the Cross Island area offshore between Prudhoe and Mikkelsen bays. Within 30 days after a large spill occurs, the Cross Island subsistence use area has a 26 percent chance of being contacted by a large spill from the proposed LDPI July through September; the chance of this important area being contacted by a large spill from the pipeline is 13 percent.

If any or all of these areas of coastal bird habitat were oiled by a large spill during the goose and eider seasons, Nuiqsut waterfowl hunters could experience severe and thus major impacts because this is their core waterfowl hunting area. Individual birds could be killed if contacted by oil. Waterfowl hunters from Nuiqsut would most likely stop goose hunting in the Colville River area and stop eider hunting near Thetis Island for one or more seasons due to oiled beaches and the potential for contamination of migratory birds. Geese may not be completely unavailable; hunters would be able to pursue geese farther inland closer to town along the Colville River. They could look for eiders in the Cross Island area May through July, but this activity would most likely be limited to whaling crews August through September, plus Cross Island has a greater chance of being oiled July through September than Thetis Island and the Colville River Delta. Eider hunting by Nuiqsut hunters could be severely limited due to a large oil spill from the Proposed Action. Stress and worry about the potential for contaminated birds would most likely be long lasting and severe due to a large oil spill for most of Nuiqsut’s waterfowl hunting territory.

The far western portions of Kaktovik’s waterfowl hunting area could be contacted by crude oil in the event of a large spill. The Sagavanirktok River Delta and Foggy Island Bay have a 68 percent chance of being oiled within 30 days after a large spill starting at the proposed LDPI during July through September; the chance of contact is 59 percent for a large spill originating at the pipeline. In the event of a large spill in the Proposed Action Area, Kaktovik hunters would most likely avoid the far western portions of their waterfowl hunting area between Prudhoe Bay and Flaxman Island. This would limit their waterfowl hunting opportunities to areas closer to town in the core hunting area for one or more seasons; the effects of which are expected to be minor to moderate depending on availability of geese and eider in the core area at the time of the spill. A large spill from the Proposed Action could cause long lasting and widespread and thus moderate impacts related to psychological stress and worry over the potential for contamination of geese and eiders as a food source for one or more hunting seasons for residents of Kaktovik.

For Utqiaġvik, BOEM expects short-term and localized, and thus minor, impacts to subsistence goose and eider hunting as a result of a large spill of crude or refined oil. This is particularly the case for coastal areas east of Point Barrow such as southern Smith Bay if the shoreline or birds were oiled there. The Proposed Action Area is too great a distance from Utqiaġvik’s core offshore eider hunting area to be contacted by oil. Moreover, most goose hunting and some eider hunting is done inland on various rivers south of town that would not be contacted by a large oil spill (SRB&A, 2010). However, a large spill could cause long lasting and widespread and thus moderate impacts related to psychological stress and potential contamination of geese and eiders as a food source for one or more hunting seasons for residents of Utqiaġvik.

Subsistence waterfowl hunting could be adversely affected by spill response and cleanup activities if volunteer or paid employment of local subsistence hunters diverted time, effort, and equipment away from bird hunting to OSR and cleanup for one or more seasons. However, earning cash from paid work in spill response and cleanup could allow some subsistence hunters to purchase newer boats, motors, snowmachines, firearms, ammunition, and fuel needed to effectively pursue waterfowl.

Depending on the size of the spill and whether or not it contacted onshore and offshore important habitat for geese and eiders and other subsistence resources, response and cleanup duration and impacts could be short-term and localized or long lasting and widespread.

Mechanical methods used to recover spilled oil offshore are not expected to adversely affect subsistence waterfowl hunting. Mechanical recovery and physical cleanup methods used on the shorelines and in nearshore waters in summer could disrupt waterfowl and subsistence hunting by boats for Nuiqsut and Kaktovik. The use of in-situ burning would most likely result in worry about environmental contamination and potential contamination of waterfowl and their critical habitat areas that could last for one harvest season or longer. Potential contamination of birds used for food due to spill response and cleanup could result in cessation of subsistence waterfowl hunting in oiled coastal areas such as shorelines of barrier islands or river deltas for one or more season.

Impacts to subsistence waterfowl hunting for Nuiqsut and Kaktovik caused by spill response and cleanup activities are expected to be minor to moderate depending on the extent and location of the spill. BOEM anticipates that spill response and cleanup activities would have negligible effects on Utqiaġvik's waterfowl hunting activities. Negligible to moderate effects from spill response and cleanup are not expected to change the overall impact conclusions for a large spill.

Conclusions for Subsistence Waterfowl Hunting

BOEM anticipates negligible impacts to Nuiqsut's goose hunting season from routine construction, development, production, and decommissioning activities and negligible impacts to subsistence waterfowl hunting for harvesters from Utqiaġvik.

Noises and disturbances from LDPI slope protection work and associated support vessel and aircraft traffic scheduled for May through August could result in minor impacts to subsistence waterfowl hunting for Nuiqsut and Kaktovik.

Noises and disturbances from summer reclamation work at the proposed gravel mine and associated support vehicle and aircraft traffic could result in minor impacts to subsistence waterfowl hunting for Kaktovik. BOEM anticipates that minor impacts to waterfowl hunting from LDPI slope protection and mine reclamation activities could be reduced to negligible or completely eliminated. This would require communication and monitoring on the part of both industry and subsistence harvesters (Appendix C). Industry should work with waterfowl hunters from Nuiqsut and Kaktovik to establish a communication center and hire local subsistence advisors. Other specific measures include:

- Plan timing and siting of construction and reclamation activities to minimize exposure of waterfowl and hunters to noise and vessel and vehicle traffic.
- Learn from local hunters the areas and times that are most sensitive for waterfowl and subsistence hunting activities (SRB&A, 2009).
- Set minimum altitudes for industrial helicopter overflights, for example 1,500 feet.
- Establish a real-time monitoring and response communication system so harvesters out on the land and water can speak directly with dispatchers, alert harvesters to planned construction activities, and enable harvesters and industrial pilots to exchange ideas to minimize impacts from helicopter overflights.

For small spills of crude or refined oil, BOEM anticipates minor to moderate impacts to subsistence waterfowl hunting for Nuiqsut and Kaktovik. BOEM anticipates that small spills would have a negligible Impact on waterfowl hunting for Utqiaġvik hunters because there is no spatial overlap between the Proposed Action Area and the waterfowl hunting area for Utqiaġvik.

For a large oil spill, BOEM expects major impacts to subsistence waterfowl hunting for Nuiqsut and minor to moderate impacts to subsistence waterfowl hunting for Kaktovik and Utqiaġvik.

4.4.3.2 Alternative 2 (No Action)

Under Alternative 2, potential impacts would not occur to subsistence activities and harvest patterns from disruptions to hunting and fishing due to noise, physical presence, diversion of animal and fish migrations, and potential resource contamination associated with the Proposed Action. There would be no impacts on subsistence harvest patterns for Nuiqsut, Kaktovik, and Utqiaġvik.

4.4.3.3 Alternative 3 (Alternate LDPI Locations)

In Alternative 3, the proposed LDPI would be relocated to one of two locations (Section 2.2.4). Alternative 3A would relocate the proposed LDPI one mile to the east into slightly deeper water, and Alternative 3B would relocate the proposed LDPI 1.5 miles to the southwest into slightly shallower water and closer to the shoreline of Foggy Island Bay.

For both Alternative 3A and 3B, the proposed LDPI would remain in the southern portion of Nuiqsut's whaling area. Moving the proposed LDPI closer to shore into shallower water would most likely reduce the likelihood of the proposed LDPI interfering with movement patterns of bowhead whales inside the barrier islands and Cross Island whaling activities. The decreases in this case would be negligible since most whaling activities and whale sightings have been farther to the north and east of the proposed LDPI site. Moving the proposed LDPI farther to the east into deeper water could increase the likelihood of interference with whaling practices and bowhead movement patterns, but these increases in likelihood would be negligible for the same reasons.

Alternatives 3A and 3B would not change the potential likelihood or severity of whaler avoidance of the Proposed Action Area.

Both options under Alternative 3 would increase drilling time, size and power of the drill rig, fuel consumption, risk, and technical difficulty. These changes would most likely increase the amount of overall noise produced at the proposed LDPI site. However, the increased drilling noise under Alternatives 3A and 3B is not expected to change the likelihood or severity of potential impacts to subsistence harvest patterns. Placing the island closer to shore could mean that any deflection of whales that occurs would most likely occur closer to shore, which would reduce the likelihood that whales will travel farther out to sea than whalers can safely and effectively travel while scouting for whales.

Alternative 3A would increase construction time and materials which could extend potential impacts from LDPI slope protection activities into late summer-early fall. This change could increase potential impacts to subsistence harvest patterns especially if construction activities were extended into the fall whaling season for Nuiqsut and/or into a second summer construction season and hence a second whaling season. Under Alternative 3A, effects to whaling for Nuiqsut from summer construction activities at the proposed LDPI would remain major but prolonged into a second whaling season. This increase in summer construction time could also increase impacts to subsistence seal hunting from minor to moderate for Nuiqsut and Kaktovik.

Alternative 3B would decrease construction time and materials, which could reduce potential impacts to subsistence harvest patterns. Under 3B, effects to whaling for Nuiqsut from summer construction activities at the proposed LDPI could be reduced. Under Alternative 3B, if construction at the proposed LDPI ceased August 25 or at the start of the Cross Island Hunt (whichever occurs first), impacts to whaling for Nuiqsut from LDPI slope protection work could be reduced from major to moderate. If summer construction at the proposed LDPI site ceased August 1 under Alternative 3B, impacts to whaling for Nuiqsut from LDPI slope protection work could be reduced from major to minor. This change could also reduce potential impacts to subsistence seal hunting from minor to negligible for Nuiqsut and Kaktovik hunters.

Alternative 3B would move the proposed LDPI and operations into waters managed by the SOA. If the proposed LDPI were moved 1.5 miles to the south into State waters, the property taxes would increase (Section 2.2.4). Increased revenue to the State and NSB from Alternative 3B could have long lasting and widespread beneficial effects to subsistence harvesters, sharing networks, and North Slope communities. Increased revenue could have moderate beneficial impacts to the sociocultural systems in the NSB (Section 4.4.1.4).

Alternative 3A would most likely increase the length of the annual ice road from the SDI to the proposed LDPI and summer travel between SDI and the proposed LDPI. A slightly longer ice road on sea ice is not expected to change the likelihood or severity of impacts to subsistence harvest patterns. More travel time during the summer via vessels and helicopters could increase impacts to subsistence harvest patterns; in particular, increased helicopter over flights could add to the severity of impacts on summer caribou hunting for Kaktovik. However, BOEM does not expect this change to increase the likelihood of impacts on subsistence caribou hunting in summer for Kaktovik because the Proposed Action Area is located in the far western portion of Kaktovik's historic caribou hunting territory. During the 25-year life of the Proposed Action, hunters from Kaktovik would most likely rarely use the coastal areas of western Foggy Island Bay for caribou harvest. Overall, impacts to summer caribou hunting would not differ substantially from impacts associated with the Proposed Action.

4.4.3.4 Conclusion for Alternatives 3A and 3B

Most impacts of Alternative 3A on subsistence activities and harvest patterns would be the same as those for the Proposed Action (4.3.3.1) with the exception of potential effects of summer construction on whaling and seal hunting. Potential effects on whaling for Nuiqsut from summer construction activities at the proposed LDPI would remain major but prolonged into a second whaling season, which could increase the duration and likelihood of impacts to subsistence whaling. Impacts to subsistence seal hunting from LDPI slope protection work could increase from minor to moderate, especially if seal hunters from Nuiqsut and Kaktovik could not find seals closer to home and needed to look for seals closer to the proposed LDPI. Overall, BOEM expects Alternative 3A to have moderate to major adverse effects to subsistence whale and seal hunting for Nuiqsut and Kaktovik.

Most impacts of Alternative 3B on subsistence activities and harvest patterns would be the same as those for the Proposed Action (4.4.3.1) with the exception of potential effects of summer construction on whaling and seal hunting. If summer construction at the proposed LDPI ceased by August 25 or at the start of the Cross Island hunt (whichever occurs first), impacts to whaling for Nuiqsut from LDPI slope protection work could be reduced from major to moderate. If summer construction at the proposed LDPI site ceased by August 1 under Alternative 3B, impacts to whaling for Nuiqsut from LDPI slope protection activities could be further reduced to minor. This change could also reduce potential impacts to subsistence seal hunting for Nuiqsut and Kaktovik hunters. BOEM anticipates minor to moderate adverse effects to subsistence whale and seal hunting for Nuiqsut and Kaktovik from Alternative 3B.

Under Alternative 3B, if increased tax revenue was provided to the NSB as a result of moving the proposed LDPI into State waters, subsistence harvesters in Nuiqsut, Kaktovik, and Utqiaġvik could benefit through moderate beneficial impacts to the sociocultural system (Sections 4.4.1.1.2 and 4.4.1.4).

4.4.3.5 Alternative 4 (Alternate Processing Locations)

Under Alternative 4, oil and gas processing would not occur on the proposed LDPI, but relocated to one of two alternate facilities (Section 2.2.5).

Both Alternative 4A and 4B would reduce the construction time for the offshore proposed LDPI, perhaps by as much as 20 days, which could reduce potential effects to subsistence harvest patterns. Decreasing summer construction activities at the proposed LDPI site related to LDPI slope protection could reduce impacts to whaling for Nuiqsut from major to moderate or minor, depending on when summer construction would cease. This change could also reduce potential impacts to subsistence seal hunting from minor to negligible for Nuiqsut and Kaktovik hunters.

For both Alternative 4A and 4B, the proposed LDPI would remain in the southern portion of Nuiqsut's whaling area. Alternative 4 would not change the potential likelihood or severity of whaler avoidance of the Proposed Action Area.

Both Alternative 4A and 4B would increase construction time for the offshore pipeline in winter months. Alternative 4B would increase onshore construction activities in winter at the Badami pipeline tie-in point and would most likely increase the likelihood and severity of potential impacts to caribou if the processing facility was built and operated there. However, BOEM does not anticipate that these longer construction times in winter for the pipeline or the new processing facility would increase the likelihood or severity of potential impacts on subsistence activities or harvest patterns, including caribou hunting by subsistence harvesters from Kaktovik.

Over the 25-year life of proposed operations, Alternatives 4A and 4B would most likely reduce the overall noise produced at the proposed LDPI because all noise directly associated with processing would be substantially farther from the proposed LDPI site. All power for both the onshore and offshore facilities would be generated onshore, further reducing noises offshore at the proposed LDPI site. The added pumps at the proposed LDPI location would produce some noise during seawater injection and movement of unprocessed product to the onshore processing facility. Overall, BOEM does not anticipate any added advantage or reduced impact to marine mammals such as bowhead whales from this reduction in offshore noise. The reduction in noise would most likely be indiscernible from background noise levels generated during production as currently measured (4.4.1.6). However, any reduction of noise offshore at the proposed LDPI site would most likely reduce impacts to Cross Island whalers and other residents of Nuiqsut associated with their knowledge and experience of how noise decreases whaling success.

4.4.3.6 Conclusion for Alternatives 4A and 4B

Most impacts of Alternative 4A on subsistence activities and harvest patterns would be the same as those for the Proposed Action (Section 4.4.3.1) with the exception of potential effects of summer construction on whaling and seal hunting. For Nuiqsut, decreasing the time needed for summer construction activities for LDPI slope protection work could reduce impacts to whaling from summer construction from major to moderate or minor, depending on when summer construction would cease (Section 4.4.3.1). This change could also reduce potential impacts to subsistence seal hunting for Nuiqsut and Kaktovik hunters. Moreover, moving processing to Endicott or onshore near Badami would most likely decrease noise in the vicinity of the proposed LDPI that Cross Island whalers know can cause deflection of whales farther offshore, increased difficulty in hunting, skittishness in whale behavior, and lower success in whaling. Overall, BOEM expects minor to moderate adverse effects to subsistence whale and seal hunting for Nuiqsut and Kaktovik from Alternative 4.

4.4.3.7 Alternative 5 (Alternate Gravel Sources)

Alternative 5 would relocate the gravel mine from the proposed mine site west of the Kadleroshilik River to a new or existing gravel mine site (Section 2.2.6). There are two alternate mine sites, Alternatives 5A and 5B, east of the Kadleroshilik River.

BOEM anticipates that impacts from Alternatives 5A and 5B on subsistence activities and harvest patterns would be essentially the same as impacts described for the Proposed Action (Section 4.4.3.1).

4.4.3.8 Conclusion for Alternatives 5A and 5B

Impacts from Alternatives 5A and 5B on subsistence activities and harvest patterns would be essentially the same as impacts described for the Proposed Action (Section 4.4.3.1).

4.4.4 Community Health

4.4.4.1 Overview

The main community health conclusions of the Arctic Monitoring and Assessment Program oil and gas assessment (AMAP, 2009, p. 16-17) indicate that there are unlikely to be any major impacts from contaminants exposure from exploration and extraction activities on human populations in the Arctic unless there are major oil spills.

Social impacts from arctic oil and gas development are foreseeable, however. Social impacts are consequences of private or public actions or programs that result in changes in people’s ways of life, cultures, communities, economies, political systems, environments, health and well-being, or aspirations for the future (CGG, 2006). Social impacts of oil and gas activities associated with increased disposable income, an influx of workers from outside the arctic communities, more community revenue, and changes in social and cultural integrity may occur and could affect community health outcomes (AMAP, 2009, p. 17). Social effects are expected to be both positive (e.g., better health and educational services) and negative (e.g., dietary, social, and cultural disruptions).

4.4.4.1.1 Community Health and Subsistence

In the NSB, healthy people and community well-being are inseparable from a subsistence way of life and depend on having intact and functional sociocultural systems (Section 3.3.4.3). Participation in traditional subsistence activities provides nutritious foods, physical activity, and social interactions across generations and is a vital part of maintaining cultural integrity and individual and community health and well-being (Gadamus, 2013; Haley and Magdanz, 2008; McAninch, 2012, p. 90; Smith et al., 2009; USARC, 2015). Availability of and access to traditional foods and other local subsistence resources are critical determinants of physical and social health and cultural well-being in Nuiqsut and other communities in the NSB.

Perceived and actual threats to subsistence activities and harvest patterns are a primary source of ongoing concern and stress in North Slope communities (Kruse, 2010). Harvest loss, if sustained, could result in disruptions to food sharing patterns, which could create cultural stress and diminish general health, nutritional health, and well-being for some rural residents of the NSB; in turn, these effects could adversely affect rates of social problems, mental health disorders, and suicide (McGrath-Hanna et al., 2003). Ultimately, sustained loss of subsistence harvests could erode or damage cultural values and create stress on local institutions such as local whalers’ associations and health care providers.

4.4.4.1.2 Community Health and Climate Change

As described in Chapter 3, global climate change could alter current conditions in the Proposed Action Area during the 25-year life of the Proposed Action. Further disruptions to subsistence harvest patterns from global environmental and climatic changes could foreseeably have adverse effects on community health in the NSB (ANTHC, 2014). Beneficial effects of climate change may occur as well. Effects of global climate change to community health are anticipated to continue well into the future beyond the 25-year life of the Proposed Action. Adverse effects would most likely be related to losses of opportunities to practice subsistence hunting, fishing, and sharing. For example, factors associated with climate change may alter communities’ abilities to harvest resources due to less reliable ice conditions and more severe weather events. Beneficial effects would most likely be related to increased or improved access to current or new subsistence resources such as improved ability to travel and navigate rivers in search of terrestrial mammals and freshwater fishes (Huntington, Quakenbush, and Nelson, 2016). The capacity of vulnerable individuals and communities to adapt could have substantial bearing on community health and wellbeing (Curtis et al., 2005; Gadamus, 2013). However, during the next 25 years, BOEM does not expect the effects of the Proposed Action on subsistence harvest patterns to change from those described in Chapter 4 due to potential changes related to global climate change. Overall, BOEM does not anticipate, in this relatively short timeframe, that climate change would alter the potential impacts of the Proposed Action to community health as described in Chapter 4. Climate change is further discussed in Chapter 5 in the context of cumulative effects on community health and sociocultural systems.

4.4.4.2 The Proposed Action

To analyze the effects of the Proposed Action and alternatives on community health, BOEM used a subsistence harvest lens and applied a broad definition of community health (Section 3.3.4). The analysis is focused on potential disruptions to sociocultural systems, subsistence activities, subsistence harvest patterns, and other determinants of community health. This analysis primarily focuses on Nuiqsut because it is located closest to the Proposed Action Area (Figure 3.3.3-1 in the Baseline Human Health Summary at www.boem.gov/liberty) and has the greatest potential to experience changes to subsistence harvest patterns (Table 4-32; HHIC, 2015). If subsistence harvest patterns and sociocultural systems are disrupted by the Proposed Action (if not reduced or avoided through appropriate mitigation measures), local diets and community organization could be compromised, and adverse impacts to community health could result (USDOI, BOEM, 2015, p. 421).

Potential health effects of oil and gas development are a matter of growing concern for the Iñupiat people of Alaska's North Slope (Gore, 2009, p. 35; HHIC, 2015; BLM, 2014, p. 462; Wernham, 2007, p. 501). During public scoping for this Draft EIS, BOEM heard examples of community health concerns related to the Proposed Action, including:

- Effects of a large offshore oil spill on biological resources, human health, and cultural well-being of communities that depend on subsistence resources, especially migratory marine mammals and ocean fishes; for more discussion see EDAW AECOM (2008).
- Concerns over food security, food purity, environmental contaminants, and related community health outcomes.
- Concern that conditions related to encroaching industrial developments pose unreasonable risks to community health; for more discussion see Ahtuangaruak (2015), BLM (2014, Section 4.4.6), and SRB&A (2009).

This analysis focuses on potential effects to community health by the following means:

- Disruptions to subsistence activities and harvest patterns, which in turn can adversely affect food security, nutritional status, and cultural well-being
- Emissions of air pollutants
- Decreased water quality
- Increases in employment, income, and economic revenue could affect health in both positive and negative ways.
- Oil spills and spill response and cleanup activities

4.4.4.2.1 Subsistence, Food Security, and Nutrition

More than one in three household heads in the NSB reported difficulty in getting the food needed to eat healthy nutritious meals, and more than one in four Iñupiat household heads reported that, at times last year, household members did not have enough to eat (McAninch, 2012, p. 6). Kaktovik reported 40 percent of households to be food insecure (Kofinas et al., 2016, p. 214).

Residents of the NSB derive substantial health benefits from harvesting and eating traditional foods (Section 3.3.4.3; Bersamin et al., 2007; McAninch, 2012; Reynolds et al., 2006; Smith et al., 2009). Adverse effects on subsistence harvests discussed in Section 4.3.1 could result in increased food insecurity and nutritional deficiencies (DHSS, 2011, p. 61), which could increase the risk of chronic illnesses related to diet and nutrition such as diabetes, high blood pressure, and cardiovascular diseases. These chronic illnesses are referred to as metabolic disorders, and the risk of developing these health problems increases with decreasing intake of subsistence foods (Curtis et al., 2005; McAninch, 2012; McGrath-Hanna et al., 2003; Reynolds et al., 2006; USDOI, MMS, 2007, p. IV-240; Wernham, 2007). The combination of diet (e.g., lean protein sources, low sugar levels, healthy fatty acids) and active lifestyle (i.e., physical exercise) associated with subsistence hunting, fishing, and gathering is the most important protective factor against developing metabolic disorders. Adverse metabolic health effects could accrue as a result of the Proposed Action if subsistence resources became unavailable or undesirable for use as foods or subsistence areas were avoided.

As analyzed in Section 4.4.3.1.1, if adverse moderate to major impacts to subsistence harvest patterns resulted from the Proposed Action or alternatives (if not reduced or avoided through appropriate mitigation measures), the highest potential for changes to community health related to food insecurity and nutrition would most likely be in the community of Nuiqsut. The Proposed Action could adversely affect community health if it adversely affects subsistence harvest patterns or disrupts availability of and/or access to important subsistence resources such as bowhead whales, seals, and waterfowl (Kuukpik Corporation, 2015).

Over 93 percent of households in Nuiqsut use foods from the bowhead whale and other products (Brown et al., 2016). Loss of opportunities to harvest bowhead whales (i.e., for a large part of one whaling season or more) due to possible deflection, vessel interference, whaler avoidance, or summer construction at the proposed LDPI (as described previously), could result in long lasting and widespread adverse effects to community health. Moderate effects would be a result of reduced consumption and sharing of bowhead whale. This could decrease food security and compromised nutritional status in Nuiqsut. These in turn could erode or damage community health, which could stress local institutions such as health care systems, whaling crew relationships, and annual community feasts. A previous analysis of onshore development described how loss of subsistence opportunities could lead to diminished nutrition in a small community that relies on harvest and consumption of wild foods such as caribou (DHSS, 2011, p. 61). If the Proposed Action reduced the quantity of whales harvested by Nuiqsut, they would likely purchase more food from outside the area as bowhead whale became a less dominant part of their diets; this could result in poorer nutrition. It is important to point out the interrelated assumptions underlying potential effects to nutrition: whalers could completely avoid the area for a prolonged time; a reduction in the whaling area could equal a reduction in whale harvest; a reduction in harvest could equal a reduction in consumption; and residents could replace lost whale foods with less nutritious alternatives purchased from outside.

Potential moderate to major disruptions to bowhead whaling conducted near Cross Island by Iñupiaq crews from Nuiqsut (Table 4-32) could adversely impact community health (if not reduced or avoided through appropriate mitigation measures). In turn, impacts from loss of subsistence bowhead harvests on community health could be long lasting and widespread and thus moderate. If potential adverse impacts to subsistence harvest were reduced to minor through mitigation measures (Section 4.4.3.1.1), contemporary harvest patterns and sharing networks would be able to compensate, and there would likely be little to no adverse impacts to community health related to loss of subsistence harvest opportunities (Baseline Human Health Summary at www.boem.gov/liberty).

4.4.4.2.2 Cultural Well-Being

Sociocultural values can have a positive influence on community health. A loss of sociocultural values can occur with a loss of eating and sharing traditional subsistence foods. Eating and sharing traditional subsistence foods has been reported to be a substantial contributor to cultural identity, tradition, and social cohesion in Inuit communities; to eat and enjoy traditional food is a marker of identity similar to speaking the Inuit language (Curtis et al., 2005). Social cohesion, interconnectedness, and stability in cultural and social institutions make up the core of community health and well-being in Inuit communities, and research has shown connections between cultural continuity and mental health in the Arctic (Curtis et al., 2005).

The process of cultural change, especially if dramatic and rapid, can cause stressors such as loss of traditional food resources and practices, unemployment, loss of cultural practices, psychological stress, and out migration. These experiences may overwhelm individuals in a community with feelings of loss of control, leading to depression, anxiety, substance abuse, and suicide (Curtis, et al., 2005). Social problems may be related to long-term economic and structural changes in Iñupiat culture (Kruse et al., 1982). However, historic patterns of social problems (e.g., alcohol abuse) on the North Slope during periods of oil development such as 1970-1977 do not suggest that oil and gas development itself caused or accelerated social disorganization on the North Slope (Kruse et al., 1982, p 103).

The Proposed Action is not expected to dramatically or rapidly change the Iñupiaq culture of the North Slope or substantially reduce cultural well-being in Nuiqsut, Kaktovik, or Utqiaġvik. Some adverse impacts to cultural well-being and community health could occur, however, if the Proposed Action caused a substantial loss of subsistence harvests or large influxes of outside oil and gas workers into communities (DHSS, 2011; USDOI, MMS, 2007c, p. IV-241). Potential moderate to major disruptions to bowhead whaling conducted near Cross Island by Iñupiaq crews from Nuiqsut (Table 4-32) could adversely impact cultural well-being and community health (if not reduced or avoided through appropriate mitigation measures). Impacts from loss of subsistence bowhead harvests on community health could be long lasting and widespread and thus moderate.

4.4.4.2.3 Air Pollutant Emissions

Community members from Nuiqsut have expressed concerns about adverse health impacts due to air pollution emitted from oil and gas developments near their community (Ahtuangaruak, 2015; SRB&A, 2009; BLM, 2014, p. 462-463).

Airborne emissions from the Proposed Action include the USEPA’s criteria pollutants (Section 4.2.3, Air Quality). The criteria pollutants have been associated with a variety of adverse health effects (BLM, 2014, p. 463; USEPA, 2017; USDOI, MMS, 2007, p. IV-242; Wernham, 2007). The most common and major health effects include causing and exacerbating respiratory illnesses such as asthma, cardiac arrhythmias, coronary artery disease, and excess mortality among vulnerable groups of people. Particulate matter is associated with increased respiratory symptoms, including irritation of the airways, coughing or difficulty breathing, chronic bronchitis, and decreased lung function (EPA, 2016).

Air pollution would result from emissions of criteria pollutants from diesel engines associated with routine vessel traffic, construction activities, and operation of equipment in support of the Proposed Action. Support vessels, helicopters, and drilling rigs would emit air pollutants, mainly from combustion of diesel fuel. Well venting and flaring during development would result in combustion products and particulate matter. Construction vessels, trucks, cranes, and other hauling and lifting equipment used to construct ice roads, the proposed LDPI, and the pipeline would emit air pollutants.

Emissions of these criteria pollutants from the Proposed Action would increase concentrations to some extent in various locations within the NSB. However, emissions from vessels, helicopters, and onshore vehicles associated with the Proposed Action are expected to have a negligible impact on the air quality in Nuiqsut and other onshore locations (Section 4.2.3.2).

Accordingly, BOEM anticipates little to no and thus negligible impacts to community health due to air pollution emissions. Emissions of air pollutants from the Proposed Action are not expected to result in losses of subsistence harvest opportunities or disruptions to sociocultural systems.

4.4.4.2.4 Water Quality

A reduction in water quality as a result of the Proposed Action could adversely impact community health if discharges or oils spills occur in waters used for subsistence hunting and fishing activities.

Overall, it is expected that the Proposed Action would have minor to moderate impacts on marine water quality because there is no planned discharge of drilling wastes into the marine environment (Section 4.2.2, Water Quality; Hilcorp, 2015, Appendix A). Hilcorp (2015, Appendix A) anticipates negligible to minor impacts to freshwater quality. Increased turbidity caused during construction of the LDPI and offshore pipeline would most likely have the greatest effect on water quality; however, these increases would be short-term, primarily occurring during the first winter and following summer construction seasons (Hilcorp, 2015, Appendix A).

NPDES-permitted discharges are anticipated to have negligible to no impacts on community health.

BOEM anticipates little to no and thus negligible impact on community health related to water quality. The Proposed Action is not expected to impact drinking water supplies in the NSB. BOEM expects no loss of subsistence harvest opportunities or disruptions to sociocultural systems due to minor to moderate increases in turbidity.

4.4.4.2.5 Employment, Income, and Economic Growth

Potential effects to the economy could occur if the Proposed Action alters employment or income characteristics of the area, increases tax revenue, changes the population demographics of the area, changes the workforce, or otherwise affects the employment and economic opportunities for residents of Nuiqsut or other communities on the North Slope (Section 4.4.2).

Increased oil and gas development and production from the Proposed Action could contribute benefits to the local economy. Community health could improve from greater personal income and improved local infrastructure, educational systems, law enforcement, and healthcare services (Kruse et al., 1982; USDOI, BOEM, 2015, Section 4.4.2.1). More disposable income could allow residents to purchase better gear and hunting and fishing equipment and increase their hunting effectiveness (Kruse et al., 1982). On the other hand, more time spent working for wages could take time away from subsistence activities.

Employment and economic development are viewed as positive in terms of effects to social problems and pathologies (USDOI, MMS, 2007c, p. IV-241). To the extent that the Proposed Action results in increased regional or local income, this could result in beneficial effects to community health. Increased income for individuals or families could improve health in Nuiqsut through increased standard of living, reductions in stress, and increased opportunities for personal growth and social relationships (BLM, 2014, p. 462). Income and employment also could strengthen community and cultural ties and improve diet and nutrition through better funded subsistence activities and more affordable and healthier store-bought foods.

However, if local economic changes result in actual or perceived inequalities in a community, tensions and social stresses could develop (USDOI, MMS, 2007c, p. IV-241). During public scoping in Nuiqsut, BOEM learned of increased infighting over economic benefits of oil and gas development (Section 3.3.5.4). Income disparity could increase if some residents benefited or were more adversely impacted than others; disparities in occupational status and income have been linked to adverse impacts to health and well-being (Wilkinson and Marmot, 2003). In the past, the NSB has done a reasonably good job of distributing high paying jobs funded through oil tax revenues to a large portion of the population with the effect of preventing large disparities in income (Kruse et al., 1982). Other potential adverse impacts of economic growth are related to increased prevalence of social problems such as substance abuse, domestic violence, and accidental and intentional injuries (BLM, 2014, Section 4.4.4) and negative perceptions about the availability of fish and game and erosion of Iñupiaq cultural values and practices (Kruse, et al., 1982).

Revenue from property taxes to the NSB could allow for continued and improved funding of existing healthcare and social programs in communities such as Nuiqsut. New jobs in the oil and gas sector could be created, but it is anticipated that few new jobs in this sector would directly go to Iñupiaq workers to create any local health benefits (BLM, 2014, p. 462). BOEM expects negligible to minor beneficial effects from employment and earnings, and moderate beneficial effects from tax revenue generated by the Proposed Action (Section 4.4.2; Table 4-40). Property tax payments by North Slope oil producers are the main source of revenue for the NS B (accounting for approximately 90 percent of the NSB operating budget in 2015), and these revenues directly support wages for NSB government jobs held by residents of the NSB. Increased tax revenue could have moderate beneficial effects to the economy of the NSB. Subsequent increases in population from the Proposed Action are anticipated to be negligible, and healthcare delivery systems would not be adversely affected.

During the 25-year life of the Proposed Action, overall beneficial impacts to community health in the NSB from more tax revenue would most likely be long lasting and widespread, and thus moderate, depending on how many local jobs are created in the NSB government. BOEM anticipates little to no adverse impacts to community health from increased tax revenue.

4.4.4.2.6 Oil Spills and Spill Response

Small spills have the potential to adversely impact sociocultural systems, and thus community health, by disrupting subsistence harvest patterns (Section 4.4.1). Effects to community health from small accidental spills occurring during routine construction, development, production, and decommissioning operations are expected to be short-term and localized and thus minor.

A large spill during development and production activities could adversely impact community health depending on the type and amount of oil spilled, location, and season. In the event of a large oil spill, subsistence resources and harvest patterns would most likely be affected due to contact with crude oil or refined products and could result in long lasting and widespread to severe impacts to community health for Nuiqsut. These impacts to community health would primarily be realized through major disruptions to subsistence practices and loss of harvest opportunities (Section 4.4.1.1.1, Potential Loss of Subsistence Harvests). Moderate to major impacts to community health would include compromised nutrition and decreases in community and cultural well-being due to a decrease in traditional foods and inability to engage in traditional practices such as sharing food with elders.

A large oil spill could affect NSB communities due to the potential for toxic contamination of air, water, soils, and subsistence harvest resources such as fish or marine mammals. In turn, the potential for contamination could increase community stressors such as avoidance of subsistence harvests and decreased sharing and consumption of traditional foods. Moreover, impacts of a large oil spill to subsistence harvest of bowhead whales could be major for Nuiqsut and moderate to major for Kaktovik and Utqiaġvik (Table 4-32; Section 4.4.3). Potential impacts to bowhead whaling from a large spill of crude or refined oil could translate to severe impacts to community health in the NSB, especially for Nuiqsut where major impacts to whaling could occur in the event of a large spill (Section 4.4.3).

Spill response and cleanup workers from both inside and outside communities could experience potential health hazards from toxic oil byproducts. Drowning, cold exposure, and falls also pose hazards to OSR workers. Changes in air quality could occur as a result of spills of crude or refined oil. Adverse health consequences of a large oil spill to community members could be experienced from exposure to vapors, particulate matter from controlled burns of spilled oil, VOC, PAHs, and heavy metals. However, impacts to air quality from accidental small oil spills would most likely be short-term and localized and thus minor due to the limited geographical and temporal extent of the spill (Section 4.1.2.1). Impacts on air quality due to a large spill also are likely to be minor; air quality impacts immediately following a large spill would most likely be short-term (Section 4.1.2.1), and BOEM does not expect adverse impacts to community health to occur from air pollutants released during a large oil spill.

Impacts to community members could occur when they work on spill response and cleanup alongside outside workers who may be unfamiliar with Iñupiaq culture, and who may bring illnesses and social conflicts to communities. Large oil spills can have long lasting and widespread adverse but reversible physical and mental impacts for community members living in the affected area (Eykelbosh, 2014).

Researchers working on health impacts in Alaskan communities impacted by the EVOS in 1989 found community members showed greater degrees of stress in the forms of recurrent, unprovoked, negative thoughts about the spill and avoidance behaviors such as suppression of thoughts and behaviors related to the spill (Picou et al., 1992). Researchers found these intrusive stresses declined somewhat over time but remained elevated compared to the control community 18 months after the spill; avoidance behaviors remained constant over time, indicating persistent, long-term psychological harm to individuals (Eykelbosh, 2014, p. 19). The trauma associated with oil spills, whether due to income loss, disruption of culturally important activities, or the stress of long-term uncertainty, can lead to depression, generalized anxiety disorder, and post-traumatic stress (Eykelbosh, 2014, p. 34).

Spill response and cleanup activities could include mechanical recovery methods and in-situ burning of spilled oil. Increased aircraft and vessel traffic, and corresponding increases in vessel discharges and noise, would also be associated with spill response and cleanup operations. Depending on the size of the spill and whether or not it contacted onshore resources response and cleanup time and extent of cleanup activities could be short-term and localized or long lasting and widespread.

If spill response and clean-up operations included sections of beach and shorelines of barrier islands, access to areas used for subsistence fishing, waterfowl hunting, caribou hunting, and butchering of whales could be disrupted by spill response and cleanup activities or restricted by regulators due to conservation and species recovery issues. Disruptions to subsistence harvest practices due to spill response and cleanup could be long lasting and widespread for Nuiqsut. Loss of subsistence opportunities from response and cleanup could cause moderate impacts to community health.

Offshore mechanical recovery methods are not expected to impact community health because this method of spill cleanup is not expected to affect subsistence harvest patterns, social organization, local institutions, cultural well-being, or cultural values. The use of in-situ burning would most likely result in worry over environmental contamination and potential contamination of subsistence resources that could last for one or more seasons. Potentially contaminated marine resources from cleanup activities could result in avoidance of subsistence harvest of marine resources. Avoidance of subsistence harvests due to in-situ burning could cause long-lasting and widespread adverse impacts to community health and well-being.

Effects to community organization and capacity to provide healthcare services can occur due to local employment in spill response and cleanup activities. A sudden increase in employment in spill response and cleanup work could have long lasting and widespread effects, including displacement of Alaska Native residents from their normal subsistence harvests, processing, and sharing activities. Increased employment of local residents could place stresses on community infrastructures such as hospitals and health clinics by drawing away local workers from community service jobs or increased medical visits from outside cleanup workers. These changes could increase healthcare demands, crime and injury rates, and social conflicts between local residents and outsiders. The deterioration of social relationships, anxiety, stress, and depression may result from long-term and widespread spill response and cleanup operations, making routine stress-coping strategies ineffective at the local level and contributing to compromised community health (Palinkas et al., 1993; USDOI, BOEM, 2015).

Overall, impacts to community health from spill response and cleanup activities will depend on the extent and location of the spill and to what extent subsistence harvest patterns, local institutions, and community resilience are affected (Eykelbosh, 2014; USDOI, BOEM, 2015).

The Proposed Solid Ice Condition (Section 2.5.1) would shift much of the risks associated with a large oil spill from summer months to winter months. The effects of this condition on community health would be similar to those described in Section 4.4.3, Subsistence Activities and Harvest Patterns (Bowhead Whaling Practices).

4.4.4.3 Conclusion

Appendix C describes mitigation measures derived from lease stipulations, design features and BMPs the operator committed to, and requirements and BMPs that other agencies typically require (Sections C-1 to C-3). BOEM's conclusions regarding impacts assume implementation of, and compliance with, the mitigation measures described in Sections C-1 through C-3.

Availability of and access to subsistence foods and other local subsistence resources are critical determinants of community health and cultural well-being in the NSB. Potential impacts to community health from loss of subsistence bowhead harvests and other harvest opportunities could be moderate. Impacts of air pollution and emissions from routine construction, development, and production on community health are expected to be negligible. BOEM anticipates negligible impacts on community health related to water quality. Beneficial impacts to community health from increased property tax revenue are expected to be moderate. Adverse impacts to community health related to economic growth would most likely be negligible. Overall, adverse impacts to community health as a result of the Proposed Action are anticipated to be negligible to moderate. BOEM anticipates moderate beneficial effects to community health.

Effects to community health from small accidental spills occurring during the life of the Proposed Action are expected to be minor. For a large oil spill, impacts to community health for Nuiqsut could be major. Impacts to community health for Kaktovik and Utqiaġvik from a large oil spill are expected to be moderate to major, depending on the size and location of a spill and whether or not impacts disrupt subsistence harvest activities for one or more seasons, alter local healthcare services, disrupt traditional sharing networks, and/or threaten cultural values and identities.

Impacts to community health from spill response and cleanup activities are expected to be minor to moderate depending on method of oil recovery and removal, extent and location of the spill, and extent of disruption to subsistence harvest patterns, social organization, local institutions, and community healthcare services. Minor to moderate effects from spill response and cleanup are not expected to change the overall impact conclusions for a large spill.

Government initiated unannounced exercises (GIUE) (e.g., oil spill drills), which are infrequent, of short duration, (less than 8 hours), and utilize existing equipment, would not alter impact conclusion for community health.

4.4.4.4 Alternative 2 (No Action)

Under Alternative 2, the no action alternative, potential impacts on subsistence activities, harvest patterns, and sociocultural systems would not occur for Nuiqsut, Kaktovik, or Utqiaġvik. There would be no increases in food insecurity or adverse effects to cultural well-being from the Proposed Action under Alternative 2. Under the no action alternative, there would be no changes to employment, income, or tax revenue, and no small or large oil spills would occur. Therefore, there would be no adverse or beneficial impacts to community health under Alternative 2.

4.4.4.5 Alternative 3 (Alternate LDPI Locations)

In Alternative 3, the proposed LDPI would be relocated (Section 2.2.4). Alternative 3A would relocate the proposed LDPI one mile to the east into slightly deeper water, and Alternative 3B would relocate the proposed LDPI 1.5 miles to the southwest into slightly shallower waters managed by the SOA.

4.4.4.5.1 Alternative 3A: Relocate the LDPI Approximately One Mile to the East

Alternative 3A could prolong potential impacts to community health especially if construction activities were extended into the fall whaling season for Nuiqsut and/or into a second summer construction season and hence the beginning of a second whaling season. Under 3A, potential effects to whaling for Nuiqsut from summer construction activities at the proposed LDPI would most likely remain major (Section 4.3.4.2.3) (if not reduced or avoided through appropriate mitigation measures). However these effects could be prolonged into a second whaling season, which could have severe and thus major impacts on community health through potential longer-term food insecurity, decreases in nutritional health, and compromised cultural well-being in Nuiqsut. This increase in summer construction time could also increase impacts on subsistence seal hunting from minor to moderate for Nuiqsut and Kaktovik, potentially causing long lasting and widespread, but less than severe, and thus moderate impacts to social organization and cultural identity in these villages, which could in turn increase adverse effects to community health. Adverse effects to community health from loss of bowhead whale harvests could increase from moderate to major under Alternative 3A.

Alternative 3A would increase emissions of harmful air pollutants due to longer construction time (Section 4.2.3). Impacts of Alternative 3A on air quality would be minor for routine activities associated with the Proposed Action (Section 4.2.3.5). However, BOEM does not expect impacts to community health related to emissions of air pollutants to increase under Alternative 3A. Nuiqsut, Kaktovik, Utqiaġvik, and Prudhoe Bay would most likely not be exposed to increased air pollutants because they are located outside the area where minor air quality impacts are expected to occur under Alternative 3A.

4.4.4.5.2 Alternative 3B: Relocate LDPI 1.5 miles to the Southwest

If under Alternative 3B summer construction at the proposed LDPI ceased August 25, impacts to whaling for Nuiqsut from LDPI slope protection work could be reduced from major to moderate. If under Alternative 3B summer construction at the proposed LDPI ceased by August 1, impacts to whaling for Nuiqsut from LDPI slope protection work could be reduced from major to minor. This change could also reduce potential impacts to subsistence seal hunting from minor to negligible for Nuiqsut and Kaktovik hunters. Ceasing summer construction work at the proposed LDPI by August 1 would most likely reduce impacts to community health and sociocultural systems, especially for Nuiqsut. Due to potentially less impacts to subsistence harvests, Alternative 3B could decrease adverse impacts to community health related to loss of subsistence harvests from moderate to minor.

Alternative 3B would increase impacts to air quality due to a smaller area for dispersion and substantially increased emissions of pollutants (Section 4.2.3.5). However, BOEM does not expect impacts to community health related to emissions of air pollutants to increase under Alternative 3B. Nuiqsut, Kaktovik, Utqiaġvik, and Prudhoe Bay would most likely not be exposed to increased air pollutants because they are located outside the area where minor to moderate air quality impacts are expected to occur under Alternative 3B.

Alternative 3B would move the proposed gravel island and operations into waters managed by the SOA, which would increase property tax revenue (Section 2.2.4; Table 4-40). Some of the increased revenue to the SOA from Alternative 3B could benefit the communities of the NSB. Added revenue income to the NSB could benefit Nuiqsut and other communities through improved healthcare and education and increased employment opportunities for residents. Similar to the Proposed Action, increased tax revenue under Alternative 3B could have long lasting and widespread, and thus moderate, beneficial effects to community health for Nuiqsut and other communities in the NSB.

4.4.4.6 Conclusion for Alternatives 3A and 3B

Most impacts of Alternative 3A on community health would be the same as those for the Proposed Action (Section 4.4.4.2) with the exceptions of potential effects of loss of subsistence bowhead harvests and seal hunting opportunities. Under Alternative 3A, BOEM anticipates that impacts to community health would be moderate to major.

Some impacts of Alternative 3B on community health would be the same as those for the Proposed Action (Section 4.4.4.2). BOEM expects some effects to community health to change under Alternative 3B. There could be a reduction in impacts to subsistence whaling due to decreased construction time. Overall, BOEM minor to moderate adverse impacts to community health for Nuiqsut and Kaktovik under Alternative 3B due to a decrease in adverse impacts to subsistence activities. BOEM anticipates moderate beneficial effects to community health in the NSB due to increased tax revenue.

Impacts to community health as a result of NPDES-permitted discharges under Alternative 3B would be the same as for the Proposed Action, which are negligible to none.

4.4.4.7 Alternative 4 (Alternate Processing Locations)

Under Alternative 4, oil and gas processing would be relocated to one of two alternate facilities (Section 2.2.5). Alternative 4A would relocate oil and gas processing activities to Endicott. Alternative 4B would relocate oil and gas processing to a new onshore facility near the Badami pipeline tie-in.

Both Alternative 4A and 4B would reduce the construction time for the proposed LDPI, perhaps by as much as 20 days. Decreasing summer construction activities at the LDPI related to LDPI slope protection could substantially reduce impacts to subsistence harvest patterns and sociocultural systems, thereby potentially reducing adverse impacts to community health related to food insecurity and compromised nutritional health and cultural well-being from moderate to minor.

Alternatives 4A and 4B would most likely reduce the overall noise produced at the proposed LDPI. Overall, BOEM does not anticipate any direct added advantage or reduced impact to subsistence resources from this reduction in offshore noise because it would be relatively small and indiscernible from production noises (Section 4.4.1.6). However, any reduction of noise at the offshore LDPI would most likely reduce whalers’ anxieties over noise due to their knowledge and experience of how noise in the offshore environment decreases bowhead whaling success. Reducing noise in the marine environment could lower community stress and improve overall community health and well-being, which could have beneficial effects to community health, especially in Nuiqsut.

Both Alternatives 4A and 4B would increase tax revenue for the SOA and the NSB. BOEM expects long lasting and widespread beneficial impacts to community health under Alternatives 4A and 4B due to increased tax revenue.

4.4.4.8 Conclusion for Alternatives 4A and 4B

The overall adverse effect on community health under Alternatives 4A and 4B is expected to be less than that for the Proposed Action due to lower impacts to subsistence harvests and less psychological stress on whalers and whaling crews. BOEM anticipates that Alternatives 4A and 4B would have a minor adverse effect on community health due to reduced impacts to subsistence whaling. Under Alternatives 4A and 4B, there would be a moderate beneficial effect on community health from increased tax revenue.

Impacts to community health as a result of NPDES-permitted discharges under Alternatives 4A and 4B would be the same as for the Proposed Action, which are negligible to none.

4.4.4.9 Alternative 5 (Alternate Gravel Sources)

Alternative 5 would relocate the proposed gravel mine (Section 2.2.6). There are two alternate mine sites, Alternatives 5A and 5B, east of the Kadleroshilik River.

BOEM anticipates that overall adverse impacts from Alternatives 5A and 5B on community health would not change from those described under the Proposed Action, which are negligible to moderate (Section 4.4.4.2).

4.4.4.10 Conclusion for Alternatives 5A and 5B

Adverse impacts from Alternatives 5A and 5B to community health would be minor to negligible to moderate. Beneficial impacts from Alternatives 5A and 5B to community health would be moderate.

4.4.5 Environmental Justice

4.4.5.1 Overview

Oil development and production can have environmental and social consequences that are disproportionate across populations (O'Rourke and Connolly, 2003). Iñupiat people living on the North Slope have the potential to be affected by the Proposed Action and alternatives primarily due to their reliance on local natural resources for health, nutrition, social organization, cultural identity, and well-being.

This section describes potential disproportionately high and adverse effects from activities associated with the Proposed Action and alternatives for three environmental justice (EJ) communities: Nuiqsut, Kaktovik, and Utqiaġvik. These are considered EJ communities based on their proportional minority membership as compared to the SOA as a whole (i.e., Alaska Native peoples, specifically Iñupiat) (Section 3.3.5.3; CEQ, 1997).

4.4.5.2 The Proposed Action

Subsistence continues to be the central organizing element of Iñupiaq society, and it is primarily through damage to subsistence resources and disruptions to subsistence activities and harvest patterns that environmental justice concerns can be assessed for Iñupiaq communities located on the North Slope. The Proposed Action has potential to affect subsistence harvest patterns in the central Beaufort Sea and coastal areas (Section 4.4.3.1.1, Table 4-32; EDAW AECOM, 2008; Galginaitis, 2014b: USDOI, MMS, 2002, p. 10). Any major disruptions to local subsistence practices (Section 4.4.3), sociocultural systems (Section 4.4.1), or community health (Section 4.4.4) from the Proposed Action could cause disproportionately high and adverse impacts to these EJ communities.

The Proposed Action could cause disproportionately high and adverse impacts to EJ communities through a number of means, including:

- Major impacts to subsistence harvest patterns
- Major impacts to sociocultural systems
- Major impacts to community health

As analyzed in Section 4.4.3, if potential impacts to subsistence harvest patterns were to occur, the highest potential for changes to the sociocultural system and community health would be in the community of Nuiqsut with likely impacts to the sociocultural system reaching Kaktovik and possibly Utqiaġvik, especially in the event of a large oil spill.

The primary subsistence activity that could be adversely affected by the Proposed Action is bowhead whaling conducted by crews from Nuiqsut near Cross Island (Table 4-32). If major impacts occurred from the Proposed Action, such as from summer construction at the LDPI or whaler avoidance (Section 4.4.3.1.1) (if not reduced or avoided by implementing mitigation measures), BOEM expects disproportionately high and adverse impacts to occur for Nuiqsut. If major effects occur from small spills to subsistence harvest patterns, BOEM anticipates disproportionately high and adverse impacts for Nuiqsut. If major impacts from a large spill occur to Cross Island whaling, BOEM expects disproportionately high and adverse impacts for Nuiqsut.

The Proposed Action and small and large oils spills could have some major effects on the sociocultural system in Nuiqsut (Section 4.4.1). If these major effects to social organization, cultural values, and local institutions occur, BOEM anticipates disproportionately high and adverse impacts.

In the event of a large spill, moderate to major impacts are expected to occur for whaling for Kaktovik and Utqiaġvik crews (Table 4-32). BOEM expects severe and thus major impacts on sociocultural systems lasting more than one year for Kaktovik and Utqiaġvik if their bowhead whaling areas are contacted by oil from a large spill. If these major impacts occur to sociocultural systems, BOEM anticipates that a large spill could have disproportionately high and adverse impacts in Kaktovik and Utqiaġvik.

BOEM anticipates major impacts to community health to occur as a result of a large oil spill for Nuiqsut and moderate to major effects to community health for Kaktovik and Utqiaġvik (Section 4.4.4.2). If these major impacts occur to community health, BOEM anticipates that a large spill could have disproportionately high and adverse effects on EJ communities.

BOEM will continue to work closely with residents and leaders in Nuiqsut, Kaktovik, and Utqiaġvik and Hilcorp to develop mitigation measures and communication strategies to address EJ concerns related to the Proposed Action.

4.4.5.3 Alternative 2 (No Action)

Under Alternative 2, potential impacts to subsistence harvest patterns from disruptions to hunting and fishing and the potential for contamination of subsistence foods associated with the Proposed Action would not occur. There would be no impacts on sociocultural systems or community health for Nuiqsut, Kaktovik, and Utqiaġvik. Therefore, there would be no disproportionately high and adverse impacts to EJ communities under Alternative 2.

4.4.5.4 Alternative 3 (Alternate LDPI Locations)

In Alternative 3, the proposed LDPI would be relocated (Section 2.2.4). Alternative 3A would relocate the proposed LDPI one mile to the east into deeper water, and Alternative 3B would relocate the proposed LDPI 1.5 miles to the southwest into shallower waters managed by the SOA.

4.4.5.4.1 Alternative 3A: Relocate LDPI Approximately One Mile to the East

Under Alternative 3A, BOEM anticipates that some major adverse impacts could occur to subsistence harvest patterns, sociocultural systems, and community health for Nuiqsut. Under Alternative 3A, BOEM expects disproportionately high and adverse environmental and health effects to occur in Nuiqsut if these major impacts occur to subsistence harvest patterns, sociocultural systems, and community health.

4.4.5.4.2 Alternative 3B: Relocate LDPI Approximately 1.5 miles to the Southwest

Under Alternative 3B, BOEM does not expect disproportionately high and adverse effects on EJ communities because reducing summer construction time at the proposed LDPI would most likely reduce impacts to subsistence, sociocultural systems and community health, especially for Nuiqsut.

4.4.5.5 Alternative 4 (Alternate Processing Locations)

Under Alternative 4, oil and gas processing would be relocated to one of two alternate facilities (Section 2.2.5). Alternative 4A would relocate oil and gas processing activities to Endicott. Alternative 4B would relocate oil and gas processing to a new onshore facility near the Badami pipeline tie-in. Both 4A and 4B would reduce offshore construction times.

Under Alternatives 4A and 4B, BOEM anticipates that impacts to subsistence whaling for Nuiqsut would decrease. Decreasing summer construction activities at the proposed LDPI site related to slope protection could reduce impacts to whaling for Nuiqsut from major to moderate or minor, depending on when summer construction at the LDPI ceased (Section 4.4.3.5). Under Alternatives 4A and 4B there would most likely be no major (i.e., high and adverse) impacts to subsistence whaling, therefore BOEM does not expect disproportionately high and adverse effects for EJ communities under Alternative 4.

4.4.5.6 Alternative 5 (Alternate Gravel Sources)

Alternative 5 would relocate the proposed gravel mine (Section 2.2.6). There are two alternate mine sites. Impacts from Alternatives 5A and 5B on EJ communities would be the same as impacts described for the Proposed Action (Section 4.4.5.6).

4.4.6 Archaeological Resources

Any offshore activity that disturbs the seafloor of the Beaufort Sea has the potential to affect archaeological and historic resources. Areas having high-density ice gouging are assumed to be of low potential for historic and prehistoric archaeological sites.

The National Historic Preservation Act of 1966 as amended (NHPA) and attendant Federal regulations that promulgate the NHPA, specifically 36 CFR 800, require that Federal agencies make reasonable and good faith efforts to identify historic properties within the area of potential from federally permitted, licensed, or funded onshore and offshore operations. Compliance with NHPA leads to:

- Identification of archaeological and historic resources
- Determination of eligibility for placement on the National Register of Historic Places (NRHP)
- Assessment of adverse effects
- Resolution of adverse effects

NHPA requires that both direct and indirect effects to historic properties be considered. An example of a direct impact would be drilling through a buried archaeological site. An example of an indirect effect would be vandalism.

All of the activities described herein would require Federal approval and thus compliance with the NHPA and its implementing regulations. Identification of historic and prehistoric archaeological sites, the area of potential effect, mitigation, and monitoring measures would be accomplished in accordance with the NHPA and in consultation with the State Historic Preservation Officer (SHPO). On June 2, 2017, BOEM initiated consultation with the Alaska SHPO through a letter detailing the Liberty DPP (Proposed Action) and all Action Alternatives (Alternatives 3 through 5). On July 6, 2017, BOEM received a finding from the AK SHPO of no historic properties affected by the Proposed Action or Action Alternatives.

The discovery of an archaeological site within the area of potential affect from development would initiate an additional NHPA Section 106 process. First, the significance of the site would be assessed to determine eligibility for placement on the NRHP in consultation with consulting parties. In this case, consulting parties, as defined by 36 CFR 800, could include the Federal agency official, the Advisory Council on Historic Preservation, the SHPO, federally recognized tribe, Alaska Native Claims Settlement Act (ANCSA) regional corporation, ANCSA village corporation, local governments, and applicant. It is reasonable to assume that any archaeological site found buried below the seafloor of the Beaufort Sea would be considered eligible for placement on the NRHP because it could be associated with Beringian occupation.

Multiple Geological and Geophysical (G&G) and acoustic remote sensing surveys conducted in the offshore resulted in multiple archaeological reviews; on land, pedestrian and archaeological surveys were performed. No new archaeological sites were discovered within the footprint of the Proposed Action and the other action alternatives. However, there are previously identified archaeological and historical resources along the shoreline were pinpointed with Global Positioning System (GPS) units.

4.4.6.1 The Proposed Action

The DPP includes the following ground disturbing activities:

- Development of a gravel mine site
- Construction of the LDPI
- Installation of a 16-inch diameter pipeline both onshore and offshore
- Dredged material disposal

All but one of the activities proposed under the Proposed Action have received archaeological surveys both onshore and offshore as described in Chapter 3 (Section 3.3.6.1). Archaeological survey techniques included multiple survey methodologies ranging from acoustic remote sensing and archaeological analysis of G&G cores in the marine environment to standard archaeological survey techniques, both pedestrian and air-born, of the lands proposed for development. Infrastructure surveyed included the proposed gravel mine sites, the LDPI sites, and the marine pipeline corridor. No surface or subsurface archaeological or historic sites were discovered, and BOEM anticipates that unless a post-review discovery is made, no historic properties would be affected by the proposed activities.

Proposed activities on the LDPI would not require additional archaeological review, since the LDPI would be manmade for this proposed development.

Construction of ice roads associated with the Proposed Action would not involve ground disturbance, and have no potential to cause effects to archaeological or historic resources.

HAK proposes to transport excess dredge spoils from the pipeline trenching activities to Prudhoe Bay for disposal in the nearshore area on the ice in the scour zone. The scour zone has natural high turbidity due to annual sediment removal by sea ice. Disposal of dredge materials would have negligible effects.

Facilities for small marine vessels would be located either at West Dock, Prudhoe Bay, or at the Endicott SDI, a pre-existing manmade island created for the purposes of the Endicott field oil and gas development. None of these locations would have more than a negligible effect on archaeological or historic properties, since they would have no effect.

The pipeline would be elevated on VSMs with thermosiphons inserted to prevent melting of the permafrost. The proposed route was archaeologically surveyed in 2013 using a helicopter flyover, limiting pedestrian surveys to higher potential ground, specifically elevated gravel pingos (Higgs, 2013). However, much of the vegetation along the proposed pipeline route is dry, rather than wet tundra tussock.

These proposed activities have the potential to cause effects ranging from negligible to major on prehistoric archaeological or historic resources, depending on the level of disturbance and the archaeological resource disturbed. The level of effect would depend on location and type of site, the type, magnitude, and duration of disturbance of the proposed action, and the season of the year. Effects would become more acute if prehistoric archaeological or historic resources were found to be Historic Properties eligible for listing on the NRHP.

4.4.6.1.1 Oil Spills

An offshore oil spill of any magnitude is not anticipated to have a direct effect on any identified archaeological or historical site. An oil spill would not affect marine cultural resources because there are no reported shipwrecks in the area, and acoustic remote sensing did not discover archaeological or historic resources on the seafloor.

However, oil spills of any size could result in impacts to numerous archaeological and historic resources from response activities. These impacts could range from negligible to major. Cleanup crews might be needed in a number of locations. The greatest threat to archaeological and historic resources during an oil spill would result from the larger number of response crews being employed. Following the EVOS, most impacts to archaeological and historic resources that occurred during spill response were the result of vandalism or physical damage from spill response activities (Bittner, 1996; Reger et. al., 2000). Furthermore, timely monitoring of affected sites might not be possible, given the number of resources to be considered and personnel limitations (Reger et al., 2000).

The level of effect on the archaeology would depend not only on the magnitude of the spill and direct impacts to a resource, but the time of the year. If the spill were to occur when the ground was frozen or covered by snow, these factors would lessen potential impacts to archaeological sites. Thus, the effect of an oil spill could range from negligible through major, depending upon if historic properties were to be adversely impacted by the oil response.

The Proposed Solid Ice Condition (Section 2.5.1) would shift much of the risks associated with a large oil spill from summer months to winter months. A large spill which occurred during the solid ice conditions of winter would likely have fewer impacts to archaeological sites because a spill during solid ice conditions would disperse over a smaller area and be more easily cleaned up. Restricting reservoir drilling to winter months would also extend the time period required to complete the overall drilling program, but this would neither incur nor mitigate additional impacts to archaeology.

4.4.6.2 Conclusion for the Proposed Action

Identification and protection of archaeological resources are components of applicable lease stipulations. The overall impacts of the Proposed Action to archaeological resources would be negligible unless an historic property or other as yet undiscovered site were to be inadvertently damaged during normal project activities or inadvertently damaged or vandalized during oil spill cleanup. Impacts to archaeological resources would then be major.

4.4.6.3 Alternative 2 (No Action)

Under this alternative, the Proposed Action would not cause any effects on archaeological and historic resources.

4.4.6.4 Alternative 3 (Alternate LDPI Locations)

4.4.6.4.1 Alternative 3A: Relocate LDPI Approximately One Mile to the East

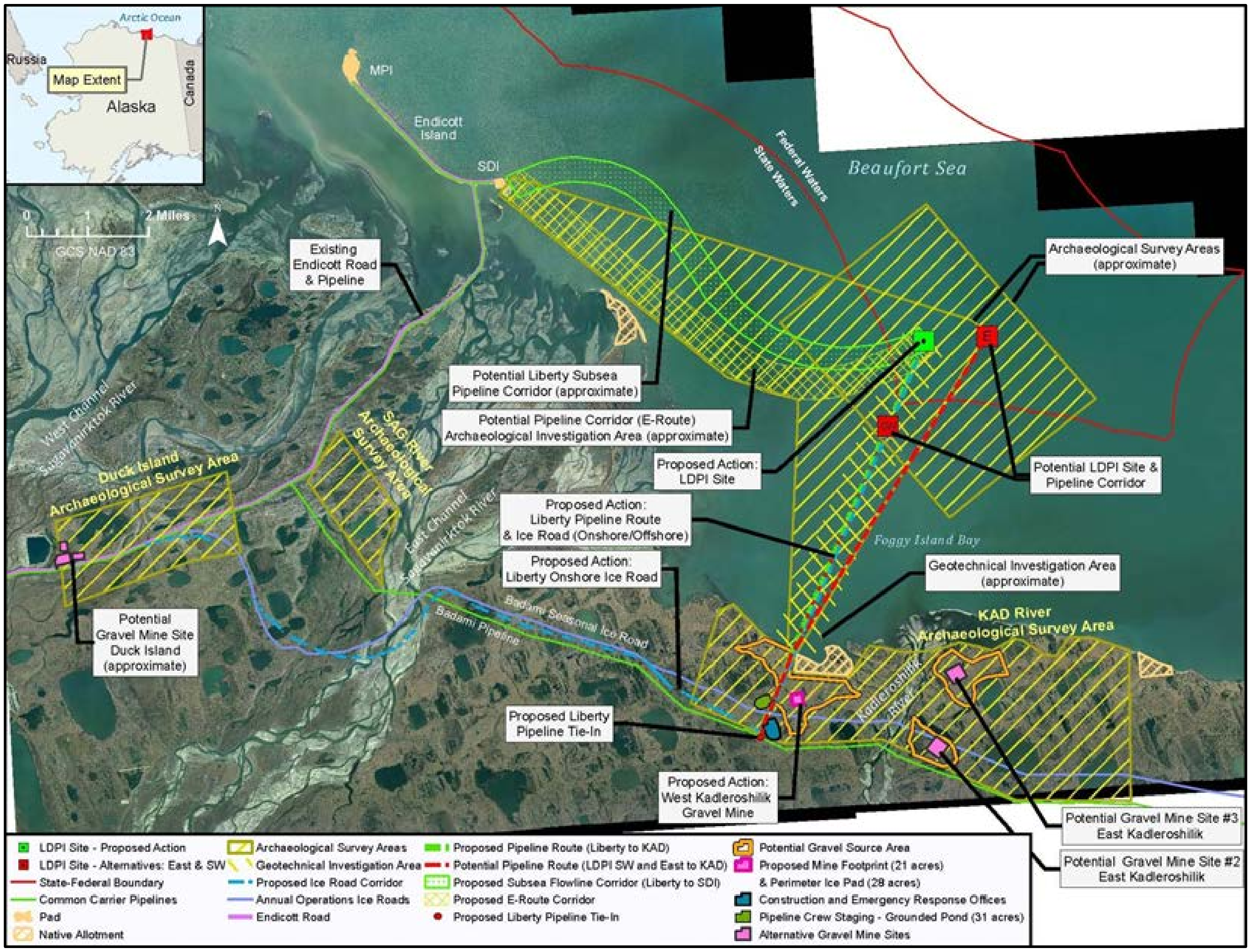

Figure 4-27 Proposed DPP Significant Archaeological Surveys

Alternative 3A would relocate the LDPI to a site approximately one mile to the east (Figure 2-17). The potential marine pipeline corridor would be east of the pipeline corridor in the Proposed Action. The LDPI is in an area that has received remote acoustic sensing and archaeological analysis, and no surface or subsurface archaeological or historical sites being identified. However, neither the LDPI nor the proposed pipeline corridor has received a G&G survey that involved penetration of the seabed through coring, and thus there has been no archaeological or paleo-ecological analysis. It cannot be stated with the same degree of certainty that no historic properties would be affected as can be asserted for the Proposed Action. All potential actions would remain the same on land as described in the Proposed Action, and the recommendations would remain the same. Selection of Alternative 3A would include additional archaeological surveys, and Section 106 consultation under the NHPA. Effects could range from negligible to major, depending upon if an archaeological site is discovered onshore or offshore, and if the discovery is adversely impacted by ground disturbance.

As with the Proposed Action, the area that has not received a thorough archeological survey is the terrestrial pipeline, extending approximately 1.5 miles from the coast to tie-in with the Badami Oil Pipeline tie-in point. The operator has agreed to have a pedestrian archaeological survey performed along the terrestrial pipeline route during the 2017 field season. If an archaeological or historic site is found, it is likely that it would be avoided or mitigated in conformance with 36 CFR 800. It is difficult to assess effects because it is not known if there are sites along the pipeline corridor crossing land, and effects are considered to range from negligible to major, depending upon if an archaeological site is discovered.

4.4.6.4.2 Conclusion for Alternative 3A

The overall impacts of Alternative 3A to archaeological resources would be negligible unless an historic property or other as yet undiscovered site were to be inadvertently damaged during normal project activities or inadvertently damaged or vandalized during oil spill cleanup. Impacts to archaeological resources would then be major.

4.4.6.4.3 Alternative 3B: Relocate LDPI Approximately 1.5 Miles to the Southwest

Alternative 3B places the LDPI approximately 1.5 miles closer to shore into SOA waters and would be 1.5 miles from the proposed LDPI (Figure 2-18). The LDPI would likely require additional G&G coring to ensure stability, and would also be subjected to archaeological and paleo-ecological analysis of the new borings. The potential pipeline corridor is the same as the proposed pipeline corridor. All potential actions would remain the same on land as described in the Proposed Action, and the recommendations would remain the same. Selection of Alternative 3A would include additional archaeological surveys. Effects could range from negligible to major, depending upon if an archaeological site is discovered.

The terrestrial pipeline would extend approximately 1.5 miles from the coast to tie-in with the Badami Oil Pipeline. The pipeline would be elevated on VSMs and may use freeze-back technology to stabilize support members. The proposed route was surveyed in 2013 but the archaeologists did so in a helicopter flyover, limiting pedestrian surveys to higher potential ground, specifically elevated gravel pingos (Higgs, 2013). However, much of the vegetation along the proposed pipeline route is dry, rather than wet tundra tussock.

Another area of concern is that there are known archaeological and/or historic sites in the vicinity. None of these would be directly affected by any of the alternatives described herein.

Construction of ice roads associated with the Liberty project would not involve ground disturbance, and have no potential to cause effects to archaeological or historic resources.

4.4.6.4.4 Conclusion for Alternative 3B

Appendix C describes mitigation measures derived from lease stipulations, design features and BMPs to which the operator has committed, and requirements of Cooperating Agencies. Identification and protection of archaeological resources is required by applicable lease stipulations. These mitigation measures have been assumed to be a part of Alternative 3B. Alternative 3B would necessarily include archaeological surveys and analyses in conjunction with G&G coring and acoustic remote sensing surveys of the potential island. The overall impacts of Alternative 3B to archaeological resources would be negligible unless an historic property or other as yet undiscovered site were to be inadvertently damaged during normal project activities or inadvertently damaged or vandalized during oil spill cleanup. Impacts to archaeological resources would then be major.

4.4.6.5 Alternative 4 (Alternate Processing Locations)

4.4.6.5.1 Alternative 4A: Relocate Oil and Gas Processing to Endicott SDI

Alternative 4A would construct the proposed LDPI but processing would take place on the Endicott SDI. An alternative pipeline corridor would extend from the LDPI west to the SDI. Oil would be pumped through the existing Endicott Pipeline. The alternative pipeline corridor has received multiple surveys (Figure 2-19). It would be the only newly introduced component in Alternative 4A.

Alternative 4A would not require any further archaeological surveys. Effects would be negligible with little or no impact to archaeological and historical resources. The overall impacts of Alternative 4A to archaeological resources would be negligible unless an historic property or other as yet undiscovered site were to be inadvertently damaged during normal project activities or inadvertently damaged or vandalized during oil spill cleanup. Impacts to archaeological resources would then be major.

4.4.6.5.2 Alternative 4B: Relocate Oil and Gas Processing to a New Onshore Facility

Alternative 4B would include all elements of the Proposed Action with the exception that a new onshore oil and gas processing facility would be constructed approximately 1.5 miles inland from the coast near the Badami Sales Oil Pipeline tie-in point. The facility would include production modules, custody transfer metering, sale oil pumps and oil storage tanks, gas processing equipment for the LDPI, water treatment equipment, power generation, and a seawater treatment plant. The proposed site lies within the area surveyed for the Kadleroshilik River Mine site in 2013. The survey was a blend of low altitude, low speed airborne transects supplemented by pedestrian surveys of elevated pingos. No sites were found in the vicinity of what would now be the Badami Sales Oil Pipeline tie-in point (Higgs, 2013). A pedestrian archaeological survey would likely be necessary of the potential oil and gas processing facility if Alternative 4B is selected. Effects could range from negligible to major, depending upon if an archaeological site is discovered within the oil and gas processing footprint, and if the discovery is adversely impacted by ground disturbance.

4.4.6.6 Conclusion for Alternatives 4A and 4B

The overall impacts of Alternative 4A and 4B to archaeological resources would be negligible unless an historic property or other as yet undiscovered site were to be inadvertently damaged during normal project activities or inadvertently damaged or vandalized during oil spill cleanup. Impacts to archaeological resources would then be major.

4.4.6.7 Alternative 5 (Alternate Gravel Sources)

Alternatives 5A and 5B consider each of three different proposed gravel mine site locations. These alternative gravel mine sites received an archaeological survey that was comprised of low altitude, low speed airborne transects supplemented with pedestrian surveys of elevations. No archaeological or historic sites were discovered. The Proposed Action, would extract gravel from a site within the West Kadleroshilik River mine site. Alternative 5A is the East Kadleroshilik River Mine Site No. 2, which lies within the large Kadleroshilik River mine site that was surveyed archaeologically in 2013. No archaeological or historic sites were discovered (Higgs, 2013). Alternative 5B is the East Kadleroshilik River Mine Site No. 3.

4.4.6.8 Conclusion for Alternatives 5A and 5B

The overall impacts of the Alternatives 5A and 5B to archaeological resources would be negligible unless an historic property or other as yet undiscovered site were to be inadvertently damaged during normal project activities or inadvertently damaged or vandalized during oil spill cleanup. Impacts to archaeological resources would then be major.

4.5 Unavoidable Adverse Effects

Below is a list of resource areas that could experience unavoidable adverse effects under all of the action alternatives. A summary of the types of impacts resulting in unavoidable adverse effects is provided for each resource:

- **Water Quality.** An increase in suspended sediments associated with construction of the LDPI, and the presence of the LDPI itself.
- **Air Quality.** Ambient air pollution from pollutant emission from diesel engines associated with vessel traffic, construction activities, and operation equipment in support of the Proposed Action.
- **Lower Trophic Level Organisms.** Impacts to water quality (listed above) would also adversely affect lower trophic level organisms.
- **Fish.** Similar adverse effects as those to water quality, but with the addition of sound from vessel traffic and oil and gas activity.
- **Marine and Coastal Birds.** Collisions resulting from the physical presence of vessels and aircraft associated with the Proposed Action.
- **Marine Mammals.** Disturbance resulting from the sound and physical presence of vessels, aircraft, drilling, construction equipment, and presence of the LDPI.
- **Terrestrial Mammals.** Sound from and presence of aircraft and vehicle traffic, construction activities, and pipeline/facility presence associated with onshore oil and gas activities in support of OCS development.
- **Vegetation and Wetlands.** Loss or alteration of vegetation due to gravel pit development, onshore construction/support activities, and increased vehicle traffic in support of OCS development.
- **Subsistence.** Adverse effects to marine and coastal birds and marine mammals (listed above), and could also adversely affect subsistence harvest patterns and sharing structures.
- **Sociocultural Systems.** Adverse effects to subsistence harvest patterns, social organization, sharing networks, cultural values, and local institutions.
- **Public Health.** Minor population influx increasing social stressors/tensions.
- **Environmental Justice.** Similar impacts as those to public health, related to population changes and social stressors and tensions potentially increasing.
- **Archaeological Resources.** Ground and seafloor disturbing activities conducted in areas not previously surveyed have the potential to adversely affect archaeological resources.

A VLOS is not considered in this section because it is extremely unlikely and the adverse effects from one are not considered “unavoidable.”

4.6 Relationship between Local Short-Term Uses and Maintenance and Enhancement of Long-Term Productivity

The Proposed Action would entail some impacts to nearly all resource areas. In each case, the potential for impacts to long-term productivity is solely derived from the risk of a large-scale oil spill. The one exception to this trend was archaeological resources where destruction of archaeological sites and unauthorized removal of artifacts could occur via development and production activities, and represent an inherently long-term loss. The potential for such impacts exists under each action alternative.

4.7 Irreversible and Irretrievable Commitment of Resources

Irreversible and irretrievable commitment of resources refers to impacts or losses to resources that cannot be reversed or recovered. Examples include permanent conversion of wetlands or loss of cultural resources, soils, and wildlife, or changes in socioeconomic conditions.

Irreversible is a term that describes the permanent loss of future options. It applies primarily to the effects of use of nonrenewable resources such as minerals or cultural resources, or to those factors such as soil productivity that are renewable only over long periods of time. Irretrievable is a term that applies to the loss of production, harvest, or use of natural resources. For example, wetland habitat in an area is lost irretrievably while the area is being used as a gravel mine, but the action is not irreversible. Once the area is no longer needed as a gravel mine and is revegetated and restored, the wetland habitat could again become productive.

The Proposed Action would result in irreversible and irretrievable commitment of construction materials and the consumption of fossil fuels. The labor of local workers during construction would also be irretrievable, but reversible at the conclusion of that phase. Removal of habitat for fish, birds, and wildlife during construction and operation would result in irretrievable impacts to several species as well as to subsistence activities and sociocultural systems, but some of these impacts are reversible once these activities conclude. Destruction of certain cultural resources as a result of the Proposed Action could also be considered irretrievable and irreversible.

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Chapter 5

Cumulative Effects

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CHAPTER 5. CUMULATIVE EFFECTS

5.1 Introduction

This section analyzes the potential cumulative effects of the Proposed Action and its alternatives. Cumulative impacts are defined by Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations [CFR] 1508.7) as:

> Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or Non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The ultimate goal of identifying potential cumulative effects is to provide for informed decisions that consider the total effects (direct, indirect, and cumulative) of the Proposed Action and Alternatives. The CEQ handbook, "Considering Cumulative Effects under the National Environmental Policy Act (CEQ, 1997b)," suggests considering the following basic types of effects:

- Additive – the sum total impact resulting from more than one action
- Countervailing – adverse impacts that are offset by beneficial impacts
- Synergistic – when the total impact is greater than the sum of the effects taken independently

5.1.1 Framing the Analysis

BOEM used previous analyses to guide the scope of this analysis and help identify past, present, and reasonably foreseeable future actions and their effects on the marine, coastal, and human environments, though the overall scope of the analysis in this Environmental Impact Statement (EIS) and project area are narrower. This EIS considers the Chukchi Sea Outer Continental Shelf (OCS) Lease Sale 193 Second Supplemental EIS, the 2015 Shell Exploration Plan Environmental Assessment (EA), Bureau of Land Management's (BLM) 2012 National Petroleum Reserve in Alaska (NPR-A) Integrated Activity Plan (IAP)/EIS, U.S. Army Corps of Engineers' (USACE) 2012 Point Thomson EIS, and National Marine Fisheries Service's (NMFS) 2016 EIS on the Effects of Oil and Gas Activities in the Arctic Ocean.

The past, present and reasonably foreseeable future actions considered for the cumulative effects analysis in this EIS are identified in Table 5-1 to Table 5-11, and are described in the subsequent sections of this chapter. In identifying past, present, and reasonably foreseeable future actions germane to this analysis, Bureau of Ocean Energy Management (BOEM) considered:

- Past oil and gas activities – activities that resulted in existing infrastructure.
- Present oil and gas activities – activities for which new facilities are under construction.
- Reasonably foreseeable future oil and gas activities – activities where sufficient planning and/or initiation of appropriate permitting processes have begun that they are considered likely to proceed during the life of the Proposed Action. These include potential projects in the U.S. and Canadian waters of the Beaufort Sea.
- Past, present and reasonably foreseeable future actions other than oil and gas activities.

Potential cumulative impacts were considered in the context of a changing climate. A changing climate could contribute to cumulative effects through:

- Increased noise and disturbance due to increased shipping.
- Increased severity of storms.

- Thawing of permafrost impacting onshore infrastructure.
- Increased coastal erosion.
- Decreases in ice cover with the potential for resultant changes in prey-species concentrations and distribution with related changes in species distributions.
- Increased ocean acidity.
- Range extension of species into the Arctic.
- Changes in timing and magnitude of plankton blooms.
- Changes in subsistence harvest practices.
- Changes in potential for community economic development and regional tourism activities.

While the cumulative impacts analysis in this EIS focuses on the Proposed Action, where the selection of an alternative would lead to notable reductions (or other changes) in the project's contributions to cumulative impacts, these instances are noted.

Under the No Action alternative, the activities described in the Liberty Development and Production Plan (DPP) would not occur, and would not contribute to any cumulative impacts.

Both the time period and geographic scope of this cumulative impacts analysis vary according to the resource/activity under consideration. While relevant past actions can date back to the 1940s or prior, the analysis is generally focused on more recent actions. The general future timeframe extends through, at minimum, the duration of the Proposed Action (roughly 2050).

The spatial domain considered in this cumulative analysis generally extends across much of the North Slope and the Beaufort and Chukchi seas, as any activities taking place in these regions tend to use the same infrastructure and impact interconnected resource systems. In some cases, such as with certain species of birds or marine mammals that migrate great distances, the spatial extent of the analysis may be greater.

Projects for which no official proposal has been submitted and which are not certain to occur within the foreseeable future are considered speculative. Speculative actions are not considered reasonably foreseeable and are not analyzed as part of the cumulative impacts associated with this EIS. The intent is to keep the cumulative analysis useful, manageable, and concentrated on meaningful potential effects. The cumulative analysis considers in greatest detail activities that are more certain to happen and that are geographically in or near the project area.

5.1.2 Past, Present, and Reasonably Foreseeable Future Actions

Potentially relevant past, present and reasonably foreseeable future actions (RFFA) are identified in this section. General categories of these actions are introduced and discussed in Table 5-1. These include oil and gas activities, community development, recreation and tourism, marine vessel traffic, aircraft traffic, subsistence activities, research and survey activities, mining projects, and military activities.

Table 5-1 Relevant Past, Present and Reasonably Foreseeable Future Action Categories

Table	Category	Area	Type of Action
5-2	Oil and Gas Activities	State and Federal Waters (Beaufort and Chukchi seas); Onshore Alaska North Slope; MacKenzie Delta (CAN) and Beaufort Sea; Russian Chukchi Sea	Geological and Geophysical Surveys; Infrastructure Development; Gravel Mining; Construction and Maintenance; Exploration; Energy Development and Production
5-3	Community Development	North Slope Borough	Demographic/Population Change, Migration; Commercial Fishing; Infrastructure Development Projects (e.g., Capital Improvement Projects; Energy Development, Communication)

Table	Category	Area	Type of Action
5-4	Recreation and Tourism	Beaufort and Chukchi Sea and Adjacent Near Shore Area	Wildlife viewing (e.g., Polar Bear Viewing in Kaktovik); Sport/commercial guiding and fishing; Recreational activities; Cruise ships and commercial vessels; Increased Visitors at Arctic Refuge
5-5	Marine Vessel Traffic	US and Canada Beaufort seas; U.S. and Russia Chukchi seas; Nearshore Beaufort and Chukchi seas; Transportation corridors to Dutch Harbor	Industry vessels, oil field support and transports; Community barge and supply vessels; Global Shipping through the Arctic; Research Vessels; Commercial Fishing Vessels; introduction of invasive species
5-6	Aircraft Traffic	Beaufort and Chukchi seas; Overland	Industry Crew Transfers; Commercial and private flights, National and International Cargo Flights; Expansion of airfields; Research flights
5-7	Subsistence Activities	Utqiaġvik, Kaktovik, Nuiqsut	Subsistence harvesting (e.g., caribou), fishing (e.g., whitefish species), and gathering; Bowhead Whaling; Traveling (small marine vessels, off-road vehicles, private fixed-wing airplanes)
5-8 and 5-9	U.S. and Canadian Research and Survey Activities	Nearshore and offshore waters (Beaufort and Chukchi seas); Onshore	Studies and Surveys: Oceanographic; Biological; Geophysical; Archaeological; Socioeconomic
5-10	Mining Projects	North Slope Borough; Northwest Arctic Borough; Nome Census Area	Resource extraction
5-11	Military/Homeland Security Activities	Coastal sites (Northwest Alaska, North Slope); Federal waters (Beaufort and Chukchi seas)	Distant Early Warning Line Sites maintenance and demolition; Marine and air vessel presence; Onshore base/infrastructure/ personnel

5.1.2.1 Oil and Gas Activities

5.1.2.1.1 Past and Present Oil and Gas Activities

Onshore oil development has been the main agent of industrial change on the North Slope and throughout the Arctic OCS in the twentieth and twenty-first centuries. Oil and gas exploration activities have occurred on the North Slope since the early 1900s, and oil production started at Prudhoe Bay in 1977. Oil production has occurred for over 40 years in the region, and presently spans from Alpine in the west to Point Thomson in the east. Onshore gas production from the Barrow gas field began over 60 years ago. Associated industrial development has included the creation of industry-supported community airfields at Deadhorse and Kuparuk, and an interconnected industrial infrastructure that includes roadways, pipelines, production and processing facilities, gravel mines, and docks.

In 1977, the Trans-Alaska Pipeline System (TAPS) began to transport North Slope crude oil to a year-round marine terminal in Valdez, Alaska. Today, it continues to transport the North Slope’s entire onshore and offshore oil production, and is projected to do so for years to come.

Past and present onshore and offshore oil and gas facilities in the U.S. Arctic are summarized in Table 5-2. Oil and Gas projects in current development with future production goals are summarized in Table 5-2.

Definitions

- Field—an area consisting of a single reservoir or multiple reservoirs all grouped on, or related to, the same general geologic structural feature and/or stratigraphic trapping condition. Fields are currently or should soon be producing hydrocarbons.
- Satellite—a small prospect or field which must use infrastructure from another field in order to be economic
- Pool—a discovered or undiscovered accumulation of hydrocarbons, typically within a single stratigraphic setting
- Prospect—a geologic feature having the potential for trapping and accumulating hydrocarbons

- Show—a one-well discovery with poorly defined limits and production capacity

Endicott Island, built in 1987, was the first continuously producing offshore oil field in the Arctic. The Northstar offshore island for oil production was constructed in 1999 to 2000. Northstar, as well as the Nikaitchuq and Oooguruk developments, currently operates in nearshore areas of the Beaufort Sea, and is expected to continue operating in the future. Additional oil and gas activities that have occurred in the Beaufort Sea and Chukchi Sea OCS to date include exploration wells, exploration seismic surveys, geohazard surveys, geotechnical sampling programs, and baseline biological studies and surveys. In November 2017, three Chinese companies (Sinopec, China Investment Corp., and the Bank of China) signed a non-binding agreement with the State of Alaska to advance liquefied natural gas (LNG) projects in Alaska (https://www.cnbc.com/2017/11/08/chinese-companies-agree-to-develop-lng-in-alaska-as-trump-visits.html).

Table 5-2 Past and Present U.S. Arctic Oil and Gas Discoveries as of September 2016

Production Facility Name	Production	Location	Discovery	Category
South Barrow	Gas	Onshore	1949	Field
Prudhoe Bay	Oil	Onshore	1977	Field
Kuparuk River	Oil	Onshore	1969	Field
East Barrow	Gas	Onshore	1974	Field
Lisburne	Oil	Onshore	1969	Field
Milne Point/ Kuparuk River	Oil	Onshore	1969	Field
Endicott	Oil	Offshore	1978	Field
Sag Delta North/Ivishak	Oil	Offshore	1982	Satellite[1]
Schrader Bluff	Oil	Onshore	1969	Satellite[3]
Walakpa	Gas	Onshore	1980	Field
Point McIntyre	Oil	Onshore	1988	Field
Niakuk	Oil	Onshore	1985	Field
Sag River	Oil	Onshore	1965	Satellite[3]
Cascade	Oil	Onshore	1993	Field
West Sak	Oil	Onshore	1971	Satellite[2]
Badami	Oil	Onshore	1990	Field
Tarn	Oil	Onshore	1991	Field
Tabasco	Oil	Onshore	1986	Satellite[2]
Midnight Sun	Oil	Onshore	1997	Satellite[4]
Aurora	Oil	Onshore	1969	Satellite[4]
Alpine	Oil	Onshore	1994	Field
Polaris	Oil	Onshore	1969	Satellite[4]
Northstar	Oil	Offshore	1984	Field
NW Eileen/Borealis	Oil	Onshore	1969	Field
Meltwater	Oil	Onshore	2000	Field
Orion	Oil	Onshore	1968	Satellite
Palm	Oil	Onshore	2001	Field
Fiord (CD 3)	Oil	Onshore	1992	Field
Nanuq (CD 4)	Oil	Onshore	2000	Field
Qannik	Oil	Onshore	2006	Field
Raven	Oil	Onshore	2001	Field
Nuiqsut	Oil	Offshore	1992	Field
Oooguruk-Kuparuk	Oil	Offshore	1992	Field
Torok	Oil	Offshore	1992	Field
Hooligan	Oil	Offshore	1984	Field
Nikaitchuq-Schrader Bluff	Oil	Both	2004	Field
Alpine West (CD 5)	Oil	Onshore	1998	Field
Point Thomson	Gas and Oil	Onshore	1977	Field

Note: Footnotes for Satellites identify the associated production unit:
[1] Duck Island Unit [3] Milne Point Unit
[2] Kuparuk River Unit [4] Prudhoe Bay Unit

Source: Field information from State of Alaska, Dept. of Natural Resources Division of Oil and Gas Website and Petroleum News

Recent exploration drilling has occurred in both the Beaufort and Chukchi Sea OCS, as well as in the nearshore state waters of Smith Bay in the Beaufort Sea. In 2012, Shell Offshore, Inc. proposed exploration of two new prospects in Camden Bay, the Sivulliq and Torpedo prospects. Though four wells were permitted, only one well was drilled. The well targeted the Sivulliq prospect approximately 16 miles offshore. Prior to penetrating potentially oil-bearing zones, Shell ceased drilling, and the well was temporarily abandoned and the exploration program was terminated.

In 2012, approximately 60 miles from shore in the Chukchi Sea OCS, Shell Gulf of Mexico, Inc. also attempted exploration of the Burger prospect. As with the Sivulliq well, Shell ceased drilling, temporarily abandoned the well, and terminated the exploration program prior to penetrating the potentially oil-bearing Burger prospect. Shell returned to the Burger prospect in 2015 to drill a new exploration well, this time reaching the Burger prospect and confirming a lack of economically producible oil. The well was plugged and abandoned and Shell later relinquished all Chukchi Sea OCS leases. After relinquishments by other Chukchi Sea OCS lessees, there are currently no remaining Chukchi Sea leases issued in Lease Sale 193.

In 2016, Caelus Energy Alaska, LLC (Caelus) drilled two exploration wells into the Tulimaniq prospect on nearshore State of Alaska leases in Smith Bay approximately 59 miles southeast of Utqiaġvik in the Beaufort Sea. By October 2016, Caelus announced it has made an oil discovery estimated at 200,000 barrels per day (bbls/d) of light, highly mobile oil. The recovery rates, if correct, would put the field's estimated oil potential between 1.8 billion barrels (Bbbl) and 4 Bbbl. By way of comparison, Prudhoe Bay oil field was originally estimated to have 25 Bbbl. Additional well testing would tell more about potential production rates.

The Alaska LNG Pipeline Project (AK LNG) has been a possible project since oil was discovered at Prudhoe Bay in the late 1960s, though the economics have not been satisfactory and the three major producers have opted to reinject the natural gas in order to increase liquid oil production. In December 2015, however, the Alaska Gasline Development Corporation approved a budget of more than $230 million to continue preliminary engineering on the $45 to $65 billion project.

Several recent ancillary activities have also been conducted in the Beaufort Sea OCS. BP Exploration Alaska, Inc. (BPXA) completed a 3D Ocean Bottom Node (OBN) Seismic Survey in the North Prudhoe Bay area during the open-water season of 2014. Earlier that year, SAExploration, Inc. also completed an on-ice 3-D Seismic Survey extending from onshore Alaska across nearshore State waters into the Beaufort Sea OCS. In 2012, Ion Geophysical Corporation completed a 2-D Seismic Survey across a large swath of the Beaufort Sea OCS and extending into the Chukchi Sea OCS. Other less recent Beaufort Sea OCS surveys include one 3-D survey each by Shell and BPXA in 2008 and three surveys by Shell in 2007 (one 3-D marine seismic, one 3-D on-ice seismic, and one high resolution shallow seismic survey). Geological and Geophysical activities do not require leases and are individually permitted by BOEM after project-specific regulatory and National Environmental Policy Act (NEPA) reviews.

5.1.2.1.2 Reasonably Foreseeable Future Oil and Gas Activities

BOEM considered reasonably foreseeable future oil and gas activities both offshore and onshore in this cumulative effects analysis. Some activities are currently being implemented and others have been sufficiently advanced to be considered likely (e.g., are currently undergoing permitting; have been permitted, but not constructed; or have been funded for construction).

The discussion on reasonably foreseeable future actions does not include small discoveries and undiscovered resources that are very unlikely to be developed in the next 20 years. With respect to undiscovered resources, it is not reasonable to estimate new infrastructure or predict the impacts of development for prospects that have not been located or leased to industry for exploration. Accurate predictions of the location, size, or development schedules are not possible at this time, thus analyzing such development is not within the scope of this EIS.

The following projects represent a subset of the reasonably foreseeable future onshore oil and gas activities on the North Slope of Alaska.

Point Thomson

ExxonMobil has completed the initial phase of developing this field on the eastern North Slope. Point Thomson is a gas condensate field that is currently producing condensate and shipping it via a 22-mile oil pipeline to Pump Station 1 on the TAPS. Current estimated recoverable condensate resources are 200 MMbbl. First oil production from Point Thomson began in May 2016. Peak production from the first stage of development at this facility is estimated at 10,000 barrels of oil per day (BOPD). The drillsite and production facilities are located on state onshore lands just west of the Alaska National Wildlife Refuge with long-reach wellbores drilled more than 1.5 miles into the nearshore waters of the Beaufort Sea. The project includes production pads, process facilities, an infield road system, a pipeline, infield gathering lines, and an airstrip. To avoid offshore development and potential impacts on the marine environment, onshore drilling pads were selected to enable directional drilling to offshore locations.

Greater Prudhoe Bay/Kuparuk/State Offshore Areas

This main producing part of the Alaska North Slope is expected to have numerous small developments as smaller accumulations of oil are discovered and can be produced using existing infrastructure. Production from these developments would flow from existing facilities into Pump Station 1 of TAPS. The timing of these developments would be scattered over the next 10 years.

In 2012, ConocoPhillips Alaska, Inc. (CPAI) drilled a successful appraisal well into an undeveloped section of the Kuparuk formation on the southwest flank of the Kuparuk field and began construction of a new drill site in 2014. Named Drill Site 2S, this was the first new drill site in Kuparuk in 12 years. Construction was completed in 2015 and first production flowed in October 2015. Estimated peak production from this new drill site is 8,000 BOPD. In 2015, CPAI also dedicated funding for an extension of the Kuparuk field. Existing Drill Site 1H was constructed in 2017 and consists of four production wells, fifteen injection wells, and associated surface equipment. Drilling commenced in August 2017.

To the west of Kuparuk River Unit lies the Mustang oil field, part of the Southern Miluveach Unit now owned by Brooks Range Petroleum Corporation (Brooks Range Petroleum). After construction of a gravel road and drill site, and drilling several development wells starting in early 2015, Brooks Range Petroleum announced the delay of first oil production after encountering mechanical and reservoir problems while drilling. First oil production is expected early 2019. The estimated 44 MMBO Mustang field is equipped with a standalone production facility and pipeline on a gravel pad and road which connects to existing infrastructure at Kuparuk.

Alpine CD-5

CPAI began construction of the newest Alpine field satellite development drill site named CD-5 in 2014. This new drill site is located on Alaska Native village corporation lands near Nuiqsut and is the first commercial oil production from within the NPR-A. As a satellite to Alpine Central Processing Facility (CPF), CD-5 has only minimal on-site processing facilities but required 6 miles of gravel road, 4 bridges, and 32 miles of pipelines including completion of a gravel road and natural gas pipeline from Alpine CPF into Nuiqsut. First production flowed from CD-5 to Alpine CPF in October 2015 and is estimated to peak at a rate of 16,000 BOPD. CPAI plans to continue drilling an additional 18 wells at CD-5 after the original 15 wells are completed, for an eventual total of 33 wells.

Greater Mooses Tooth

In October 2015, CPAI received approval for construction of the Greater Mooses Tooth-1 (GMT-1) project, the first commercial development on Federal lands in the NPR-A. Initially targeting the Lookout oil pool with a total of 9 wells, the GMT-1 drill site would host 24 additional wells slots for eventual development of 2 other oil and gas pools in the Federally-managed Greater Mooses Tooth Unit. The 7.7-mile long GMT-1 road, 2 bridges, and pipelines would connect to Alpine CPF through the existing CD-5 road and pipeline extension. During the 2017 winter construction season, 756 vertical support members, more than 12 miles of pipeline, 7.7 miles of gravel road, more than 11 acres of gravel pad, and 2 bridges were installed in support of GMT-1. Project construction will continue winter of 2018 with first oil planned for late 2018.

In August 2015, CPAI announced submission of applications for construction of the Greater Mooses Tooth-2 (GMT-2) project on Federal lands in the NPR-A. If approved, GMT-2 would target the Spark oil pool with as many as 48 wells drilled from a 14-acre drill site 8 miles to the southwest of GMT-1. The proposed 8.6-mile gravel road and pipeline would connect through GMT-1 and on to Alpine CPF through the existing CD-5 extension. Production estimates are yet to be published but CPAI anticipates first oil production by the end of 2020 if permits are approved on schedule.

Smith Bay Development

In 2016, Caelus Energy Alaska (Caelus), made a significant light oil discovery on its Smith Bay state leases on the North Slope of Alaska. Caelus estimates the amount of oil in place to be approximately 6 Bbbl with an additional 10 Bbbl of oil in place when the adjoining acreage is included. Caelus expects to achieve recovery factors in the range of 30 percent to 40 percent due to the favorable fluids contained in the reservoir. According to Caelus, the Smith Bay development has the potential to provide 200,000 BOPD of light, highly mobile oil which would both increase TAPS volumes and reduce the average viscosity of oil in the pipeline, extending its long-term viability. If developed, this may require constructing a new pipeline. Caelus is currently planning an appraisal program which would include drilling an additional appraisal well and acquiring a new 3D seismic survey of additional acreage. The appraisal program would enable Caelus to confirm reservoir continuity, optimize future drilling locations, and ultimately increase reserves. Caelus is also studying and planning the development of facilities to process and transport the oil to TAPS.

Pikka Unit and Nanushuk Development

The Pikka Unit was approved in 2015 to accommodate Repsol and Armstrong Energy's exploration leases. Wells referred to as Horseshoe-1 and 1A were drilled on State land during the 2016 to 2017 winter season in a section of the Pikka Unit known as the Nanushuk Prospect. In 2017, Repsol and Armstrong Energy reported they had discovered the largest U.S. onshore oil discovery in 30 years between the Colville River Unit, the Oooguruk Unit, and the Placer Unit in the central North Slope. The Horseshoe discovery wells are located approximately 12 miles south of Nuiqsut and extend the Nanushuk Prospect by 20 miles.

The Pikka Unit (including the Nanushuk Development) and the Horseshoe discovery apparently contain at least 1.2 Bbbl of recoverable light oil combined. First production for the Pikka Unit from the Nanushuk Development could occur as early as 2021, with a potential rate approaching 120,000 BOPD. Armstrong Energy, proposing to develop Nanushuk, would target oil deposits in the Alpine C and Nanushuk reservoirs. The project is southeast of the East Channel of the Colville River, located approximately 52 miles west of Deadhorse and about 6.5 miles from Nuiqsut (at the southernmost location of the Nanushuk Project). The project would include construction of the Nanushuk Pad comprised of Drill Site 1 and a CPF, Drill Site 2, Drill Site 3, an operations center pad, infield pipelines, the export/import Nanushuk Pipeline, infield roads, and an access road.

5.1.2.1.3 Pipelines

BOEM also considered proposed onshore and offshore construction of pipelines for this cumulative impacts analysis.

Alaska (AK) LNG Project

The project, still in preliminary engineering and design stages and under environmental review, is a proposal originally put forth by a consortium comprised of major North Slope oil and gas producers ExxonMobil, BPXA, and CPAI, along with partners TransCanada and the State of Alaska. The development would include a gas treatment plant at Prudhoe Bay to remove carbon dioxide and other impurities from the gas stream; a 42-inch diameter, high-pressure, 800-mile pipeline; and 8 compressor stations to move the gas to a proposed liquefaction plant at Nikiski, on the Kenai Peninsula. The Nikiski site would include LNG storage tanks and a marine shipping terminal for gas exports. Up to five take-off points for in-state gas delivery are also planned upstream of the Nikiski LNG plant.

The pipeline would be designed to accommodate 3 billion to 3.5 billion cubic feet of gas (Bcfg) per day, with an initial mix of gas from the Prudhoe Bay and Point Thomson fields, and room to accommodate other gas fields in the decades ahead. Best case, the engineering, design, and permit work could run into 2019, followed by final investment decisions, equipment procurement, construction, with first gas in 2023 to 2024 should the project move forward to completion.

Alaska Stand Alone Gas Pipeline

A second partnership, the Alaska Stand Alone Gas Pipeline (ASAP) project, was originally planned as a 24-inch diameter natural gas pipeline with a natural gas flow rate of 500 million cubic feet (MMcf) per day at peak capacity of consumer grade, “lean gas.” This is to be a reliable, affordable energy source to Alaskan communities. The Alaska Gasline Development Corporation (AGDC) in partnership with TransCanada Corp. has led the planning effort for ASAP. Production from this pipeline would emphasize in-State distribution, although surplus gas would also likely be condensed and exported. According to the USACE, the 727-mile, low pressure ASAP pipeline route would generally parallel the TAPS and Dalton Highway corridor to near Livengood, northwest of Fairbanks. At Livengood, the mainline route would continue south, to the west of Fairbanks and Nenana. The pipeline would bypass Denali National Park and Preserve to the east and would then generally parallel the Parks Highway corridor to Willow, continuing south to its connection into ENSTAR's distribution system at Milepost (MP) 39 of the Beluga Pipeline southwest of Big Lake. The Fairbanks 30-mile Lateral tie-in would be located approximately 2.5 miles south of the Chatanika River crossing at MP 440 of the mainline. From the mainline tie-in point, the Fairbanks Lateral pipeline would traverse east over Murphy Dome, following the Murphy Dome and Old Murphy Dome Roads, and then extend southeast into Fairbanks.

In 2015, members of the AGDC decided to put ASAP on hold, instead focusing their efforts on the AK LNG project. According to the AGDC, ASAP is the State of Alaska’s backup plan and they continue to maintain its viability and readiness in the event the Alaska LNG initiative does not progress to project sanctioning. As of 2015, the State of Alaska had already invested over $125 million into ASAP.

If either project moves forward, it would include an underground pipeline with elevated bridge stream crossings, compressor stations, possible fault crossings, pigging facilities, and off-take valve locations. Either pipeline would be designed to transport a highly conditioned natural gas product, and would follow the same general route. A gas conditioning facility would need to be constructed near Prudhoe Bay and would likely require one or more large equipment modules to be off-loaded at the West Dock loading facility. Shipments to West Dock would likely require improvements to the dock facilities and dredging would be needed to deepen the navigational channel to the dock head.

5.1.2.2 Community Development

Community development projects in Arctic communities involve both large and small infrastructure projects. Examples of community development activities are provided in Table 5-3. Examples of past major community development projects include the construction of a new airport in Kaktovik. Smaller projects resulting from and leading to community growth could further increase demand for public services and infrastructure, such as housing, energy efficiency, water, waste disposal and storage, electricity, health care, telecommunications, port and dock construction, and roads (NSB, 2014, 2015). These infrastructure projects would likely generate increases in economic activity, and would also result in increased construction noise and air emissions, increased water turbidity and sedimentation, additional marine and aircraft traffic from construction activities, and changes in population demographics. Marine and air transportation would contribute to potential cumulative effects through noise and atmospheric pollution resulting in disturbance of marine mammals and impacts to subsistence harvest practices and related social organization and cultural values.

Table 5-3 Past, Present, and Reasonably Foreseeable Community Development Projects

Community	Action / Project	Past	Present	Future
Kaktovik	Marine and air, airport construction upgrades, transportation, energy efficiency improvements; alternative energy infrastructure	Yes	Yes	Yes
Nuiqsut	Marine and air traffic, upgrade and expand airport facilities; capital improvement projects; improved utilities, housing, and roads; construct access road to Colville River; erosion control and new ice cellar projects	Yes	Yes	Yes
Utqiaġvik	Marine and air traffic, capital improvement projects, transportation, energy efficiency improvements; alternative energy infrastructure	Yes	Yes	Yes

5.1.2.3 Recreation and Tourism

The shallow waters and industrial activity and development near the Proposed Liberty Development and Production Island (LDPI) preclude visitations by cruise ships and make private access to the area difficult. Thus, neither recreation nor tourism is expected to occur in appreciable levels in the immediate vicinity of the Proposed Action. Recreation and tourism activities have, however, historically occurred in northern Alaska and are expected to continue and possibly increase during the 25-year life of the Proposed Action. Therefore, these activities are considered as a minor factor in this analysis. Examples of reasonably foreseeable future recreation and tourism activities are provided in Table 5-4.

Table 5-4 Past, Present, and Reasonably Foreseeable Future Recreation and Tourism

Activity Type	Area	Action / Project	Activities	Open Water	Winter	Past	Present	Future
Wildlife Watching, Flightseeing, Cruise Ships, Wilderness Adventure	Eastern Beaufort Sea Coastal and activities originating from inland areas	River trips, wildlife viewing, hiking, flightseeing	Aircraft and, freshwater vessels	Yes	No	Yes	Yes	Yes
Wildlife Watching, Flightseeing, Cruise Ships	Eastern Beaufort Sea Coastal and Inland - North Slope (Kaktovik)	Polar bear viewing	Aircraft, marine, and freshwater vessels	Yes	No	Yes	Yes	Yes
Wildlife Watching, Flightseeing, Cruise Ships	Beaufort Sea Offshore and Nearshore	Cruise ships, eco tours	Marine vessels	Yes	No	No	Yes	Yes
Sport Hunting & Fishing	Eastern Beaufort Sea Coastal and Inland -Arctic Refuge	Hunting, Fishing, flightseeing	Aircraft, marine, and freshwater vessels	Yes	Yes	Yes	Yes	Yes

5.1.2.4 Marine Vessel Traffic

Marine vessel traffic in the past has been associated with subsistence hunting, oil exploration, research, and military activities in the Chukchi and Beaufort seas. Weather and ice have typically limited marine vessel traffic in these areas to July through September. Future marine traffic patterns may change due to the influence of a longer ice-free period and overall decreased ice cover, potentially increasing the number of vessels associated with industrial transportation, tourism, and non-subsistence fishing. The U.S. Coast Guard (USCG) recently completed a Port Access Route Study to increase the efficiency of vessel traffic in the Chukchi Sea, Bering Strait, and Bering Sea. Most vessels engaged in OCS activity in the Beaufort and Chukchi seas would follow these shipping lanes as they transit through the Bering Strait, unless environmental conditions such as heavy ice cover make following those routes impracticable. Transits of the Northern Sea Route, used by vessels carrying oil and gas products from Russian oilfields to the far east, are usually draft limited to 39.4 to 42.7 feet, which limits the maximum size of these vessels. Table 5-5 below summarizes the major sources of marine vessel traffic in the Proposed Action Area of effect.

Dutch Harbor, Alaska is an extremely busy commercial port and thousands of vessels pass through the area annually. While BOEM does not regulate transit from Dutch Harbor, most vessels used for the Liberty Project would transit from Dutch Harbor to the Proposed Project Area for resupply each drilling season.

Table 5-5 Past, Present and Reasonably Foreseeable Future Marine Vessel Traffic

Area	Project	Activities	Open Water	Winter	Past	Present	Future
Coastal	Supply Barges	Marine and freshwater vessels	Yes	No	Yes	Yes	Yes
Coastal	Local resident boat traffic	Subsistence, travel, small boats	Yes	No	Yes	Yes	Yes
Coastal	Industry crew change, supply and materials transfer	Hydrocarbon offloading, transport, storage, marine vessel traffic	Yes	No	Yes	Yes	Yes
Coastal	Donlin Gold Mine	Marine vessel traffic	Yes	No	No	No	Yes
Offshore	Icebreaker and ice management, Northern Sea Route tanker transport of crude oil Marine Vessel Traffic	Marine vessel traffic	Yes	Yes	Yes	Yes	Yes
Offshore	Crew transfer, transport of supplies and equipment, aircraft traffic	Marine vessel and aircraft traffic	Yes	Yes	Yes	Yes	Yes

Marine vessels are the greatest contributors of anthropogenic sound introduced to the Beaufort Sea. Sound levels and frequency characteristics of vessel sound are generally related to vessel size and speed. Larger vessels generally emit more sound than do smaller vessels. Same size class vessels travelling at higher rates of speed generally emit more sound than the same vessels travelling at lesser speeds. Vessels underway with a full load, or vessels pushing or towing loaded non-powered vessels, generate more sound than unladen vessels in a similar size class. The most common sources of marine vessel noise are propulsion engines, generators, bearings, pumps, and other similar components. Operations and navigation equipment, including fathometers and sonar equipment, also contain mechanical components that create and propagate sound into the marine environment. The most intense level of sound pressure introduced into the water from an underway marine vessel originates from cavitation associated with the energy of spinning propellers. Moored vessels can generate sound from the operation of engines and pumps. Cranes or other equipment performing construction activities or other work functions may transmit sound directly to the marine environment through the air-water interface or through propagation of sound waves through hulls or other support structures.

The number of marine vessels in both the Beaufort and Chukchi seas has increased in recent years due to advances in the technology of ice strengthening and ice breaking capacities, changes in ice cover and classifications of ice, increases in use of both the Northern Sea Route over Russia and the Northwest Passage through Canada for commercial and tourist voyages, and increased interest in scientific and economic pursuits in the area. Reasonably foreseeable future traffic in the region includes small craft involved in the fall whaling hunts; USCG vessels; cargo vessels; other supply ships, tugs, and barges; cruise ships; and vessels associated with scientific endeavors. There are also several newly built ice strengthened LNG carriers and more on order that are expected to carry an increasing volume of Russian LNG Cargoes across the Northern Sea Route and through the Bering Strait to markets in the Far East. As more development takes place on the North Slope and in other coastal areas in Western Alaska (e.g., Donlin Mine) vessel traffic in Dutch Harbor may increase.

USCG District 17 (USCG, 2013) reported annual vessel traffic transiting the Bering Strait, which is the entry and exit point to the Western Arctic, increased from 220 to 480 vessels a year (a more than 100 percent increase) between 2008 and 2012. In recent years, there has been a drop in Bering Strait transits. There were 440 in 2013 and 340 in 2014. The Office of Naval Intelligence (2014) reported Bering Strait transits may exceed 1,000 vessels per year by 2025 due to changes in ice patterns across the northern sea routes (greater than or equal to 400 percent increase from 2012 numbers). The same publication reports that in 2012, 96 vessel passages occurred in the Northern Sea Route over Russia and the Northwest Passage through Canada combined. That level of activity may increase to 1,000 passages by 2025, due to an increase in open water periods from approximately 2 to more than 5 weeks, resulting in cost savings because of shorter routes and transit times. The estimated number of miles of non-seismic vessel traffic in the Chukchi Sea for July through October increased from approximately 2,000 miles in 2006 to more than 11,500 miles in 2010 (Marine Exchange of Alaska, 2011).

5.1.2.5 Aircraft Traffic

Air traffic has increased in recent years, mostly from increases in research, survey, commercial, military, and recreational operations. Table 5-6 summarizes past, present, and reasonably foreseeable air traffic in the Beaufort and Chukchi seas. Aircraft traffic in the Arctic includes fixed wing and helicopter flights for research programs and marine mammal monitoring operations; cargo flights for supplies to villages and for commercial ventures including oil and gas related activities (such as crew changes and supply flights); flights for regional and inter-village transport of passengers; air-ambulance and search and rescue emergency flights; general aviation for the purpose of sport hunting and fishing or flightseeing activities; and multi-governmental military flights. An average of 92 U.S. carrier flights per month occurred from Nuiqsut airport and 291 U.S. carrier flights per month occurred from Utqiaġvik’s Wiley Post–Will Rogers Memorial Airport between July and October, 2003 to 2016 (http://www.transtats.bts.gov/Data_Elements.aspx?Data=2). Nationally, the Federal Aviation Administration forecasts an average annual increase in aircraft operations of 2.0 percent for air carriers, 1.5 percent for air taxis with commuters, and 0.3 percent for total general aviation through 2032 (FAA, 2012, Table 32).

Table 5-6 Past, Present and Reasonably Foreseeable Air Traffic

Area	Project	Traffic Type	Open Water	Winter	Past	Present	Future
Coastal	Aerial surveys of marine mammals	Air traffic	Yes	Yes	Yes	Yes	Yes
Coastal	Scheduled air transportation	Air traffic	Yes	Yes	Yes	Yes	Yes
Coastal	Coastline erosion surveys	Air traffic	Yes	No	Yes	Yes	Yes
Coastal	Tourism	Flightseeing	Yes	Yes	Yes	Yes	Yes
Offshore	Industry crew changes and supply flights	Helicopter traffic	Yes	Yes	Yes	Yes	Yes
Offshore	Marine mammal surveys	Air traffic	Yes	Yes	Yes	Yes	Yes

Note: Area includes Beaufort and Chukchi seas.

5.1.2.6 Subsistence Activities

Two major subsistence resource categories occur on the North Slope: coastal/marine and terrestrial/aquatic (Table 5-7). Coastal/marine food resources include whales, seals, walruses, waterfowl, and fish. Terrestrial/aquatic resources include caribou, freshwater fish, moose, Dall sheep, edible roots and berries, and furbearing animals. Generally, communities harvest resources most available to them. The distribution, migration, seasonal, and more extended cyclical variation of animal populations drive decisions on what, where, and when to harvest a subsistence resource. Many areas might be used infrequently, but they can be quite important harvest areas when they are used.

Subsistence activities tend to be concentrated along rivers, lakes, and coastlines, near communities, and where resources are at high abundance levels.

Table 5-7 Past, Present, and Reasonably Foreseeable Future Subsistence Activities

Action / Project	Community	Open Water	Winter	Past	Present	Future
Bowhead whale harvest	Kaktovik, Nuiqsut, Utqiaġvik	Small boat and snowmachine travel	Yes	Yes	Yes	Yes
Harvest of beluga, walrus, seals	Kaktovik, Nuiqsut, Utqiaġvik	Small boat and snowmachine travel	Yes	Yes	Yes	Yes
Hunting, gathering, fishing, trapping, and associated activities.	Kaktovik, Nuiqsut, Utqiaġvik	Small boat, vehicular, and snowmachine travel	Yes	Yes	Yes	Yes

The subsistence pursuit of bowhead whales has major importance to the communities of Utqiaġvik, Nuiqsut, and Kaktovik. The harvesting, processing, distribution, and sharing of whale *muktuk* and whale meat is important and continues to be the most valued activity in the subsistence economy of these communities. It is anticipated that subsistence activities would continue in the foreseeable future.

5.1.2.7 Scientific Research Activities

Numerous offshore scientific research programs in the Beaufort and Chukchi seas are conducted annually (Table 5-8). These activities involve vessel, air, and over-ice support which may contribute to cumulative effects through disturbance of marine animals and impacts to subsistence harvest through marine vessel and aircraft traffic, and disturbance of bottom sediments through sampling for biological and chemical studies.

Table 5-8 U.S. Past, Present, and Reasonably Foreseeable Future Scientific Research

Project	Activities	Open Water	Winter	Past	Present	Future
Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA III)	Long-term environmental monitoring, including boulder patch kelp beds, sediment and water column contaminants, bioaccumulation, marine vessel traffic.	Yes	No	Yes	Yes	Yes
Bowhead whale satellite tagging study (ADF&G)	Satellite telemetry of bowhead whales, ecology, diving behavior, feeding behavior, marine vessel traffic.	Yes	No	Yes	Yes	Yes
Bowhead Whale Aerial Survey Project (BWASP), Chukchi Sea offshore monitoring in drilling area (COMIDA), and Aerial Surveys of Arctic Marine Mammals (ASAMM)	Aerial surveys of the autumn migration of bowhead whales through the Alaskan Beaufort Sea and transect data on all other marine mammals sighted. Aerial traffic.	Yes	No	Yes	Yes	Yes
Distributed Biological Observatory (IARPC)	Long-term monitoring of active biological zones in the Chukchi and Beaufort seas, collections of physical and biological data, marine vessel traffic	Yes	No	Yes	Yes	Yes
U.S. Canada Transboundary Fish and Lower Trophic Communities	Regional area survey of fish and benthic invertebrates, physical oceanography, and marine vessel traffic.	Yes	No	Yes	Yes	Yes
Shore Zone: Mapping of the North Slope of Alaska	Helicopter flights of coastline, filming of coastal loss and erosion, collecting and mapping coastal vegetation zones and aerial traffic.	Yes	No	Yes	Yes	No
Shorebirds and Infaunal Abundance and Distribution on Delta Mudflats along the Beaufort Sea	Benthic invertebrate collections, bird observations, sediment collections.	Yes	No	Yes	Yes	Yes
Ice seal movements and foraging: Village based satellite tracking of ringed and bearded seals	Satellite telemetry studies of ice seals, traditional ecological knowledge component through interviews of village elders, small boat and local traffic.	Yes	No	Yes	Yes	Yes

Project	Activities	Open Water	Winter	Past	Present	Future
Chukchi Sea Environmental Sciences Program (CSESP)	Physical and chemical oceanography, acoustic moorings, biological sampling of plankton, invertebrates, fish, bird and mammal observational data, and marine vessel traffic.	Yes	No	Yes	Yes	Yes
Chukchi Sea Acoustic, Oceanography and Zooplankton Study	Physical and chemical oceanography, acoustic moorings, biological sampling of plankton, invertebrates, fish, bird and mammal observational data, and marine vessel traffic.	Yes	No	Yes	Yes	Yes
Use of the Chukchi Sea by Endangered Baleen and other Whales (Western Extension of BOWFEST)	Aerial surveys of bowhead whales and aerial traffic.	Yes	No	Yes	Yes	Yes
COMIDA: Ecosystem Observations in the Chukchi Sea: Biophysical Mooring and Climate Modeling	Physical oceanography, benthic, zooplankton, fish, acoustic, bird, mammal, and ice studies, and marine vessel traffic.	Yes	No	Yes	Yes	Yes
COMIDA-CAB: Chemical and Benthos	Chemical oceanography, collection of benthic sediment and biological sampling, and marine vessel traffic.	Yes	No	Yes	No	No
COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales: Passive Acoustic Detection and Monitoring of Endangered Whales in the Arctic	Aerial surveys of bowhead whales, physical oceanography, benthic, zooplankton, fish, acoustic, bird, mammal, and ice studies, and marine vessel and aircraft traffic.	Yes	No	Yes	No	No
Pinniped Movements and Foraging: Walrus Habitat Use in the Potential Drilling Areas	Satellite telemetry and tagging of walrus.	Yes	No	Yes	No	No
National Aeronautics and Space Administration (NASA), U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA)	Physical oceanography, ice studies, marine mammal population and ecological studies, seismic and side scan radar studies, sediment coring, marine vessel and air traffic.	Yes	Yes	Yes	Yes	Yes
Arctic Ecosystem Integrated Survey	Development of a framework to select habitat focus areas, to improve understanding of ecological and hydrodynamic factors pertaining to impacts of oil spills.	Yes	Yes	Yes	Yes	Yes
Office of Naval Research, and other military research ventures	Various studies involving national security interests, maneuvers, etc. marine vessel and air traffic.	Yes	Yes	Yes	Yes	Yes

Future scientific research on the Canadian Beaufort Sea that may reasonably be expected to impact U.S. OCS interests is summarized in Table 5-9.

Table 5-9 Canadian Past, Present, and Reasonably Foreseeable Future Scientific Research

Project	Activities	Open Water	Winter	Past	Present	Future
U.S. Canada Transboundary Fish and Lower Trophic Communities	Regional area survey of fish and benthic invertebrates, physical oceanography, and marine vessel traffic.	Yes	No	Yes	Yes	Yes
Oceans and Fisheries Canada (OFC) Arctic Fish Ecology and Assessment Research (AFEAR)	Oceanographic and biological sampling, and marine vessel traffic.	Yes	Yes	Yes	Yes	Yes
OFC Arctic Marine Mammal Ecology and Assessment Research (AMMEA)	Bowhead tagging and marine vessel traffic	Yes	Yes	Yes	Yes	Yes
Ocean Fisheries Canada Arctic Stock Assessment movement of ringed seals, belugas, fish survey	Satellite telemetry studies, aerial surveys, and small vessel traffic.	No	No	No	Yes	Yes
Canadian High Arctic Research Station (CHARS)	Physical, chemical, and biological research, marine mammal research, vegetation and wetlands studies, indigenous studies, and marine vessel and aircraft traffic.	Yes	Yes	No	Yes	Yes

It is anticipated that scientific research activities would continue into the foreseeable future at potentially greater levels, due to the increased concerns about climate change and associated effects.

5.1.2.8 Mining Projects

The majority of mining activities in Alaska take place hundreds of miles inland from the Proposed Action but are included here because marine and air transportation associated with these activities could contribute to potential cumulative effects through the disturbance of marine mammals and impacts to subsistence harvest.

The world's largest known zinc resources are located in the western Brooks Range. As much as 25 million tons of high-grade zinc is estimated to be present near Red Dog Mine, approximately 40 miles from the southwest corner of the NPR-A (Audubon Alaska, 2002). Due to the potentially high levels of activity associated with Red Dog Mine, BOEM considers it as part of the cumulative effects analysis despite its geographic distance from the Liberty project. In addition, one of the largest undeveloped gold deposits in the world is located in western Alaska. Donlin Gold Mine is located about 10 miles from the village of Crooked Creek near the Kuskokwim River. This mine would use both marine and air transport. Past, present and reasonably foreseeable future activities related to mining activities are summarized in Table 5-10.

Table 5-10 Past, Present, and Reasonably Foreseeable Future Mining Activities

Area	Action / Project	Activities	Open Water	Winter	Past	Present	Future
Southwest Chukchi Sea Inland - Red Dog Mine	Red Dog Mine	Marine vessel traffic, aircraft traffic	Yes	Yes	Yes	Yes	Yes
Southwest Alaska, Bering Sea area, Donlin Gold Mine	Minerals Export	Marine vessel traffic , aircraft traffic	Yes	No	No	No	Yes

5.1.2.9 Military / Homeland Security Activities

Military activity in the Arctic is thought to have increased in recent years, and it is reasonable to expect military activities should increase in the foreseeable future (Axe, 2015; Watkins, 2015). Military activities in the Arctic include movements of military vessels and submarines (Vandiver, 2016), and aircraft, as well as ground operations (Olson, 2016). Military vessel, submarine, aircraft traffic, and the potential for spills could contribute to cumulative effects through the disturbance of marine mammals and effects to the subsistence harvest (Table 5-11).

Table 5-11 Past, Present, and Reasonably Foreseeable Military Activity

Area	Action / Project	Activities	Open Water	Winter	Past	Present	Future
Eastern Beaufort Sea Coastal – Barter Island	Distant Early Warning Line Sites	Radar site still active, aircraft and barge traffic	Yes	Yes	Yes	Yes	Yes
Central Beaufort Sea Coastal – Bullen Point Short Range Radar Site (SRRS[1])	Distant Early Warning Line Sites	Aircraft and barge traffic	Yes	Yes	Yes	Yes	Yes
Central Beaufort Sea Coastal – Flaxman Island SRRS[1]	Distant Early Warning Line Sites	Demolition complete	No	No	Yes	No	No
Western Beaufort Sea Coastal – Point Barrow	Distant Early Warning Line Sites	Demolition complete but radar site still active, aircraft and barge traffic	No	No	Yes	No	No
Eastern Chukchi Sea Coastal – Wainwright	Distant Early Warning Line Sites	Potential demolition, aircraft and barge traffic	No	No	Yes	Yes	No
Central Chukchi Sea Coastal – Point Lay	Distant Early Warning Line Sites	Demolition complete	No	No	Yes	No	No
Central Chukchi seas Coastal – Cape Lisburne	Distant Early Warning Line Sites	Radar site still active, aircraft traffic, barge traffic	No	No	Yes	Yes	Yes

Area	Action / Project	Activities	Open Water	Winter	Past	Present	Future
Western Chukchi Sea Coastal – Kotzebue	Distant Early Warning Line Sites	Potential demolition, aircraft and barge traffic	No	No	Yes	No	No
Submarines, other Naval Vessels	Arctic Submarine Laboratory has conducted various arctic activities since 1940[1].	Vessel traffic, sonar impacts, ship strikes	Yes	Yes	Yes	Yes	Yes
US Coast Guard icebreakers	POLAR STAR and HEALY icebreakers	Vessel traffic and icebreaking	Yes	Yes	Yes	Yes	Yes
US Coast Guard – Chukchi and Beaufort seas	Arctic Operations and Training Exercises	Shore-, air-, and sea-based operations; includes increased aircraft and vessel traffic, berthing and facilities for personnel,	Yes	Yes	Yes	Yes	Yes
Overflights	North American Aerospace Defense Command (NORAD) Elmendorf AFB	Aircraft traffic	Yes	Yes	Yes	Yes	Yes

Note: [1] http://www.csp.navy.mil/asl/Timeline.htm) locations unknown

5.1.3 Climate Change

Climate change is an ongoing consideration in evaluating cumulative effects on environmental resources of the Arctic region (See Section 3.1.6 for more information).

Research evaluated by organizations such as the Intergovernmental Panel on Climate Change (IPCC) found that “rising global emissions of greenhouse gases (GHG) are significantly affecting the earth’s climate” (CEQ, 2010; IPCC, 2013). As a result of these GHG emissions and subsequent environmental effects, Alaska has warmed more than twice as rapidly as the rest of the United States, with state-wide average annual air temperature increasing by 3°F and average winter temperature by 6°F over the past 60 years (Stewart et al., 2014). Average annual temperatures in Alaska are projected to rise by an additional 2°F to 4°F by 2050. If global emissions continue to increase during this century, temperatures can be expected to rise 10°F to 12°F in the north, 8°F to 10°F in the interior, and 6°F to 8°F in the rest of the state. Even with substantial emissions reductions, Alaska is projected to warm by 6°F to 8°F in the north and 4°F to 6°F in the rest of the state by the end of the century (Markon, Trainor, and Chapman, 2012).

Due to these influences, climate change is an ongoing factor in the consideration of cumulative impacts in the Arctic region. Climate change has been implicated in changing weather patterns, changes in the classification and seasonality of ice cover, ocean surface temperature regimes, and the timing and duration of phytoplankton blooms in the Arctic (NMFS, 2013c). These changes have been attributed to rising carbon dioxide (CO_2) levels in the atmosphere and corresponding increases in the CO_2 levels of the waters of the world’s oceans, which have led to the phenomena of ocean acidification (IPCC, 2007a; Mathis et al., 2014). This phenomena is often called a sister problem to climate change because they are both attributed to human activities that have resulted in increased CO_2 levels in the atmosphere. Ocean acidification in high latitude seas is happening at a more advanced rate compared to other areas of the ocean. The capacity of the Arctic Ocean to uptake CO_2 should increase in response to predicted increase in atmospheric CO_2 levels (Bates and Mathis, 2009). Sea ice losses increase the open water surface area of Arctic seas, and exposed surface water lowers calcium carbonate solubility, or saturation, leading to lower levels of available minerals for shell-producing organisms (Fabry et al., 2009). In addition, climate change could affect the natural cycles occurring in the Arctic. Many of the organisms present in the Arctic during the summer breeding season are migratory. The regions used during other life stages of their annual cycle may not be experiencing climate change at the same rate as in the Arctic. This could lead to phenological mismatches of organisms with their habitats or prey species where time-sensitive relationships, such as breeding, could be changed to the detriment or benefit of some species (Miller-Rushing et al. 2010).

Measurable changes in climate are ongoing and have been occurring over the last 180 years in Alaska (Smith et al., 2005; Wendler and Shulski, 2009; Abram et al., 2016) and are projected to occur into the future (Markon, Trainor, and Chapman, 2012). See Chapters 3 and 4 of this FEIS for further discussion of climate change.

5.2 Analysis of Cumulative Effects

5.2.1 Water Quality

5.2.1.1 Summary of Impacts

Impacts on water quality from the Proposed Action and alternatives are analyzed in detail in Chapter 4 and summarized here. Effects on water resources include:

- Introduction of pollutants
- Increased suspended sediments
- Increased turbidity
- Temporary disruption of flow, decreased water levels, and physical alteration of ponds, lakes, and streams
- Introduction of invasive species
- Accidental oil spills

The primary impact to water quality as a result of the Proposed Action is increased total suspended solids (TSS). Adverse impacts to water quality would be moderate for short periods of time, but negligible overall.

5.2.1.2 Discussion of Other Relevant Actions

Other relevant actions that have occurred in the past, are currently occurring, or may occur in the foreseeable future that affect or could affect water resources in the U.S. Beaufort Sea and fresh or estuarine waters in the surrounding lands are described in Table 5-1 through Table 5-11. These actions could originate in the U.S. Arctic, Canadian Arctic, or the Russian Arctic.

Activities described in Table 5-1 through Table 5-11 that occur in or near waterbodies can affect water quality through a variety of ways, including: discharges of pollutants; increases in suspended sediments and turbidity; decreases in dissolved oxygen in bottom water; increased risk of introducing aquatic invasive species; increased risk of hydrocarbon spills; and elevated sea surface temperatures and salinity levels.

5.2.1.3 Analysis of Cumulative Impacts

Impacts on water quality of the activities described in Table 5-1 through Table 5-11 would depend on the number of sources, their location, and their duration.

The Proposed Action would temporarily increase vessel traffic on a localized level. This increase in vessel traffic would be additive to increasing vessel traffic from global shipping vessels, oil and gas vessels, cargo vessels, military vessels, supply barges, cruise ships, commercial fishing vessels, survey vessels, and research vessels.

Discharges from many types of vessels are regulated by the U.S. Environmental Protection Agency (EPA) and the USCG. EPA's Vessel General Permit (VGP) applies to discharges from the normal operation of all non-recreational, non-military vessels 79 feet long or more, which discharge to waters of the United States (defined at 40 CFR 122.2) extending to the outer reach of the 3-mile territorial sea (see 40 CFR 122.2 and CWA Section 502[8]). The VGP ballast water discharge provisions also apply to any non-recreational vessel less than 79 feet long or commercial fishing vessel of any size. Information on the VGP can be found online at: http://cfpub.epa.gov/npdes/vessels/vgpermit.cfm.

Section 312 of the Clean Water Act (CWA) sets out the principal framework for domestically regulating sewage discharges from vessels, and is implemented jointly by the EPA and the USCG. The CWA defines sewage as "human body wastes and the waste from toilets and other receptacles intended to receive or retain body wastes," and includes gray water discharges from commercial vessels (see 33 USC 1322[a][10]). CWA Section 312 controls vessel sewage by regulating the equipment that treats or holds the sewage, called marine sanitation devices (MSDs) (see 33 USC 1322[a][5]). Support vessels are required to use operable, USCG-certified MSDs onboard when operating in U.S. waters, including the 3-mile territorial sea.

BOEM anticipates that the effects on water quality from the Proposed Action would be intermittent and localized. Under the Proposed Action, an increase of TSS in the water column during the construction, maintenance, and decommissioning stages of the project would be expected. Turbidity caused by suspended solids during gravel placement, trenching, and burial of the marine pipelines creates temporary localized plumes. Because the reasonably foreseeable future projects are expected to be several miles away and not constructed within the same time frame as the Proposed Action, cumulative effects associated with turbidity plumes are not expected to occur.

Pursuant to Section 402 of the CWA, wastewater discharges from oil and gas exploration facilities in the Beaufort and Chukchi seas require authorization by EPA or, if in State waters, by the Alaska Department of Environmental Conservation (ADEC). Discharges into the territorial seas, the contiguous zone and the oceans may not cause an unreasonable degradation of the marine environment as determined under 40 CFR Part 125 Subpart M. On October 29, 2012, EPA issued two National Pollutant Discharge Elimination System (NPDES) general permits for exploration discharges into the Beaufort and Chukchi seas – permit numbers AKG-28-2100 and AKG-28-8100 – respectively. These permits expired in November 2017. The EPA intends to reissue the Beaufort exploration permit. The general permits authorize discharges from 13 categories of waste streams, subject to effluent limitations, restrictions, and requirements. The general permits require operators to submit Notices of Intent to EPA requesting authorization to discharge at least 120 days prior to commencing discharges. Information about EPA's general permits for offshore oil and gas discharges to federal waters of the Beaufort and Chukchi seas can be found at https://yosemite.epa.gov/r10/water.nsf/npdes+permits/arctic-gp.

In addition, on January 29, 2015, EPA issued a final wastewater discharge general permit authorizing discharges from Oil and Gas Geotechnical Surveys and Related Activities in Federal Waters of the Beaufort and Chukchi seas (Geotechnical General Permit [GP]; AKG-28-4300). The Geotechnical GP authorizes 12 types of wastewater discharges from oil and gas geotechnical surveys and related activities. The GP establishes effluent limitations and requirements to ensure the discharges do not cause unreasonable degradation of the marine environment. Information about EPA's Geotechnical GP can be found online at https://yosemite.epa.gov/r10/water.nsf/npdes+permits/arctic-gp.

ADEC has developed a similar permit under its APDES permitting authority for oil and gas geotechnical surveying activity discharges to state waters of the Beaufort and Chukchi seas. The APDES general permit AKG283100 – Geotechnical Facilities in State Waters in the Arctic Ocean (the APDES Geotechnical GP) was issued on May 31, 2015. A detailed summary of the APDES Geotechnical GP is included in the Final Fact Sheet, available online at https://dec.alaska.gov/water/wwdp/pdfs/PublicNoticedocs/AKG283100%20-%20Arctic%20Geotech%20Final%20FS%20v.final.PDF.

The Proposed Action would increase onshore construction and maintenance projects and facilities on a short-term basis, adding incrementally to the effects from past, present, and future onshore development and mining that affect water resources (Table 5-1). The Proposed Action would also add incremental impacts to water resources from water withdrawals; non-point source discharges; gravel pad construction; permitted discharges into freshwaters; permitted discharges to nearshore waters; ice road and pad construction; and gravel mining for construction of the LDPI.

Rising CO_2 levels in the atmosphere and corresponding increases in CO_2 in the worlds' oceans have led to the phenomenon of ocean acidification (IPCC, 2007). The capacity of the Arctic Ocean to uptake CO_2 is expected to increase in response to climate change (Bates and Mathis, 2009). Ocean acidification in high latitude seas is happening at a more advanced rate than other areas of the world. This is due to the loss of sea ice that increases the surface area of the sea to warmer air temperatures.

Several studies have examined the effects of climate change on water resources (see Guinotte and Fabry, 2008; Mathis et al., 2014; SeaGrant Alaska, 2012). Climate change effects in the Arctic that impact marine and freshwater environments include:

- Warming sea temperatures
- Acidification of seawater (decrease in pH)
- Sea ice extent and thickness decreasing: increased sea surface exposed for accelerated warming of water; greater area for air-sea exchange of CO_2; decreases in surface salinity
- Coastal erosion increasing
- Aquatic invasive species, risk of introduction
- Warming pond temperatures – changes in surface area and levels ("drying")
- Melting permafrost – erosion of riverbanks and streambanks; changes in riparian vegetation and channel morphometry
- Snowpack melt increasing – river discharge increase, sea surface water salinity decrease

Although activities associated with the Proposed Action are expected to be localized and intermittent, increases in TSS from oil and gas activities may overlap temporally and spatially with increases in TSS resulting from shoreline erosion and melting permafrost. An increase in TSS could further impact water quality by increasing the temperature and levels of organic matter and nutrients in the nearshore Beaufort Sea.

5.2.1.4 Conclusion

Impacts of the Proposed Action on water quality are expected to be short-term and localized (Section 4.2.2). Activities associated with the Proposed Action may have a slight additive impact (an impact that results from the combination of two separate impacts) on the water quality effects from past, present, and RFFAs, especially when considering the effects of climate change in the Beaufort Sea region.

The overall contribution to water quality impacts from activities associated with the Proposed Action, when combined with impacts from the other past, present, and reasonably future actions described in Table 5-1 through Table 5-11, would range from negligible to minor.

5.2.2 Air Quality

This analysis of cumulative effects on air quality focuses on the impacts to the onshore areas nearest the Proposed Action and the Alaska communities along the coastline adjacent to the Liberty Development Area. The qualitative analysis is based on the behavior of pollutants released during activities associated with the Proposed Action, and how the pollutants are diluted (mixing with surrounding air) and diffused (plume continually expanding throughout both the vertical and horizontal planes) by surrounding air and the wind. The duration of the effects, if any, are temporary, as pollutants are assumed to remain within the main exhaust plume only until impact with the ground

– they are not additive, meaning the overall impact is less than the sum of the parts. Afterwards, the pollutants scatter and are further diluted into the surrounding air, causing ever decreasing effects as they are transported farther from the source and around the globe.

5.2.2.1 Summary of Impacts

Effects of emissions associated with the Proposed Action are caused by the discharge of diesel and fuel gas (natural gas) engine exhaust gases resulting from combusting fossil fuels and gases in mobile and stationary engines used to construct, implement, and operate aspects of the Proposed Action. Additional evaporative emissions of volatile organic compounds (VOCs) would occur from small spills. The dominant air pollutant throughout the Proposed Action is nitrogen oxides (NO_2). The Proposed Action would result in a minor air quality impact given the countervailing effects of wind and the dilution and diffusion of the pollutants over space and time.

Mobile sources of emissions from the Proposed Action would not produce emissions in masses sufficient to overwhelm the effects of their own movements combined with wind and transport (dilution and diffusion) over space and time. As such, accumulation of the pollutants in a single onshore location would not occur, and deterioration of air quality due to the Proposed Action emissions would not follow.

Projected emissions from stationary sources associated with the Proposed Action would be regulated under 30 CFR Part 550, Subpart C. Stationary sources whose emissions would otherwise cause an exceedance of ambient air quality standards incorporated into the BOEM Air Quality Regulatory Program (AQRP) would be required to apply Best Available Control Techniques (BACT) to reduce emissions so that the emissions are not deemed to significantly affect the air quality of the onshore area.

5.2.2.2 Discussion of Other Relevant Actions

The past, present, and reasonably foreseeable future actions listed in Table 5-1 each represent potential air emissions either onshore or near-shore. Most of the actions can be characterized as mobile or stationary sources. Actions that require aerial surveys using helicopters and small aircraft, transportation by motor vehicles, other over-ice types of vehicles, or use of marine vessels are mobile sources. There are many sources of emissions already existing on the North Slope. However, none produces air emissions that cause an exceedance or violation of the National Ambient Air Quality Standards (NAAQS).

5.2.2.3 Analysis of Cumulative Impacts

Actions described in Table 5-2 did not occur simultaneously with activities associated with the Proposed Action. Emissions from those past actions would already have dispersed throughout the atmosphere. As such, the EPA has determined the North Slope, in its entirety, is an area of clean air resources where there are no exceedances or violations of the NAAQS. Additionally, the proposed action emissions produced from construction do not overlap with those from production operations. Air quality impacts from activities associated with the Proposed Action, when combined with past actions and emissions from those actions, would not have the potential to cause a significant level of effect, and would have a negligible level of cumulative effects to onshore air quality.

Present and potential future actions of oil and gas operations on the Beaufort Sea OCS which are not associated with the Proposed Action include seismic surveys, infrastructure development, and production, and would likely have the same overall negligible onshore air quality effect as analyzed for the Proposed Action in Section 4.2.3. This is because air quality effects are not additive, meaning the impact is less than the sum of the individual effects. Thus, air quality impacts from activities associated with the Proposed Action, together with present and potential future oil and gas actions and emissions from those actions, would not have the potential to cause major effects, and would have a negligible to minor level of cumulative effects to onshore air quality.

Present and reasonably foreseeable future actions not associated with the Proposed Action involve mainly mobile sources of emissions such as commercial travel (aircraft and vessels) related to fishing, wildlife viewing, sporting, and other recreation and tourism; temporary demolition and building of infrastructure; mining projects; and subsistence activities. Emissions from these sources would all likely have the same overall effect as mobile sources in general: mobile sources cause emissions to be discharged over time and space, spreading out the plume of pollutants. At the same time, the elongated plume is being diluted and diffused. The overall effect of emissions from mobile sources, onshore or offshore, would be mitigated at the source by the manufacturer, who is responsible for following Federal guidelines for emission standards for engines. Thus, air quality impacts from activities associated with the Proposed Action, together with other present and reasonably foreseeable future actions and mobile emissions from those actions, would not have the potential to cause major effects, and would have a negligible to minor level of cumulative effects to onshore air quality.

Present and reasonably foreseeable future actions that involve mainly stationary sources of emissions, such as operation of new infrastructure, and operating military bases, would all likely have negligible impacts even when considered together with projected emissions from the Proposed Action. Similar types of activities already occur on the North Slope, particularly near Prudhoe Bay, Alaska, where the population can swell to several thousand people as transient oil and gas workers support the Prudhoe Bay oil field, the largest oil field in the United States. The EPA has determined that operations of all the oil and gas activities, together with stationary facilities that are sufficient to support several thousand people at Prudhoe Bay, do not cause emissions sufficient to exceed or cause a violation of the NAAQS. Thus, air quality impacts from activities associated with the Proposed Action, together with other present and reasonably foreseeable future actions and stationary emissions from those actions, would not have the potential to cause major effects, and would have a negligible to minor level of cumulative effects to onshore air quality.

5.2.2.4 Climate Change

As Jacob and Winner (2009) comment, "Air quality is strongly dependent on weather and is therefore sensitive to climate change." Climate change would affect air quality due to increasing ambient air temperatures and a weaker global circulation. With respect to the pollutant ozone, the higher water vapor content (due to higher temperatures) is expected to decrease the ozone background concentrations. Particulate matter (including black carbon) is "much more complicated and uncertain than ozone" (Jacob and Winner, 2009). Although black carbon is a small portion of the fine particulate matter with an aerodynamic diameter of 2.5 micrometers or less ($PM_{2.5}$) spectrum it is a contributor to climate change in Arctic regions. When black carbon is deposited on snow it reduces the reflectivity of the white snow which causes it to absorb the solar radiation and leads to a localized increase in ambient air temperatures. Changes to global circulation may lead to localized changes in precipitation levels, for some this would lead to wetter than normal conditions and others drier. Activities resulting from this Proposed Action along with other past, present, and reasonably foreseeable future actions in the Region, may have an additive effect on the impacts of climate change to air quality in the Region.

5.2.2.5 Conclusion

The qualitative analysis is based on the behavior of pollutants released from the Proposed Action, present, and reasonably foreseeable future onshore and near-shore sources. Pollutants are diluted (mixing with surrounding air) and diffused (plume continually expanding throughout both the vertical and horizontal planes) by surrounding air and the wind. Pollutants are assumed to remain within the main exhaust plume only until impact with the ground – they are not additive – meaning the overall impact is less than the sum of the parts. Given the lack of profuse emissions, the consistent wind velocity over the Beaufort Sea OCS, the duration of the effects, if any, are temporary. Afterwards, the pollutants scatter and are further diluted into the surrounding air causing ever decreasing effects as they are transported farther from the source and around the globe. The overall contribution to onshore air quality impacts from activities associated with the Proposed Action, when combined with impacts from the other past, present, and reasonably foreseeable future actions and emissions described in Table 5-1 through Table 5-11, is negligible to minor.

5.2.3 Lower Trophic Organisms

5.2.3.1 Summary of Impacts

Effects on lower trophic organisms as a result of the Proposed Action are analyzed in Section 4.3.1 and summarized here. Impacts include habitat alterations due to benthic disturbance resulting from construction, development, and decommissioning activities. Effects would include:

- The temporary disruption of pelagic habitat from turbidity caused by suspended construction material. Burial of benthic communities with gravel and sediment from the turbidity plume could cause temporary loss of local benthic communities. Impacts of sedimentation would be more pronounced for the Boulder Patch because it is a highly specialized environment and is expected to require many years to recover from disturbances.
- The physical presence of the LDPI could provide habitat for some species that use hard substrates, including some Boulder Patch species.
- The effects of accidental spills and natural gas releases would be limited in time and space to localized populations near the source of the spill events. The number of planktonic species in the general environment and the probable dispersal rates of small spills by evaporation and through wind and wave energy in Stefansson Sound should prevent more than temporary and localized effects.

Cumulative effects may include the development of offshore oil production, onshore oil and gas production, construction and maintenance of infrastructure, onshore mining, and other similar activities such as trenching for telecommunication development. These activities would create further effects of discharges from nonpoint sources, sedimentary displacement and deposition, potentials for spills and natural gas releases, and activities that could further increase cumulative effects in the Proposed Action Area. Marine invasive species would be a potential risk that, if established, could affect lower trophic organisms various ways including: encrusting native habitat, competing for food sources, preying on native species, or introducing pathogens. Implementation of a Hazard Analysis and Critical Control Point Plan (HACCP) to detect and respond to invasive species presence, as suggested by NMFS during essential fish habitat (EFH) consultations, may mitigate this impact.

5.2.3.2 Discussion of Other Relevant Actions

Other relevant actions that could contribute to cumulative impacts on lower trophic organisms are listed in Table 5-2. Impacts from increases in marine vessel traffic, changes in population demographics, other oil and gas development both on and offshore, and potential for construction of infrastructure would be similar to the impacts on lower trophic organisms previously described in Section 4.3.1 for analogous activities.

The influences of climate change on lower trophic levels arguably are of the most concern in cumulative effects analysis. Climate change may result in impacts to lower trophic level organisms through habitat modification and ocean acidification. Impacts on lower trophic level organisms include direct synergistic impacts such as changes in the timing and magnitude of plankton blooms, physiological changes from altered ocean pH and temperature, and habitat modification that could occur as a result of melting ice, shoreline erosion, and sea level rise. A primary impact of ocean acidification is that it depletes seawater of the carbonate compounds—aragonite and calcite—that many marine creatures need to build shells and skeletons (Fabry et al., 2008). As a result, ocean acidification hinders organisms such as corals, crabs, seastars, sea urchins and plankton from building the protective armor they need to survive. Rising acidity also affects the basic functions of fish, squid, invertebrates, and other marine species, including detrimental effects on metabolism, respiration and photosynthesis, which can thwart their growth and lead to higher mortality (Fabry et al., 2008). In addition, ocean acidification has the potential to profoundly affect the growth and toxicity of phytoplankton associated with harmful algae blooms (HABs) (Tatters, Fu, and Hutchins, 2012; Fu, Tatters, and Hutchins, 2012). These impacts can have far-reaching effects on the structure of the food web, with some predators forced to eat non-optimal prey items. Habitat modification would expand the range for some species, while reducing it for others. In addition, the decrease of the extent of the Arctic ice pack impacts the epontic community, and subsequently, the pelagic and benthic communities. Warming ocean temperatures associated with climate change may increase all types of plankton growth rates and generation times in the region of the Proposed Action, and change the composition of lower trophic populations as warmer seas, open water and increased radiative energy from the sun increases. The effects from oil and gas activity in the reasonably foreseeable future on lower trophic levels tend to be localized to areas near the activity, and so are geographically dispersed. Although the effects of climate change would be long-term, the effects that would occur in the life of the project are not expected to considerably impact lower trophic levels.

5.2.3.3 Analysis of Cumulative Impacts

The most influential impacts on lower trophic levels historically are from activities that disturb the ocean floor. Natural impacts of ice gouging, strudel scours, and the effects of loss of landfast ice on receding shorelines are most apparent. Past anthropogenic impacts have included the discharge of drilling muds and sediments from cuttings, bioaggregation and bioaccumulation from materials released during project activities, and habitat loss. Offshore production drilling activities in the Arctic have historically used systems such as artificial islands which directly impact the sea floor and have caused direct injury and mortality to lower trophic level organisms, and disturbance leading to habitat loss. It is reasonably foreseeable that future development requiring the installation of additional platforms and subsea pipelines could occur, creating similar effects to the seafloor and lower trophic organisms. Potential discharge of cuttings also poses a threat to the benthic community’s habitat through deposition of artificial sediment on the benthic surface and temporary loss of benthic organisms. Mortality and injury are also caused by the introduction of toxins and sediments into the water column due to drilling discharges. These toxins may pose a threat to pelagic and benthic organisms. Habitat loss can also result from oil and gas exploration activities that require ice breaking efforts, forcing organisms to relocate. The effects from past and present actions on lower trophic levels tended to be localized to the areas near the activity, and so are geographically and temporally dispersed.

All factors related to offshore oil and gas exploration in the Proposed Action Area that have affected lower trophic levels in the past are likely to continue in the future. Projected activities as outlined in the Proposed Action would add to the effects on these resources through both additive and synergistic (impacts that occur due to the combination of two or more other impacts, such as two or more fishing boats operating near a seal rookery) cumulative impacts. Offshore oil and gas exploration and development is likely to increase in Arctic waters of the U.S. and other countries as the ice cover recedes and allows access to previously inaccessible areas. These activities would add to the cumulative impacts of numerous ocean floor disturbances that affect lower trophic habitat across individual localized areas. However, the continuation of offshore oil and gas exploration and production is expected to further the accumulation of persistent contaminants from multiple sources and has the potential to affect lower trophic levels in the reasonably foreseeable future. Overall effects of cumulative impacts on lower trophic resources is considered to be minor due to the reproductive capabilities of most lower trophic organisms, and the constant movement and influx of nutrients and larval stages from advection caused by currents over the Bering Sea, Sea of Anadyr, and the Arctic Ocean. Due to the extended recovery time required, some unique areas within the Beaufort Sea, such as the Boulder Patch, may have moderate cumulative impacts to habitat quality and community structure.

5.2.3.4 Conclusion

The influences of climate change on lower trophic levels arguably are of the most concern in cumulative effects analysis. In summary, the change in seasonality and decrease of the extent of the Arctic ice pack directly impacts the epontic, pelagic, and benthic communities. The positive feedback loop of warmer water temperatures and open water that absorbs more radiative energy from the sun and increased absorption of CO_2 results in earlier spring ice and snowmelt, decreased ice thickness during the winter, changes in hydrology of onshore ecosystems, accelerated rates of coastal erosion and permafrost degradation, and changes in ocean chemistry. These cumulatively affect change in the composition of lower trophic populations as warmer seas, open water, and increased radiative energy from the sun create changes in energy levels and nutrients available for growth and reproduction of invertebrate species. Climate change is likely to affect the habitat, behavior, abundance, diversity, and distribution of populations of marine mammals, fish, and other wildlife within the Proposed Action Area. The Proposed Action is unlikely to significantly individually impact the overall rate of climate change. Invasive species could spread in the affected area as a result of climate change, or from introduction through industry activities. The direct effects from the Proposed Action on lower trophic levels may overlap temporally with other actions. Impacts from the Proposed Action spatially overlapping with other actions would primarily occur within the first phases of the project. These impacts could be both beneficial and adverse to the lower trophic individuals but any change in population is not expected. Thus the contribution of the Proposed Action to the cumulative scenario would be negligible.

5.2.4 Fish

5.2.4.1 Summary of Impacts

Impacts to fish from the Proposed Action and alternatives are analyzed in detail in Chapter 4 and summarized here.

- Habitat alteration of the seafloor would disturb, damage, and bury fish habitat and sessile fish prey, resulting in mortality for individuals of some fish species unable to escape burial.
- The physical presence of the LDPI could affect available habitat and habitat type.
- Sounds associated with all phases of the Proposed Action may impact fish behavior.
- Construction of ice roads may alter habitat for freshwater fishes, resulting in localized removal of fish from ponds used for freshwater withdrawal.

All of these impacts are expected to be localized and temporary, except for the LDPI which would be a long-term alteration to 0.01 percent of Stefansson Sound.

Marine invasive species would be a potential risk that, if established, could affect fish habitat and fish in various ways including encrusting native habitat, competing for food sources, competing for spawning grounds, preying on native species, or introducing pathogens.

These effects could lead to changes in community structure and shifts in abundance and diversity of native species. Implementation of a HACCP to detect and respond to invasive species presence, as suggested by NMFS during EFH consultations, may mitigate this impact.

Accidental small refined spills (less than 1,000 bbl) could affect behavior and physiology of sensitive life stages of fish species in localized areas of surface water which could lead to chronic or acute toxicity. Large spills would affect fish species in or near the path of oil through acute effects and long-term chronic effects. The effects would depend on several factors including life stage of fish species, distribution and abundance in water column or benthos, and timing of migrations and spawning.

5.2.4.2 Discussion of Other Relevant Actions

The Proposed Action could add incremental impacts to the environment when added to other past, present, and reasonably foreseeable actions affecting the U.S. Beaufort Sea. Other relevant actions that could contribute to cumulative impacts on fish are listed in Table 5-1. Research activities in the future would likely remain relatively consistent with past and present levels, though cumulative additions due to longer open water seasons and changes in onshore hydrology are possible. The effects from oil and gas activity in the reasonable foreseeable future on fish tend to be localized to areas near the activity, and so are geographically dispersed.

The influences of climate change on fish must be considered in the cumulative effects analysis. Climate change is likely to affect the habitat, behavior, abundance, diversity, and distribution of fish. Several studies have examined the effects of climate change (including ocean acidification) on fish. These studies emphasize the implications of potential northern range expansions of fish species, the effects of warming sea surface temperatures on fish biomass, possible changes in fish species complexes, effects on commercially important species, shifts in prey availability and shifts in food webs, and the particular vulnerability of coastal areas in Alaska (Cheung et al., 2009; Sherman et al., 2009). Shifts in the food web as a result of changing climate could result in major ripple effects on fish, with some predators forced to eat non-optimal prey items, or preferred feeding spots becoming unavailable. Some species may benefit from climate change shifts in the environment. Rising ocean acidity also affects the basic functions of fish, squid, invertebrates, and other marine species, including detrimental effects on metabolism, respiration and photosynthesis, which can thwart their growth and lead to higher mortality (Fabry, et al., 2008). The decrease of the extent of the Arctic ice pack impacts the lower trophic communities, which has impacts on fish communities. Warming ocean temperatures associated with climate change may increase all types of plankton growth rates and generation times in the region of the Proposed Action, and change the composition of lower trophic populations as warmer seas, open water, and increased radiative energy from the sun increases. Although the effects of climate change will be long-term, the effects that would occur in the life of the project are not expected to considerably impact fish.

5.2.4.3 Analysis of Cumulative Impacts

Fish in the Beaufort Sea and nearshore areas could be affected by increasing vessel traffic from global shipping vessels, oil and gas vessels, cargo vessels, military vessels, supply barges, cruise ships, survey vessels, and research vessels. Increased shipping increases the occurrence of small spills, the risk of introducing aquatic invasive species, and the possibilities of oil spills or vessel groundings, all of which would affect fish, fish habitat, and fish prey.

Installation of offshore telecommunications cables would cause additional bottom habitat disturbance from surveying (current), trenching, and laying fiber optic cable (foreseeable future) north through the Chukchi Sea to Prudhoe Bay, and northeast through the Canadian Arctic.

Onshore development and mining activities, to include associated construction and maintenance projects and facilities, would affect fish, fish habitat, and fish prey via stream, pond, and lake habitat alteration; water withdrawals; permitted discharges; construction of support facilities; construction of roads, ice roads; and construction of pipelines.

5.2.4.4 Conclusion

The influences of climate change on fish are of the most concern in cumulative effects analysis. As described in Section 5.2.3, the change in seasonality and decrease of the extent of the Arctic ice pack directly impacts lower trophic communities that make up the prey species for fish. These cumulative changes in the composition of lower trophic populations create changes in energy levels and nutrients available for growth and reproduction of higher trophic predators, such as fish. Climate change is likely to affect the habitat, behavior, abundance, diversity, and distribution of populations of marine mammals, fish, and other wildlife within the Proposed Action Area. The Proposed Action is unlikely to significantly individually impact the overall rate of climate change. Invasive species could spread in the affected area as a result of climate change, or from introduction through industry activities. The direct effects from the Proposed Action on fish may overlap temporally with other actions. Impacts from the Proposed Action spatially overlapping with other actions would primarily occur within the first phases of the project. These impacts could be both beneficial and adverse to individuals but any change in population is not expected. Thus the contribution of the Proposed Action to the cumulative scenario would be negligible.

5.2.5 Birds

5.2.5.1 Summary of Impacts

Routine operations associated with the Proposed Action are analyzed in Section 4.3.3 and expected to impact birds in the following ways:

- Collision hazards would be associated with the physical presence of new facilities (e.g., LDPI, onshore pipeline) and associated vessels.
- The bright artificial lighting of the LDPI (i.e., ambient and occasional gas flaring) and some support vessels that may remain in the marine environment for extended periods (e.g., assist tug) would cause attractions, disorientations, and potentially exhaustion that would lead to increased rates of collisions when certain environmental conditions are present during migration.
- Increased nest predation would be associated with new facilities and increased human presence that incidentally subsidizes avian predators.
- Vessel, aircraft, and vehicle traffic would disturb and displace birds, including both breeding and staging waterbirds.

Many birds are at risk of collision with new facilities and vessels associated with the Proposed Action. The long-term presence (i.e., life of the Proposed Action) of these facilities and support vessels ensures that they would pose on-going collision hazards at a steady rate. Birds breed in the Proposed Action Area vicinity in abundance but primarily are distributed in territories rather than densely occupied colonies. These locally breeding individuals would have some exposure to possible collisions with Proposed Action facilities and vessels, although time during the breeding season is taken up not just with flying but with swimming, brood-rearing or other activities. It is, rather, birds in flocks engaged in migration, flying with intent along the coast to or from other areas that would be most at risk of attraction and collision. Thus birds from widespread populations could be repeatedly or steadily attracted to collision hazards, resulting in potentially widespread impacts. It is also possible that chronic or relatively large collision rates could have long-lasting impacts on certain declining or limited populations (e.g., rusty blackbird, buff-breasted sandpiper, and listed spectacled eider).

Increases in predator abundance from the Proposed Action would be long-term, and the effects of increased predation on some vulnerable nesting populations, while originally somewhat localized, would also be on-going and long-term. Traffic disturbances would be expected to impact both locally breeding birds as well as birds that may be gathered in the area to stage or molt, or moving through on migration, although those disturbances are seldom anticipated to be more than short-term or localized. Some bird populations and individuals subject to impacts use the Proposed Action Area for multiple life stages, e.g., common eider and long-tailed duck which could both breed and gather in flocks to molt, increasing their vulnerabilities to Proposed Action impacts. Taken together, overall potential effects from the Proposed Action would range as high as long-lasting or widespread, and therefore moderate, for birds.

5.2.5.2 Discussion of Other Relevant Actions

There are a variety of factors that influence bird populations in the Beaufort Sea region. The great majority of birds that occur in the Proposed Action Area are migratory, spending much of each year in distant regions where they may be subject to additional environmental impacts outside the scope of the present analysis. Many of the relevant past, present, and reasonably foreseeable future actions and events of the Arctic that could contribute to cumulative impacts on birds are listed in Table 5-2. Routine oil and gas exploration and development on the Chukchi and Beaufort seas and on the Arctic Coastal Plain (ACP), have and would continue to increase the presence of humans, infrastructure, equipment, and facilities use associated with the types of impacts that birds, such as tundra-nesting birds including eiders, have experienced and/or are currently experiencing. These include impacts associated with predator population growth and collision hazards, disturbance and displacement from vessel, aircraft, vehicle traffic and operation of heavy equipment, habitat loss and alterations, and accidental oil spills. Oil and gas development are in general the largest growing source of these collective potential impacts in the Proposed Action Area. Increased recreation/tourism/hunting, fishing and regular commerce and transport would be anticipated to eventually have some similar, if overall lesser, impacts to some of the same bird resources in the Proposed Action Area.

The greatest source of impact to birds associated with reasonably foreseeable future actions and events in the Proposed Action Area may be from climate change (Wauchope et al., 2016; Liebezeit et al., 2012). Climate change is anticipated to particularly impact the Arctic environment and in many complex ways, including influencing habitat shifts and forage competition among migratory birds. Examples of observed and anticipated environmental changes include more frequent and severe storm surges and inundations of low-lying coastal habitats; destabilized permafrost, leading to replacement of terrestrial habitat with thermokarst ponds, geomorphological hazards and slope instabilities (Shur et al., 2003; Berteaux et al., 2017); and snow cover melting and disappearing in the spring earlier, exposing prey and habitat out of synchrony with the ecology of migratory species (Therrien et al, 2015).

As a result of these changes, some species are anticipated to eventually experience breeding habitat loss and other impacts. The low-lying barrier island nesting common eider is anticipated to be affected by storm surges, tundra-nesting species such as buff-breasted sandpiper to losing habitat to pond development or shrub advancement (Lanctot et al., 2010), and cliff-nesting raptors like rough-legged hawk affected by slope instabilities (Gauthier et al., 2011; Beardsell 2016). Environmental impacts appear to be secondarily facilitating changes in phenology and distribution of some migratory birds, as in the case of brant distribution change in response to impacted forage (Flint et. al., 2008) and earlier arrivals on the Colville River of geese and other species (Ward et al., 2016). The productivity of buff-breasted sandpipers and other shorebird populations likely already in decline could be further negatively affected by loss of synchronous timing between their Arctic breeding season and prey availability (Lanctot et al., 2010). There is evidence that some tundra-nesting birds rely on the presence of alternative prey (i.e., lemmings) as a cue for spring settlement and nest initiation. Fewer rodent peaks are predicted under a changing climate regime, and the loss of this reliability could therefore impact productivity of some species, including shorebirds (Saalfeld and Lanctot, 2015; Fraser et al, 2012). Other climate change-related impacts may be anticipated, such as increased rates of vessel-associated impacts as the ice cover melts earlier and forms later, in turn increasing rates and areas of vessel access. Species of seabirds that depend on ice for their marine-foraging are also expected to be impacted.

Other local (i.e., Beaufort Sea region) anthropogenic impacts in the past and present include lead poisoning and hunting. Birds, especially waterfowl, ingest spent lead shot that washes from uplands and persists for years in freshwater wetlands, leading to death from poisoning. Exposure dangers have been so substantial that lead shot was federally banned for waterfowl hunting in 1991, and by the State of Alaska, Board of Game for upland game bird hunting on the ACP in 2006. Lead shot poisoning remains a threat to waterfowl on the ACP and lead shot can persist particularly long in arctic wetlands due to the underlying ice barrier that prevents it from sinking out of reach of foraging birds, and it also apparently remained somewhat locally available for subsistence hunting use even after the bans were imposed (USFWS, 2010).

Besides lead poisoning and hunting, various populations of tundra-nesting birds may also have begun to experience long-term impacts from increased levels of predation. Growing numbers of foxes, gulls, and ravens that feed on eggs and chicks appear to have benefited from increased access to human foods and structures that these predators use for denning, nesting, and perching. Common raven had been previously absent or rare on the ACP but has spread on the ACP with oil and gas infrastructure development and is now well-established year-round. Cumulatively, ingestion of lead shot, hunting, and changes in predation patterns are suspected as contributors to past substantial declines experienced by some populations of tundra-nesting birds. For example, they are suspected as primary contributors to the decline and Endangered Species Act (ESA) listing of spectacled eider and Alaska breeding Steller’s eider, still not considered recovered (USFWS 2010, 2002).

Another persistent and widespread impact from the increase of infrastructure and human use is collision mortality. Numerous species of birds, including passerines, seabirds, shorebirds, loons, sea ducks, and other waterfowl such as geese and swans regularly collide with existing artificial island and onshore oil and gas facilities, vessels, power lines, and other structures and are killed. Collisions documented thus far have been for up to tens of individuals or between 0 and flocks of 10s per species per year, but systematic searches for strikes are not performed at many likely hazard areas and not all collisions are documented, and these encounters, due to bird migration/weather interaction phenomena, can be highly episodic in nature.

The development of roads, oil and gas facilities, and other infrastructure has also reduced and fragmented some areas of tundra and pond-nesting habitat. These habitat alterations have thus far affected primarily only small areas of breeding and foraging habitat relative to what is available to most species on the ACP or offshore Beaufort Sea, but they would be long-lasting.

Past, present, and reasonably foreseeable onshore and offshore development and its associated vehicle, aircraft, and vessel traffic disturbs or would disturb foraging, nesting, and migrating birds. Further, it is possible that some individual birds have been harmed by small spills.

5.2.5.3 Analysis of Cumulative Impacts

As discussed above, birds using the Proposed Action Area have been exposed to a suite of activities that have impacted them. They also experience on-going impacts from past activities, impacts from current activities, and are likely to experience impacts in the future. The rate of some impacts such as habitat loss associated with climate change impacts and increased predation are likely to continue to accelerate. The largest anticipated source of impact to many birds associated with reasonably foreseeable future actions and events is climate change. Many of these climate change-related impacts, including loss of low-lying habitats to increasing erosion and effects associated with the loss of synchronized migration and brood-rearing timing with prey availability, are likely to be experienced by birds within the life of the Proposed Action.

The effects of past, present, and reasonably foreseeable routine oil and gas exploration and development activities that may occur in the Beaufort Sea are expected to be similar in type to the impacts on birds described in Section 4.3.3 for analogous activities, but much greater in overall level than that of the Proposed Action. These include increases to levels of avian predation associated with multiple infrastructure and industrial use sites; disturbances from physical presence and vessel, aircraft, and vehicle traffic; habitat alteration; light attraction and collision hazards, and oil spill hazards. Impacts on the breeding grounds are still often somewhat localized relative to the general proportions of populations of many species, but more widespread in habitats where significant numbers from a wider breeding area aggregate, as with molting or migration staging. Some populations are likely exposed repeatedly or annually to a suite of activities.

As a result of past, present, and reasonably foreseeable oil and gas exploration and development activities, numbers of both nest predators and even numbers of nest predator species have increased measurably in parts of the ACP, including hundreds of miles beyond the Proposed Action Area. Given the importance of nest predation on productivity and the number of tundra-nesting avian species that depend on the ACP breeding grounds, these changes in nest predator balance are likely to have both widespread and on-going impacts. Collision hazards have similarly proliferated with industry-related infrastructure and vessels, particularly in the Central Beaufort Sea section of the formerly dark coastline migration corridor. The ever-increasing light attractant, disorientation, and collision risk is to the overall hundreds of thousands of birds that stream in a wide swath along the Beaufort Sea coast on migration, thus an existing on-going and widespread impact. Increased recreation/tourism/hunting, fishing, and regular commerce and transport would cause some of the same types of traffic disturbances and small spill hazards, although likely at an overall lower level than oil and gas-associated impacts for the foreseeable future.

Ingestion of lead shot, hunting, and changes in predation patterns have been suspected as primary contributors to the past substantial declines experienced by some populations of tundra-nesting birds (e.g., spectacled eider, Steller's eider) (USFWS, 2016, 2010, 2002). Tundra-nesting waterbirds, particularly eiders, are believed to have been the most impacted avian species from the effects of past and present actions. Most of these impacts have been persistent and widespread, although some of the causal factors have somewhat abated and some populations have stabilized, but at a lower level.

In summary, climate change has begun to show its effects in breeding habitat use and migration and brood chronologies. Impacts are likely to accelerate across most Arctic-breeding populations, having widespread and long-term effects. Birds breeding across the ACP have begun to be exposed and in some cases measurably affected by increased rates of nest predation. Lead poisoning and hunting has also affected ACP-breeding waterbirds and long-term population effects still linger. ACP-nesting birds have also incurred and will continue to be impacted by various mostly temporary disturbances on nesting grounds where they have also had some habitat loss, alteration, and fragmentation. Thousands of other birds breeding in Canada or elsewhere, migrating through in flocks, have been and will be impacted in areas where they gather to molt or forage and rest on migration. Other migrants have been and will continue to be exposed to many attraction and collision risks. Cumulative effects, then, are on many types of locally-nesting birds as well as populations moving through and have many long-term and widespread impacts, however at a far greater scale than the Proposed Action. In particular, because of the critical role of migration and migration timing in the life of Arctic-breeding migratory birds, climate change's predicted impacts would likely have such a widespread and long-term impact on Arctic avian resources as to "swamp" out the proportions of impacts of many other effects.

In the absence of the Proposed Action, the activities that produce these effects on birds are still present, and result in disturbance, reduced productivity, and mortality. Because they are collectively long-lasting and widespread, but less than severe, past, present, and reasonably foreseeable future actions cause as much as a moderate impact on birds, depending primarily on species, breeding population, and location.

5.2.5.4 Conclusion

As discussed above, when added together, the overall impact of the Proposed Action would be minor for most birds; impacts would potentially be long-lasting and widespread, therefore moderate, for a few vulnerable (declining and limited population) species and ESA-listed spectacled eider.

The cumulative impact that results from the incremental impact of the Proposed Action, when added to other past, present, and reasonably foreseeable future actions, is expected to also be moderate for an array of avian species. The Proposed Action, when added to existing and reasonably foreseeable future effects and actions, is not expected to contribute measurably to the cumulative impacts to birds. This is primarily because of the chronic, complex, and swamping effects of climate change for which Arctic birds have a particularly high exposure rate, as well as other cumulative impacts including those from lead shot, multiple other infrastructure projects and disturbance related to those projects, predation, collision risks, habitat alterations, and other effects.

5.2.6 Marine Mammals

5.2.6.1 Summary of Impacts

Routine operations associated with the Proposed Action are analyzed in detail in Section 4.3.4 and summarized here. Potential effects include:

- Disturbance and displacement from the physical presence of, and noise produced by, marine, air and ground transportation and by construction, maintenance, and decommissioning activities
- Habitat loss and alteration
- Human-wildlife interactions
- Small spills

Most effects to marine mammals would be localized and range from negligible to minor.

Vessel and aircraft traffic would occur shoreward of the waters where beluga, bowhead, and gray whales typically occur; likewise the proposed LDPI site and offshore pipeline corridor are located inshore of the areas where these species are generally seen. Disturbance and displacement of whales from project activities and associated traffic would be transitory. The Proposed Action is expected to result in negligible loss or alteration of cetacean habitat since the proposed LDPI and pipeline corridor are inshore of areas where whales generally occur and the area affected by the Proposed Action is small compared to the overall habitat available in the Beaufort Sea. The greatest effect to cetaceans would arise from noise generated by pile-driving (only during island construction) and vessel traffic. Operational measures that restrict the duration of pipe/pile-driving to only 15 days during open-water season would minimize the potential for whales to be deflected offshore from this construction noise. Most cetaceans can detect and avoid most commercial vessel traffic, but vessel noise would result in short-term behavioral reactions.

Pacific walruses occur rarely in the vicinity of the Project Area and thus are unlikely to be affected by Proposed Action activities. The greatest effector to any walruses that may be seasonally present in the area would be due to disturbance and displacement from noise generated by pile-driving during island construction, and by vessel and aircraft traffic. Mitigation, detailed in Appendix C, such as timing restrictions, minimum flight altitudes, and vessel speed restrictions could minimize disturbance and displacement effects.

For bearded seals, vessel and aircraft traffic would be the greatest effector because these activities would occur in waters where this species is present and would persist annually through the life of the Proposed Action. Vessel traffic along proposed transit corridors could displace individual seals from these immediate areas, although seals are likely to habituate to vessels and aircraft.

Because ringed seals winter over and produce pups in the Proposed Action Area, the greatest potential impacts to ringed seals from the Proposed Action would come from pipeline installation activities. The portion of the offshore pipeline corridor in deeper water (i.e., further from shore) overlaps with sea ice habitat suitable for pupping lairs as well as breathing holes. Noise from installation activities could disturb and displace individual seals, and the activities themselves could reduce the quality and availability of the small amount of habitat immediately alongside of the pipeline corridor. Heavy equipment transport could also crush or collapse lairs, resulting in injury or mortality of pups and mothers. The direct effects of pipeline installation activities would not persist for longer than one season.

Polar bears occur year-round in both the on- and offshore portions of the Proposed Action Area, typically in low population densities. Polar bears are most likely to be affected by winter construction activities, including ice roads, gravel mining, LDPI construction, and pipeline installation. A small amount of habitat could be lost or altered for the duration of the activity. Individual bears could be disturbed or displaced from the immediate vicinity. Alternately, construction activity could attract bears, creating potential for human-wildlife interactions with negative consequences for both workers and bears. Ice road construction and use in denning habitat after bears have entered maternal dens would be the greatest effector for polar bears. Construction activities could disturb mothers, causing them to abandon dens prematurely, and heavy equipment transport and use could crush or collapse dens, resulting in individual injury or mortality. Mitigation, detailed in Appendix C, such as pre-activity surveys and subsequent avoidance of known polar bear dens, could minimize these potential effects.

As discussed in Section 4.3.4.6.1 (Oil Spills, Small), small spills would be localized and would dissipate rapidly. As such, they would be unlikely to contact marine mammals.

5.2.6.2 Discussion of Other Relevant Actions

Oil and Gas Activities: Oil and gas exploration, development, production, and decommissioning activities have occurred in the U.S. Beaufort Sea since the 1970s.

Future oil and gas activities in the Beaufort Sea are likely to concentrate in the vicinity of nearshore state and Federal leases. Canada is also expected to develop its own offshore oil and gas resources to the fullest extent. Gearon et al. (2014) modelled the spread of spills originating in the eastern Beaufort Sea, and found that oil from a theoretical 5.4 million bbl loss of well control could contact some Beaufort and Chukchi Sea nearshore areas. Such events would be highly unlikely considering the geology, reservoir sizes, water depths, and pressures involved in Arctic wells. Spills in Canada or Russia large enough to induce marine mammals to disperse to other areas could result in animals moving into the Proposed Action Area.

Transportation: Vessel traffic in the Arctic marine environment has historically been associated with subsistence hunting, travel between coastal communities, commerce, tourism, research, oil exploration, and some military activities.

Vessel traffic passing through the Bering Strait and into eastward into the Beaufort Sea has increased in recent years (Clarke et al., 2014), and may continue to increase into the foreseeable future, potentially adding more noise into the marine environment and increasing the risks of strikes to marine mammals. Species that may be encountered around Dutch Harbor and on transit to the Proposed Action Area include the following species: bowhead whales, fin whales, humpback whales, North Pacific right whales, sperm whales, gray whales, blue whale, minke whales, killer whales, beluga whale, Stejneger's beaked whale, Baird's beaked whale, Cuvier's beaked whale, dall's porpoise, harbor porpoise, and Pacific white-sided dolphin. Several of these species are discussed in more detail below. Impacts to from vessel traffic associated with the Proposed Action and other reasonably foreseeable future actions could include vessel strikes and small fuel spills.

Aircraft traffic has also increased across the North Slope, generally in support of commercial, government, academic, and military activities. More aircraft are associated with recreational activities, and these numbers should continue to grow, although most such flight activity would occur over onshore areas. Similarly, commuter and emergency flight activity continues to grow. Though increases in onshore air traffic are occurring, the increases remain proportionately low with respect to existing air-traffic levels.

Subsistence: Seals, bowhead whales, and other marine mammals are harvested annually in subsistence hunts. Numbers of animals harvested varies by community and hunting areas typically radiate out from each community for many miles with each community representing a particular subsistence area. Impacts to marine mammal populations are local and vary by region.

Scientific Research: Research-oriented aircraft and vessel traffic impacts to marine mammals generally occur during the open water season (July through October). On-ice research usually occurs in winter and early spring, but may also occur on pack ice during the open water season. These activities are limited in the amount of disturbance they produce due to the small footprint of their operations, the limited amount of potential disturbance created, and the limited duration and magnitude of fieldwork.

Studies conducted in the OCS tend to be non-invasive and include activities such as radio-tagging, aerial observations, etc.

Climate Change: Climate change in the Arctic is the driving factor behind increased vessel traffic, air traffic, military activity, and some economic development and is expected to have substantial effects on Arctic marine mammals. The effects of climate change on marine mammals could be partially beneficial to certain species of marine mammals while detrimental to others, depending on what life processes are affected for a species and the manner in which those effects occur.

Reasonably foreseeable changes to the Arctic climate include increased temperatures, increased sea ice losses, increased glacial ice melt, earlier and faster snowmelt, extended growing seasons, shortened winters, and increased precipitation.

Melting permafrost can also create melt ponds and lakes on tundra in low lying areas. Such catchments of soil moisture are unlikely to directly flow into streams and may be ephemeral. Rivers and streams along the ACP could also undergo impacts from changes to the climate with earlier spring flooding (Nghiem et al., 2014; Beltaos, 2013; Queenie et al., 2012) followed by decreases in groundwater inputs derived from melting snow, ice, and permafrost (Qiu, 2012). Spring and summer flooding of river systems can lead to large influxes of warmer freshwater into the Arctic marine environment. If such events occur in a rapid surge as opposed to a steady inflow, extensive areas of sea ice can rapidly melt (Nghiem et al., 2014).

Sea ice losses in the Arctic Ocean may lead to larger storms, resulting in larger waves that weather away coastlines and islands more rapidly (Vavrus, 2013), resulting in larger and more frequent storm surges reaching farther inland from the coast. Storms and storm surges, along with warming air, could increase thawing of permafrost in Arctic soils and increase the annual depth of thawed soils (Kittel, Baker, Higgins, and Haney, 2011; Vavrus, 2013), leading to the release of soil organic matter into watersheds. Nearshore areas of the Beaufort and Chukchi seas would receive larger surges of organic influxes from eroding coastlines, streambanks, and from the thawing permafrost that would add organic constituents to the marine food web.

Ocean acidification would continue as a result of climate change, and would affect the levels of calcium carbonate available to invertebrates for shell development. Under such conditions, benthic creatures such as bivalves (such as clams and mussels) and polychaete worms (having fleshy segments and bristles – bristleworms) would have difficulty creating and maintaining shells, while species such as jellies, squid, etc. might flourish. At the microbial level, blue-green algae could have trouble creating the calcium carbonate matrices needed to permit them to remain near the surface of the ocean, and such a situation could have severe repercussions throughout the oceanic food web (Raven J. et al., 2005; Riebesell and Tortell, 2011).

Both summer and winter temperatures are expected to increase across the North Slope through this century, with the greatest changes occurring in winter. Average winter temperatures are likely to increase by as much as 12.6°F by the 2040s, while summer temperatures are projected to rise by about 5.4°F by the 2040s (Scenarios Network for Alaska and Arctic Planning, 2011 updated using SNAP tool https://www.snap.uaf.edu/ accessed April, 2017). Precipitation patterns are also expected to change with 20 percent to 45 percent increased winter precipitation by the 2040s; while summer precipitation increases would be smaller. A northward shift in thaw dates is expected over the course of the century with thawing occurring in the coastal regions during the first week of June by mid-century and June 1 by the end of the century while thaws would occur around May 1 in the southern NPR-A. In comparison, fall freeze-up dates along coastal areas would extend into late September, and October 1 in the Brooks Range.

5.2.6.3 Analysis of Cumulative Impacts

5.2.6.3.1 Beluga Whale

Beluga whale populations exist in other ice-free waters, so it is likely that they could exist in an ice-free summer arctic; shrinking sea ice could draw beluga whales farther north with the ice front. They would continue feeding on appropriate fish species as long as those stocks remain abundant. Once existing prey stocks decline, belugas would likely switch to other prey species that become available. A total loss of sea ice over the Arctic Ocean during the summer months could permit different beluga and narwhal stocks to mingle. Loss of sea ice may also result in increased predation on belugas that had formerly been able to avoid killer whales by swimming under and through ice floes.

Due to their dispersal across the Chukchi and Beaufort seas, particularly areas beyond the continental shelf break, belugas would not be impacted by most of the effects of oil and gas development short of a very large oil spill (VLOS).

It is assumed that later in the 21st century as summer sea ice recedes north there would be no need for icebreaking during the July through October period. Though the ice-free season would likely extend out a few weeks from present dates, there are no known oil or gas reserves under the deep waters of the Arctic Basin where most belugas would be concentrating. Consequently, the effects of icebreaking on beluga whales should decrease into the future due to a decreasing need for such activities.

Other military activities could include aircraft operations using jets and helicopters, in addition to the types of aircraft that are normally used on the North Slope. Jets often operate at supersonic speeds which introduce much more noise into the environment than propeller-based aircraft, and helicopters create a different type of noise disturbance than fixed wing aircraft.

Climate change effects to the Chukchi and Beaufort seas would likely have a greater impact on beluga whale numbers, distribution, and population viability than all of the past, present, and foreseeable human activities combined because it has the potential to expose belugas to increased anthropogenic activities. As summer sea ice recedes, shipping lanes are likely to open, resulting in greater commercial and scientific vessel traffic passing through beluga whale habitat and possibly encountering whales. It is assumed in this analysis that belugas can detect and avoid most commercial vessel traffic, but vessel noise may impact them resulting in short-term behavioral responses.

Positive changes in the economic conditions among subsistence-dependent peoples may lead to hunting forays that travel greater distances, increase in duration and potentially find larger harvests, in places that were previously relied upon as safe refuge areas by belugas, increasing stress on beluga stocks.

The most influential RFFAs that would affect beluga whales would be climate change, followed by potential increases in subsistence hunting and commercial vessel traffic. Other activities are either too limited in their effects to produce noticeable impacts on belugas, or lack overlap with beluga whale life cycles and requirements.

Impacts to beluga whales from the Proposed Action are expected to be negligible. There is a temporal overlap between the Proposed Action and some RFFAs (i.e., climate change, and potential increases in subsistence hunting and vessel traffic). However, with the exception of climate change, which is ubiquitous, there is limited spatial overlap. This is because the Proposed Action is located in the nearshore region of the Beaufort Sea. Only a limited number of individual belugas transit and utilize the area, few subsistence hunters use the area, and the only vessels using the area are likely to be associated with the Proposed Action. Consequently, the impacts of the Proposed Action are not expected to add to, or synergistically interact with, any past, present, or RFFA to alter the condition of beluga whale stocks in the 21st century.

5.2.6.3.2 Bowhead Whale

Bowhead whales may experience positive effects from climate change in the 21st century due to increased productivity and longer open water seasons. Earlier melts of sea ice in spring could permit bowheads to migrate a few weeks earlier and a total loss of summer sea ice over the Arctic Ocean could permit different bowhead whale stocks to mingle. However, bowheads may experience negative effects where diminishing ice may also allow predators such as killer whales to more efficiently hunt bowheads, since bowheads have been known to swim under heavy sea ice cover where killer whales cannot follow. Climate change effects in the Chukchi and Beaufort seas would have a greater impact on bowhead whale numbers, distribution, and population viability than all of the past, present, and foreseeable human activities, including the Proposed Action, combined.

Commercial vessel traffic is the human activity likely to have the greatest effect on bowhead whales, through vessel strikes. Increasing vessel traffic in the Arctic would no longer be restricted to the Northwest Passage or the Northern Sea Route, which is presently open for limited periods of time. For bowhead whales, the consequences of prolonged ice-free Arctic waters would be more large commercial and tourism vessels passing through their feeding grounds in the Eastern Beaufort Sea, Barrow Canyon, and off the coast of Chukotka. This could impact bowhead whales passing through the Bering Strait during spring or fall migrations if the migrations fall out of synchronization with the fall formation and spring melt of sea ice in the northern Bering and southern Chukchi seas. The effects of the additional vessel traffic could include increased vessel strikes of bowhead whales, and increased noise production into the marine environment. Under such conditions there would be no need for icebreaking during the July through October period, and the use of icebreakers would decline.

Other forms of vessel traffic include support for scientific surveys, which are likely to increase into the future, along with subsistence activities. It is assumed for this analysis that bowhead whales would be capable of avoiding survey ships. Small watercraft used for subsistence, particularly whaling, may operate for longer periods of time due to increased financial resources among some subsistence users. Weather and sea ice have profound effects on whaling in the Arctic. If summer Arctic waters become ice free, bowhead fall migrations may shift north, beyond the reach of subsistence whalers. With larger, more frequent and powerful storms expected to occur in the Arctic Ocean as the 21st century progresses, people engaged in whaling in open water could be at a greater personal risk. Moreover, stormy weather may shorten the time available for whaling activities or make subsistence whaling unfeasible.

Similar to beluga whales, the most influential human activities and effects on bowhead whales would be anthropogenic climate change, subsistence hunting, and vessel traffic, where other activities are limited in their effects, or do not overlap with bowhead whale physiological requirements.

Impacts to bowhead whales from the Proposed Action are expected to be negligible. This is because they transit the Beaufort Sea well north of the nearshore Proposed Action, and most of the impacts associated with the Proposed Action do not extend outside of Foggy Island Bay, except for noise associated with pile-/pipe-driving during construction. There would be a temporal overlap between the Proposed Action and certain RFFAs, including climate change, subsistence hunting and vessel traffic, however there is little spatial overlap. This is because the Proposed Action is located in the nearshore region of the Beaufort Sea. Only a few bowhead whales transit the area, few subsistence hunters use the area, and the only vessels using the area are likely to be associated with the Proposed Action. However, the Proposed Action would become part of the established, nearshore oil and gas industry that spans approximately 100 miles along the coastline from Point Thomson (in the east) to the Alpine Development (in the west), but this comprises a small portion of the bowhead whale's range. Consequently, the negligible effects of the Proposed Action on bowhead whales would not appreciably add to or synergistically interact with other past, present, or RFFA to alter the condition of the Western Arctic Bowhead Whale stock in the 21st century.

5.2.6.3.3 Gray Whale

Earlier and more extensive sea ice losses due to climate change during the summer months in the Beaufort and Chukchi seas would affect gray whales by opening up more habitat for them to occupy, particularly in the northern Chukchi Sea. As the marine environment shifts towards a more pelagic system, fish could become more favored by gray whales that benthic prey. This feeding flexibility may also influence the mobility potential where North Pacific gray whales have been documented in the Atlantic Ocean (Pyenson and Lindberg, 2011; Woodward, Winn, and Fish, 2006). Climate change effects in the Chukchi and Beaufort seas are likely to have a positive, greater, and more profound impact on gray whale numbers, distribution, and population viability than all of the past, present, and foreseeable human activities in the Beaufort Sea combined.

Summer sea ice losses in the Arctic Ocean would permit increasing numbers of commercial, tourism, and scientific vessel activity. The growing numbers of scientific and commercial vessels would increase the noise and risk of vessel strikes to gray whales. U.S. vessel presence in the Chukchi and Beaufort seas may also increase.

Commercial, military, and scientific aircraft operations are also expected to increase into the foreseeable future. Greater use of military jets and helicopters would introduce more noise into the environment, though most military aircraft maintain an altitude of several thousand feet above the water or land surface which minimizes the disturbance to the marine environment. Scientific surveys using aircraft such as the ASAMM, BOWFEST, and BWASP, fly at altitudes sufficient to negate most transfer of sound into the water. Aircraft operations would have short-term and localized effects on gray whales.

Impacts on gray whales from the Proposed Action are expected to be negligible primarily because they are only occasional inhabitants of the Beaufort Sea, and would have limited contact with the project's activities. There would be temporal overlap between effects from the Proposed Action and certain RFFAs, including climate change and vessel traffic. Except for climate change, however, there would be limited spatial overlap. Climate change effects to the Chukchi and Beaufort seas would most likely have a positive effect on gray whales; one that is greater than all of the past, present, and foreseeable human activities combined. Consequently, the negligible effects of the Proposed Action on gray whales would not appreciably add to or synergistically interact with other past, present, or RFFAs to alter the condition of gray whales in the Arctic during the 21st century.

5.2.6.3.4 Pacific Walrus

The USFWS considers Pacific walrus to be extralimital to the Proposed Action Area. Alaska Native subsistence hunters currently take an average of about 1,250 Pacific walrus are taken per year mainly in the Chukchi Sea. A lack of sea ice has limited hunting opportunities for some communities. Open water can cause local walrus populations to shift making hunting more dangerous searching for walruses.

Reductions in sea ice duration and extent due to climate change are causing changes in patterns of walrus habitat use and resulting in the formation of large terrestrial haulouts along the Chukchi Sea. Walrus onshore may be more vulnerable to predators and to disturbance events that cause stampedes, resulting in injuries and mortalities. Young calves are particularly vulnerable during stampedes, and these events could lead to population level effects (Fischbach et al., 2009; Udevitz et al., 2013). Between 2007 and 2014, larger terrestrial aggregations of walrus were seen at onshore haulouts along both sides of the Bering Strait that correspond with dramatic summer sea ice retreat (Garlich-Miller et al., 2011; Jay and Fischbach, 2008; Jay, Fischbach, and Kochev, 2012; Robards and Garlich-Miller, 2013), suggesting that walruses are using these areas because they have no ice platforms for foraging. The loss of ice platforms for foraging in the Chukchi Sea could lead to sever impacts to walruses in the future. In addition, ocean acidity, temperature, and sea ice cover changes may lead to impacts on the availability of benthic invertebrate prey (Section 5.2.3).

Increases in shipping, particularly transits near shore-based terrestrial haulouts, may increase disturbance events and result in mortalities from ship strikes or prop injuries. Calves may be separated from their mothers during disturbance events onshore or on ice. Calves remain dependent upon their mothers for two years or more, and may not survive. Low flying aircraft may also cause disturbance events and stampedes, particularly at shore-based haulouts.

Only a small number of walruses would have the potential to interact with the Proposed Action spatially or temporally because walruses are extralimital in the Beaufort Sea. The majority of the Pacific walrus population resides in the Chukchi Sea. The effects of the Proposed Action are negligible on Pacific walruses, and those effects would not appreciably add, or synergistically interact with other past, present, or RFFAs, including climate change, to alter the condition of Pacific walrus stocks in the 21st century.

5.2.6.3.5 Polar Bear

Prior to the passing of the Marine Mammal Protection Act (MMPA), sport hunters took large numbers of polar bears in the U.S., with population level impacts. Polar bear numbers increased after the 1972 passing of the MMPA. Currently, some polar bears are taken in defense of life or through subsistence hunting. In 2013, for example, a total of 52 bears were taken by subsistence hunters in Alaska from the Southern Beaufort Sea Stock (SBS) and the Chukchi-Bering Sea Stock (CBS) polar bear populations (USFWS, 2014a).

Current levels of anthropogenic activity related to the oil and gas industry in Alaska result in occasional disturbance of individual bears, generally due to vessel, aircraft or ground traffic or due to deterring bears away from human activity or habitation, which also occurs near villages in Alaska and Chukotka.

Commercial shipping, tourism cruises, and research cruises are increasing in the Arctic and are projected to continue to increase. As sea ice retreat makes the Northwest Passage and the Northern

Sea Routes more viable for tourism and cargo vessels, more vessels are expected to access these routes throughout the longer open water season. The increase in vessel traffic increases the potential risk of accidents and spills.

Arctic sea ice extents have shown a decreasing trend for all months from 1979 to the present and are expected to continue decreasing (Stroeve et al., 2012). Bears would either come ashore or remain with the sea ice as it moved northward off the shelf and over waters that are not inhabited by their prey species. Onshore, bears may fast or feed on marine mammal carcasses, which may bring them increasingly into conflict with humans near villages with food. Human-bear conflicts in villages in the Chukotka region and on the Alaska North Slope have led to the formation of ‘bear patrols’ in an effort to deter bears from villages rather than destroy them to protect human life.

Currently, the greatest challenge for polar bear populations world-wide are warming temperatures and sea ice loss due to climate change. As the open water period increases, many polar bears would spend more of the year in sub-optimum foraging habitat. Bears on sea ice may be forced to attempt long distance swims to shore or other available sea ice as melting ice breaks up in summer (Pagano et al., 2012). It has been predicted that climate change with the resulting warming temperatures and loss of sea ice would lead to polar bears being extirpated from the divergent ice areas within 75 years and the southern Beaufort and Chukchi seas are part of the divergent ecoregion (Amstrup, Marcot, and Douglas, 2007). The SBS population of polar bears has decreased in number and in size in recent decades as sea ice and access to prey decline (Rode, Amstrup and Regehr, 2010; Bromaghin et al., 2014).

To date, impacts on polar bear populations from the oil and gas industry have been limited primarily to disturbance in the Beaufort Sea and adjacent shoreline. Increases in shipping, research, village bear viewing tourism, ship-based tourism, and icebreaker activities may all increase human-bear interactions, resulting in increases in disturbance and potential injuries to bears. These impacts are more pronounced on the Beaufort Sea shoreline rather than the Alaskan Chukchi Sea shoreline. Continued sea ice loss may result in CBS bears onshore spending more time searching for food near villages in Chukotka which may increase the numbers of bears taken in defense of human life. The Proposed Action could add to other sources of human-bear interactions, primarily existing industry, bear viewing tourism, and human-bear interactions in and near villages.

The effects of the Proposed Action are anticipated to have a minor level of effect on polar bears, whereby the effects would be short-term with no long-term lingering effects on the species. Of past, present and RFFAs, climate change and human-bear interactions would have the greatest potential to affect polar bears. Further, the effects of climate change and human-bear interactions would interact both spatially and temporally with those of the Proposed Action. Considering the effects of the Proposed Action in conjunction with climate change, human-bear interactions, and other RFFAs, the minor effects of the Proposed Action would have additive cumulative effects with respect to polar bears, possibly resulting in moderate to major effects of polar bears.

5.2.6.3.6 Bearded, Ringed, and Spotted Seals

Increasing sea ice losses during the summer in the Arctic Ocean are expected to have beneficial and detrimental effects for bearded and ringed seals. As sea ice melts, ice-based birthing, basking, and resting habitat would be reduced for bearded and ringed seals, and could eventually disappear. Conversely, in the near term, bearded ringed seals would enjoy larger lead and polynya systems, which may support larger numbers of seals. Likewise, the increased productivity in the Arctic Ocean from increased terrestrial inputs and longer ice-free seasons could better support bearded and ringed seals, at least into the near future. Effects of sea ice losses on spotted seals could be beneficial as well as spotted seals do not use sea ice to the extent of bearded and ringed seals and readily haul out on islands, mudbars, and other coastal areas.

While most bearded and ringed seals whelp in the Bering Sea, some remain in the Beaufort and Chukchi seas throughout the year. Birthing conditions for resident bearded seals could temporarily improve with larger lead and polynya systems offering greater access to water and an increase in the sea ice edge effect in those areas. For ringed seals birthing conditions are expected to degrade with increasing rain-on-snow events compromising the integrity of subnivean ringed seal birthing dens. In the Bering Sea where most bearded, ringed, and spotted seals whelp, sea ice would continue to form, though likely to areas farther north than presently occurs, and those seals should continue to successfully reproduce and whelping conditions should not change significantly.

During the open water season, bearded, ringed, and spotted seals spend most of their time in the water feeding, and have been known to haul out onshore in some areas. Onshore haulouts by ringed seals may increase into the future as sea ice disappears, providing such areas remain undisturbed.

Bearded seals are predominately benthic feeders, and decreases in benthic food stocks due to warming conditions could affect bearded seals, where larger fish stocks may be less favorable for them. The expected increases in pelagic fish and invertebrate production may be a positive effect of climate change on ringed seals. Spotted seals are predominately pelagic feeders, feeding on fishes and invertebrates in the water column, so large stocks of fish would favor them. Consequently, the expected increases in pelagic fish and invertebrate production should be a positive effect of climate change on ringed and spotted seals. If there is an increase in other seal species or sub-arctic whales (i.e. fin, humpback and minke whales) or an influx of immigrant species (i.e., harbor, harp, hooded or gray seals, or Steller sea lions, etc.) then there could be a rise in interspecies competition that may be detrimental to seals.

In the long-term, ocean acidification could result in a net loss of the food base for seals. Such effects are unlikely to occur in the near future; however, with the expected losses among marine micro-biota the entire marine food web would undergo some level of change from its current state, which could be harmful to seals.

Sea ice losses during the summer in the Arctic Ocean would also permit increasing numbers of commercial, tourism, and scientific vessel activity. As the Northwest Passage and Northern Sea Route remain clear of ice for longer periods of time, more vessels would likely travel through the Arctic. Growing numbers of commercial vessels could impact seals by increasing the potential for boat strikes and would introduce additional sound into the marine environment. The numbers of scientific and industry survey vessels (and associated noise) in the U.S. Beaufort Sea is also likely to increase. Because an increase in military and USCG activity in the U.S. Beaufort Sea is anticipated, U.S. Navy and USCG vessel presence is also likely to increase.

Commercial, military, and scientific aircraft operations are expected to increase into the foreseeable future and introduce additional noise. Aircraft have little effect on when they are in the water; however, hauled out seals may display flight reactions if approached too closely by low-flying aircraft by quickly slipping into the water.

Climate change effects in the Beaufort Sea are likely to have mixed effects (both beneficial and detrimental) on bearded and ringed seals and predominantly beneficial effect on spotted seals. These effects are greater and more profound with respect to impacts on seal numbers, distribution, and population viability, than all Beaufort Sea past, present, and foreseeable human activities combined. The greatest human activities and effects on bearded, ringed, and spotted seals would be anthropogenic climate change and subsistence hunting. Other activities, such as shipping, are limited in their effects to produce impacts on bearded, ringed, and spotted seals because the behavioral reactions that result from vessel interactions are not biologically significant.

Impacts to seals from the Proposed Action are expected to be negligible, but there would be both a spatial and temporal overlap between the Proposed Action and certain RFFAs including oil and gas development, climate change, subsistence hunting, and temporal overlap with vessel traffic. The established nearshore oil and gas industry spans approximately 100 miles along the coastline from Point Thomson (in the east) to the Alpine Development (in the west). Although this represents a small portion of these seal species' ranges, the Proposed Action would spatially extend the developed shoreline area and temporally overlap with industry actions as well. The effects of climate change and subsistence hunting would also spatially and temporally overlap with effects of the Proposed Action, while the effects of vessel traffic would primarily be only a temporal overlap. Overall, however, due to the Proposed Action's location and limited influence within the greater North Slope (of Alaska) oilfields, the negligible effects of the Proposed Action on bearded, ringed, and spotted seals would not appreciably add to or synergistically interact with other past, present, or RFFAs to alter the condition of the bearded, ringed, and spotted seal populations in the 21st century.

5.2.7 Terrestrial Mammals

5.2.7.1 Summary of Impacts

The level of effects of the Proposed Action on several key species were analyzed in Chapter 4 of this document and are summarized as negligible for all terrestrial mammals.

Activities associated with the Proposed Action that could impact terrestrial mammals include physical presence and noise from:

- Helicopters
- Onshore facilities
- Vehicle and equipment operations
- Pipeline construction

The greatest effects to terrestrial mammals, particularly caribou, would arise from aircraft, vehicle, and equipment operations during facility and pipeline construction that could induce injurious escape reactions some terrestrial mammals, especially caribou herds and individuals with young.

The Proposed Action could also impact terrestrial mammals through habitat alteration that could persist for years or decades. Although BOEM estimates that there is a less than 1 percent chance of a large spill occurring, a potential large spill event could also result in long-term impacts to terrestrial mammals.

5.2.7.2 Discussion of Other Relevant Actions

Oil and Gas Activities: Oil and gas exploration has occurred on the North Slope since the early 1900s. Development and production near Prudhoe Bay commenced in the early 1970s and continues today. The TAPS, built in 1977, continues to convey produced oil southward from Prudhoe Bay area developments to Valdez along the southern Alaskan coast. More recently, exploration has occurred on the Beaufort Sea OCS and Chukchi Sea and in onshore areas within the NPR-A.

In addition to exploration and field development, the State of Alaska and industry are investigating the feasibility of constructing a natural gas pipeline from Prudhoe Bay to south-central Alaska with possible spurs to support communities near the pipeline route.

Economic Development: The effects of economic development could include increased financial resources for subsistence hunters, which could result in the ability to purchase more fuel and higher quality equipment for subsistence activities, which could result in greater subsistence harvest success. In the long-term, harvests of some terrestrial mammal species should decline in tandem with the climate change effects on Arctic fox and caribou populations; however, harvests of other species such as moose, grizzly bears, muskoxen, Dall sheep, and some furbearing species could increase if those populations shift north or increase in response to habitat changes.

Recreation and Tourism: The opening of Arctic waterways connecting the Beaufort Sea with the western Atlantic Ocean and the Chukchi Sea with eastern Atlantic Ocean has allowed a tourism industry to develop in recent years. Tourism is expected to increase in the future. Such tours involve cruise ships which produce noise and discharges, as well as onshore activities including sport hunting and fishing, wildlife viewing, photography, and adventure activities. Sport hunting and fishing could produce moderate effects on some wildlife and fish populations since individuals are harvested, but population level effects are not anticipated. In comparison, activities such as wildlife viewing, and adventuring do not typically impact wildlife population. The overall effects of recreation and tourism on terrestrial mammals are expected to be moderate due to mortalities associated with recreational hunting and fishing.

Aircraft Traffic: Aircraft use on the North Slope is typically performed by oil and gas exploration companies, and by government entities who conduct surveys such as ASSAM, and BOWFEST. Aircraft traffic between communities, camps, and infrastructure developments could increase as oil and gas construction and scientific research continue and possibly increase into the future. Air traffic may have minor to moderate impacts on terrestrial mammals if aircraft altitudes drop below 1,500 feet above ground level (AGL). Otherwise the level of effects from aircraft on terrestrial mammals should be negligible to minor.

Subsistence: Thousands of caribou are harvested annually in subsistence hunts, along with many other species of mammals including moose, muskox, grizzly bear, Dall sheep, marmots, hares, and various furbearing animals. The numbers of animals harvested vary by community and hunting areas, which typically extend for many miles around each community. For this reason each community has a unique subsistence area with no two being identical in proportions.

Mining: The Red Dog mine is located in the western Brooks Range near the Chukchi Sea coast, and is the world’s largest zinc mine. Other mineral mines (e.g., Donlin Gold) are proposed for western Alaska, none of which occur near the LDPI. Barring unforeseeable accidents, it is unlikely mining itself would have any identifiable effects on terrestrial mammals; however, road creation and the vehicular, air, and vessel traffic associated with such mines would produce negligible to moderate levels of effects due to impacts on individual animals.

Climate Change: Climate change in the Arctic is the driving factor behind increasing vessel traffic, air traffic, military activity, and economic development. It is also expected to have the greatest effects on terrestrial mammals in the Arctic. The effects of climate change on terrestrial mammals include primary and secondary changes to ecological processes that mammalian species depend on for life. Some such changes could be beneficial to certain species and detrimental to others, depending on which life processes are affected for a species and the manner in which those effects occur.

Collectively, these effects of climate change could affect every living organism in the marine, coastal, and terrestrial environment of Alaska. Increasing warmth could lead to increased sea ice losses, increased glacial ice melt, earlier and faster snowmelt, extended growing seasons, increased precipitation, and shortened winters. Air and water temperatures in both summer and winter would increase. Soil moisture levels could change, becoming dryer in some areas and more hydrated in others, resulting in erosion and release of soil constituents such as CO_2 (Natali et al., 2014), nitrogen, and methane into the atmosphere. In recent years, holes as large as 98 feet wide by 230 feet deep have appeared in northern Siberia where the permafrost melted, along with methane hydrates sequestered in the soil (Moskvitch, 2014).

Melting permafrost can also create melt ponds and lakes on tundra in low lying areas. Such catchments of soil moisture are unlikely to directly flow into streams and may be ephemeral. Rivers and streams along the ACP would also experience impacts from changes to the climate with earlier episodes of spring flooding (Nghiem et al., 2014; Beltaos, 2013; Queenie et al., 2012) followed by decreases in groundwater inputs derived from melting snow, ice, and permafrost (Qiu, 2012). Spring and summer flooding of river systems can lead to large influxes of warmer freshwater into the Arctic marine environment. If such events occur in a rapid surge as opposed to a steady inflow, extensive areas of sea ice could melt rapidly (Nghiem et al., 2014).

Sea ice losses in the Arctic Ocean may lead to larger storms, resulting in larger waves that can rapidly erode coastlines and islands (Vavrus, 2013). Such events would permit larger and more frequent storm surges to reach farther inland from the coast. Storms and storm surges, along with warming air, would facilitate the thawing of permafrost in Arctic soils, increasing the annual depth of thawed soils (Kittel, Baker, Higgins, and Haney, 2011; Vavrus, 2013), and leading to the release of soil organic matter into watersheds. Nearshore areas of the Beaufort and Chukchi seas would receive larger fluxes of organic materials from eroding coastlines, streambanks, and from the thawing permafrost that would add to the organic constituents of the marine food web while removing them from the terrestrial system.

Ocean acidification would continue to occur as a result of climate change, and would decrease the availability of calcium carbonate that invertebrates use for shell development. Under such conditions creatures such as bivalves, pteropods, and polychaete worms would have difficulty creating and maintaining shells while other species such as jellies, sea urchins, and brittle stars that do not have calcium carbonate exoskeletons might flourish.

At the microbial level, blue-green algae could have trouble creating the calcium carbonate matrices needed to permit them to remain near the surface of the ocean, which could have severe repercussions throughout the oceanic food web. Anadromous fishes spawn in freshwater streams, often dying afterwards. In doing so, they provide an influx of nutrients from the marine environment to the terrestrial environment. Those nutrients positively affect vegetation growth and production in riparian areas, which provides more nutritious food to caribou, muskoxen, and other herbivores, as well as bears.

Grizzly bears, and Arctic foxes feed on salmon and other fishes if given the opportunity, and in doing so, receive high quality nutrition directly from the ocean. The herbivores feeding on riparian vegetation are often eaten by predators such as grizzly bears and Arctic foxes.

Both summer and winter temperatures are expected to increase across the North Slope through this century, with the greatest changes occurring in winter. Average winter temperatures are likely to increase by as much as 12.6°F by the 2040s, while summer temperatures are projected to rise by about 5.4°F by the 2040s (Scenarios Network for Alaska and Arctic Planning, updated using SNAP tool https://www.snap.uaf.edu/ accessed April, 2017). Precipitation patterns are also expected to change with 20 percent to 45 percent increased winter precipitation by the 2040s; while summer precipitation increases would be smaller. A northward shift in thaw dates is expected over the course of the century with thawing occurring in the coastal regions during the first week of June by mid-century and June 1 by the end of the century; while thaws would occur around May 1 in the southern NPR-A. In comparison, fall freeze-up dates along coastal areas would extend into late September, and October 1 in the Brooks Range. Consequently growing seasons could grow by another 6 weeks in the northern portions of the ACP, and by 3 weeks in the mountains of the Brooks Range (SNAP, 2011). Most of the western ACP is expected to remain within the existing temperature and precipitation ranges; but by century's end, conditions in the southern areas of the ACP (Brooks Mountains) would better match those presently found in warmer areas of Alaska. These climatic changes would lead to alterations in the vegetative communities which could have a profound impact on terrestrial mammals and productivity in the area.

Such impacts could include incursions of shrubs and trees in to areas that were formerly tundra-dominated; the replacement of existing ecological communities with new and novel ones; the arise of new ecosystems; the introduction of new diseases into the region, and the appearance of new mammal species, loss of existing mammal species, and range shifts for others.

5.2.7.3 Analysis of Cumulative Impacts

5.2.7.3.1 Caribou

In recent years, shrubs and trees have been observed growing in places where they previously did not exist; the potential for shrub and tree encroachment into the Arctic has become a cause for concern (McNew et al., 2013). The successful development of new plant communities, and the northward advance of trees and shrubs would depend on the genetically regulated abilities of a species to adapt to new environmental conditions (Nicotra et al., 2010; Shaw and Etterson, 2012; Franks and Hoffmann, 2012). Consequently there may be genetic limitations to how far north a plant species can grow, an environmental limitation other than temperature and precipitation; meaning trees and shrubs in northern Alaska may lack the genetic flexibility necessary to germinate and grow along the Chukchi and Beaufort sea coastlines or on the ACP.

Kaarlejärvi (2014) determined herbivores such as reindeer (caribou), and microtines can prevent lowland forbs from invading areas of open tundra through herbivory counteract the effects of climate warming by slowing or preventing the invasion of new plant species into tundra systems. Cahoon et al. (2012) determined large herbivores can mediate the responses of Arctic ecosystems to climate change through herbivory. Thus, maintaining healthy populations of caribou and other large herbivores in the Arctic may offset many of the ecological effects of climate change such as shifts in diversity, invasion by novel new species, and transitions to novel new ecological communities.

An effect of longer, warmer growing seasons with a deeper layer of thawed permafrost is increased root production by vascular plants. A shift to earlier emergence of plants could potentially lead to a trophic-mismatch between plant development, nutritional quality of plants, and caribou calving and grazing (Kerby and Post, 2013). Increases in growing season length, temperatures, permafrost thawing, and increased precipitation could be advantageous to the production of vascular forage plants on summer ranges. However, the increase in vascular range plants would result in a corresponding loss to non-vascular winter range plants such as lichens, which could be detrimental to caribou.

Caribou can be affected by the loss of sea ice in the Arctic. Without ice to moderate the effects of wind on the ocean’s surface, larger storm events which could destroy extensive areas of coastal habitat over time could occur throughout the Beaufort Sea.

Increasing fire frequency is another characteristic of climate change in the Arctic and could lead to long-term destruction of caribou winter ranges; some areas may take 50 years or more to recover from fires (Joly, Duffy, and Rupp, 2012; Gustine et al., 2014).

Recently, the topic of winter rain-on-snow event degradation of caribou winter ranges has been discussed. Little empirical evidence supports such a view, and Tyler (2010) concluded the effects of climate variability on caribou are “dwarfed” by the effects of density-independent factors of politics, social issues, and economics. Since 2010 other studies have been conducted which support the assumption of adverse effects from rain-on-snow events (Descamps et al., 2017; Langolis et al., 2017; Hansen et al., 2011; Hansen et al., 2014).

Changes in local economics within Arctic communities are likely to have some effects to caribou into the future. Increased financial resources would allow subsistence users to remain in the field longer, purchase better equipment, and improve their hunting success; however, increased financial resources would also allow communities to purchase more non-subsistence foods, thus potentially decreasing subsistence activity.

Recreational hunting of caribou from the Western Arctic (Caribou) Herd (WAH) is likely to decrease in response to a dwindling herd size. Military and USCG operations on the ACP may have some minor effects on caribou due to elevated levels of aircraft traffic which could be deleterious to caribou until they habituate to aircraft noise and presence (Wolfe, Griffith, and Wolfe, 2000). Other sources of aircraft traffic that could affect caribou include more commercial flights into and out of North Slope communities, and flights supporting future industrial developments that are unrelated to the Proposed Action. Increasing numbers of vehicles, roads and pipelines in association with onshore oil and gas developments are anticipated, as are the construction of infrastructure and facilities to support onshore oil and gas operations.

Climate change across the North Slope would have mixed effects on caribou; effects that are expected to be greater than all of the North Slope past, present, and RFFAs combined.

The effects of the Proposed Action on caribou would be negligible, and there would be little to no spatial overlap between the effects of the Proposed Action and those associated with RFFAs. Activities associated with the Proposed Action that would affect terrestrial habitat include construction of pads, pipeline VSMs, pipeline shore transition, an on-shore road crossing, and development of a gravel mine. Relative to the amount of terrestrial habitat that is available to caribou, the amount of lost habitat (less than 4 acres filled) or converted from wetland to open water (about 21 acres) is insignificant. Aircraft and vehicles used in support of the Proposed Action could also spatially overlap with effects from other RFFAs. However, it is unlikely that effects from these activities would add to, or synergistically interact with, effects from other RFFAs because of the limited amount of spatial overlap that is expected and because of mitigation measures proposed and described in Chapter 4 and Appendix C (see Section C-4 for a description of minimum flight elevations and vehicle speed limits).

The expected life of the Proposed Action is 25 years. During this time, activities associated with the Proposed Action would temporally overlap with continued subsistence/recreational hunting, increased on-shore industrial development, and climate change. While hunting pressure on caribou is expected to increase/decrease in response to changing herd size, and an increased number of vehicles, roads, aircraft, and pipelines in association with onshore development is anticipated, the most important RFFA that could affect caribou is climate change. The effects of climate change on caribou populations would likely lead to a decrease in herd size over the 21st century due to winter habitat losses, limited shrubland expansion onto the North Slope, and conversions of non-vascular and wetland plant communities to graminoid/forb-dominated communities. The effects of the Proposed Action on caribou populations are anticipated to be negligible, and are not expected to add to, or synergistically interact with, the major level of effects on caribou that are anticipated due to climate change.

5.2.7.3.2 Muskox

Muskox can be affected by the loss of sea ice in the Arctic. As sea ice losses continue to increase, larger storms may occur throughout the Arctic Ocean, and without sea ice to moderate the effects of winds on water, large waves and swells develop which could impact coastal habitat over time. Increases in growing season length, temperatures, permafrost thawing, and increased precipitation could be advantageous to the production of vascular forage plants on summer ranges, which would be a positive effect for muskoxen. An effect of longer, warmer growing seasons with a deeper layer of thawed permafrost is increased root production by vascular plants, and a shift to earlier emergence of plants that could lead to a trophic mismatch between plant development, nutritional quality of plants, and muskox calving and grazing, as Kerby and Post (2013) observed for caribou. However, the non-migratory behavior of muskoxen may prevent trophic-mismatches between muskox and their forage species. Increasing fire frequency could lead to the long-term destruction of musk ox winter ranges; however, seral (intermediate) stages that follow Arctic wildfires would include graminoid, forb, and shrub communities that could favor muskoxen.

Changes in long-term flora on the North Slope could affect Arctic herbivores. In recent years, shrubs and trees have been observed in places where they previously did not grow. The potential for shrub and tree encroachment into the Arctic has been a cause for concern (McNew et al., 2013); however, the development of new plant communities, and the northward advance of trees and shrubs would depend on genetically regulated abilities of each species to adapt to new environmental conditions (Nicotra et al., 2010; Shaw and Etterson, 2012; Franks and Hoffmann, 2012). Consequently, genetic limitations may limit how far north a plant species can grow; meaning trees and shrubs in northern Alaska may lack the genetic flexibility necessary to germinate and grow along the Chukchi and Beaufort sea coastlines, or on the ACP. With a mixture of habitat, muskoxen would ideally graze sedge meadows on the ACP in summer, and use shrublands during winter for cover and browse from time to time.

Kaarlejärvi (2014) determined mammalian herbivores can prevent lowland forbs from invading areas of open tundra through herbivory, and that herbivores counteract the effects of climate warming by slowing or preventing the invasion of new plant species into tundra systems. Cahoon et al. (2012) determined large herbivores can mediate the responses of Arctic ecosystems to climate change through herbivory. Thus maintaining healthy populations of muskoxen, and other large herbivores in the Arctic may offset many of the ecological effects of climate change such as shifts in diversity, invasion by novel new species, transitions to novel new ecological communities, etc. Under the current climate change projections muskoxen numbers may actually increase along the North Slope.

Recently, winter rain on snow event degradation of caribou winter ranges has been discussed; however, muskoxen rely on stored reserves during much of the winter and generally do not browse or graze extensively. Consequently, the effects of icing on muskox winter habitat would likely be negligible, and since muskoxen prefer “shrubby” habitat that is increasing in some areas of Arctic Alaska, some positive effects to muskoxen may occur through the creation of new habitat.

Changes in local economics within Arctic communities are likely to have some effects to muskox into the future. Increased financial resources would allow subsistence users to remain in the field longer, purchase better equipment, and improve their hunting success; however, increased financial resources would also allow communities to purchase more non-subsistence foods that could remove some dependency on subsistence foods, which could result in a smaller subsistence harvest on muskoxen. Recreational use of muskox may increase or decrease in response to fluctuations in the numbers of muskoxen, and the increasing costs involved with accessing the animals for sport hunting. Furthermore, military and USCG operations on the ACP may have some minor effects on muskox. The primary impact from onshore military and USCG operations would be elevated levels of aircraft traffic which may negatively affect muskox until they habituate to aircraft noise and presence.

Other sources of aircraft traffic that could affect muskox include more commercial flights into and out of North Slope communities and flights supporting future industrial developments that are unrelated to the Proposed Action. Increasing numbers of vehicles, roads and pipelines in association with onshore oil and gas developments are anticipated, as are the construction of infrastructure and facilities to support onshore oil and gas operations.

Climate change effects across the North Slope would have a mixed effect on muskoxen; effects that are expected to be greater and more profound than all of the past, present, and foreseeable human activities combined. The effects of the Proposed Action on muskox would be negligible and would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of muskox during the 21st century, which in total represent minor impacts.

The effects of climate change on muskox populations could lead to stable or increasing herd sizes over the 21st century due to longer growing season, limited shrubland expansion onto the North Slope, and conversions of non-vascular and wetland plant communities to graminoid/forb-dominated communities which would provide more forage. The human activities that are expected to occur should have negligible levels of effect on muskox, while the Proposed Action would contribute a negligible level of effect. The cumulative effects of past, present, reasonably foreseeable activities, and the Proposed Action would amount to a minor level of effects on muskox.

5.2.7.3.3 Grizzly Bear

Grizzly bears can be affected by climate change in the Arctic. As sea ice losses continue to increase larger storm events may occur throughout the Arctic Ocean. Without sea ice to moderate the effects of winds on water, large waves and swells would develop which could impact coastal habitat over time. Such storms are more likely to deposit marine mammal carcasses and other food resources onshore that would have a positive effect on grizzlies scavenging carrion.

Increases in growing season length, temperatures, permafrost thawing, and increased precipitation could be advantageous to the production of vascular forage plants on summer ranges, which would be a positive effect for grizzlies. One effect of longer, warmer growing seasons with a deeper layer of thawed permafrost is increased root production which leads to shifts from non-vascular plants to vascular plants, and a shift to earlier plant emergence that could become an important source for grizzly bears emerging from hibernation. Increasing fire frequency could lead to the conversion of moss and lichen-dominated ecological communities, to graminoid and forb-dominated ecological communities.

Changes in long-term flora on the North Slope could affect prey species such as Arctic ground squirrels, muskox, moose, and caribou. Grizzlies would respond to the probable future fluctuations in prey species numbers by switching to other food sources such as salmon. They may also shorten their denning period in response to climate change effects to the duration and severity of winter. Under the current climate change projections, grizzly numbers could increase throughout the North Slope, providing they have access to sufficient numbers of prey animals and forage plants.

The changes in local subsistence economies described above in the caribou and muskox sections would also likely result in a smaller subsistence harvest of grizzly bears.

Recreational hunting of grizzly may increase or decrease in response to grizzly population fluctuations. Military and USCG operations on the ACP may have some minor effects on grizzly bears due to elevated levels of aircraft traffic. Other sources of aircraft traffic that could affect grizzlies would include more commercial flights into and out of North Slope communities, and flights supporting future industrial developments. Increasing numbers of vehicles, roads, and pipelines in association with onshore oil and gas developments are anticipated, as are the construction of infrastructure and facilities to support onshore oil and gas operations.

Climate change effects across the North Slope would have a mixed impact on grizzly bears and these impacts are expected to be greater than all of the other past, present, and foreseeable human activities combined. The effects of the Proposed Action on grizzlies would be negligible and would not appreciably add to, subtract from, or synergistically interact with the minor, but positive, climate change effects, and other negligible effects from past, present, or reasonably foreseeable future activities on North Slope grizzly bears during the 21st century.

Climate change would have minor, positive impacts on grizzly populations. Effects would likely include slight population increases over the 21st century due to improved biological productivity and the potential for larger, and more numerous Arctic ground squirrels, larger salmon runs, increased marine mammal carrion, and other food sources. The added quantities and availability of food would be a moderate level of positive effect of climate change for grizzly bears since the grizzly population would likely increase for an extended period of time. The human activities that are expected to occur would result in a negligible level of effect on grizzly populations, as would the Proposed Action. The contribution of the Proposed Action to cumulative effects of past, present, reasonably foreseeable activities, and climate change, amount to a minor level of beneficial effects on grizzly bears on the ACP and North Slope of Alaska.

5.2.7.3.4 Arctic Foxes

Furbearing mammals such as wolves, wolverines, Arctic foxes, red foxes, and lynx can be affected by climate change in the Arctic. Larger storms coming off the ocean are more likely to deposit marine mammal carcasses and other food resources onshore, which would be a positive effect for furbearers that scavenge carrion. Another positive benefit of climate change on furbearers would be the increased biological productivity that a warming climate would have throughout the terrestrial plant communities. Such productivity would initially include increased plant vegetative production, which in turn would provide increased forage for herbivores. Healthier and more abundant prey species, or new prey species, would then have beneficial effect on furbearing mammals such as foxes, wolves, wolverines, etc., through a more diverse and reliable diet. For example, a decrease in caribou numbers might be compensated for by increases in rodent, muskox, moose, or sheep numbers due to better range conditions and milder temperatures. For furbearers, having a resident population of prey species in addition to migratory caribou could mean consistent, high-quality nutrition throughout the year, rather than hunger interspersed with periodic episodes of feasting when caribou calve or migrate through an area, or when carrion becomes available.

Changes in local economics within Arctic communities are likely to have some effects to furbearers into the future. Increased financial resources would allow subsistence users and trappers to remain longer in the field, procure better equipment, and improve their trapping success. For trappers, this would then increase revenues within households.

Military and USCG operations on the ACP may have some minor effects on furbearers due to elevated traffic, though wolves, wolverines, and foxes can habituate to aircraft noise and presence (Manci et al., 1988; Churchill and Holland, 2003). Increasing numbers of vehicles, roads, and pipelines and other infrastructure in association with onshore oil and gas developments are anticipated. As with military infrastructure, developments such as buildings, berms, and other modifications to the landscape could provide foxes with new denning areas, which would have a positive effect on fox populations.

Climate change effects across the North Slope would have a positive impact on most furbearing mammals; effects that are expected to be greater than all of the past, present, and foreseeable local human activities combined. Increases in red fox numbers would likely result in lower numbers of Arctic foxes since red foxes predate and out-compete Arctic foxes in most areas where these species coexist. The effects of the Proposed Action on all furbearers would be negligible and would not appreciably add to, subtract from, or synergistically interact with other past, present, or reasonably foreseeable future activities, or climate change, to alter the condition of furbearers during the 21st century.

Climate change would have a moderate to major level of effects on Arctic foxes on Alaska’s North Slope. Effects would likely include population reductions over the 21st century due to increased competition with red foxes, changes in biological diversity, and changes to sea ice characteristics that would restrict the extent and duration of scavenging on sea ice, etc. The Proposed Action should not significantly add to the cumulative effects of climate change and the other impactors that have already been discussed. For these reasons, the cumulative effects of the Proposed Action, future activities, climate change, and other impactors would be moderate to major for Arctic foxes.

5.2.8 Vegetation and Wetlands

5.2.8.1 Summary of Impacts

The impacts of the Proposed Action on vegetation and wetlands in the area of the Proposed Action include destruction of a small amount of vegetation and wetlands during construction of gravel pads, excavation of the 21-acre gravel mine site, construction of Vertical Support Members Construction, use of ice roads and pads, potential for colonization by non-native, invasive species, and accidental small oil spills. These impacts result in a complete loss of the functional value of approximately 26 acres of wetlands for the Proposed Action. Given the limited extent of these impacts, the amount of undisturbed wetlands and vegetation in the onshore areas surrounding the Proposed Action, and the pristine condition of these wetlands and vegetation, the overall impacts are expected to be minor to moderate.

5.2.8.2 Discussion of Other Relevant Actions

5.2.8.2.1 Past and Present Actions

North Slope vegetation and wetlands have been impacted by human activities, including oil and gas exploration and development. Archaeological and paleontological digs, camps associated with scientific studies, recreational use, overland moves by transport vehicles, and use of off-highway vehicles such as four-wheel vehicles and snowmachines, have likely caused the loss of less than 100 acres of vegetation and wetlands in the NPR-A, according to the BLM (2012). Approximately 2,500 acres on the North Slope (1,800 acres of village and public facilities, and 700 acres of military facilities) have been directly impacted by these actions, and an additional 4,630 acres of wetland are indirectly affected by human activities occurring off gravel roads and pads. This loss of vegetative cover is likely to persist into the indefinite future. Oil and gas infrastructure accounts for the largest past and present impacts to vegetation and wetlands on the North Slope. BLM has estimated that through 2012, the footprint of oil and gas activities on the North Slope (to include roads, pads and oil fields near the Dalton Highway) is approximately 18,150 acres, and the total long-term impacts to wetlands from past and present oil and gas activities on the North Slope covers approximately 36,800 acres.

5.2.8.2.2 Reasonably Foreseeable Future Actions

The amount of area on the North Slope that would be disturbed by non-oil and gas activities is projected to increase by about 2 percent annually, approximately doubling to 3,600 acres by the mid-21st century when the human population may level off (BLM, 2012).

- A continued loss of minor amounts of vegetation would be expected on the North Slope from archaeological and paleontological digs, camps associated with scientific studies, recreational use and other activities, overland moves by transport vehicles, and use of off-highway vehicles such as four-wheel vehicles and snowmachines. In most cases, loss of vegetation would be temporary, lasting only a few years.
- Villages are likely to increase in size, encroaching on vegetation and wetlands.
- Air Force Radar Sites are not likely to expand. Other military facilities, villages, airstrips, and other non-oil and gas infrastructure are likely to persist into the indefinite future.

North Slope oil and gas development activities discussed above would contribute to cumulative effects to vegetation, due to: construction of ice roads, onshore pipelines, pads, roads and airstrips for both onshore and offshore development; gravel mines; dust and moisture regime changes; and invasive species.

If current rates of development and production continue into the future in the vicinity of the Colville River to the Canning River in the NPR-A, about 3,750 additional acres would be covered by gravel for construction of pads, roads, and airstrips, and 750 acres would be impacted by gravel mines and through dust and moisture. Impacts from ice road, ice pad, and ice airstrip construction in the federally managed NPR-A on Alaska's North Slope would occur on 232,710 to 458,003 acres of vegetation; these would be short-term impacts and would not accumulate (USDOI, BLM, 2012). In total, long-term impacts to vegetation from exploration and development combined would occur on greater than 0.12 percent to less than 0.26 percent of the NPR-A.

5.2.8.3 Analysis of Cumulative Impacts

The total amount of vegetation and wetlands on the North Slope impacted by oil and gas development and other activities is anticipated to increase. The contribution of the Proposed Action to wetland loss, disturbance, and degradation is negligible but would be additive to the impacts from past, present, and reasonably foreseeable actions. Vegetation and wetland habitat impacted by oil and gas exploration and development is relatively small compared to the amount of available habitat on the ACP in Alaska and on the North Slope as a whole. Impacts on vegetation and wetlands caused by the Proposed Action and other present and future oil activities could accumulate and persist, especially if structures remain after industrial activity has ceased.

5.2.8.4 Conclusion

Impacts to vegetation and wetlands of Alaska’s North Slope from the Proposed Action are not expected to add significantly to the impacts associated with other activities. Impacts to the vegetation and wetlands from oil and gas development and other activities are anticipated to continue into the future. Many of these impacts would be permanent, but it is anticipated that some disturbances to vegetated communities would be actively restored. While the cumulative impacts from the Proposed Action and other past, present, and reasonably foreseeable actions are additive, the total amount of disturbance area is small compared to the total amount of wetlands on the ACP. Therefore, the overall contribution of the Proposed Action to cumulative effects to vegetation is negligible. It is anticipated that the environmental changes associated with Arctic climate change would, in the long run, have the greatest potential to impact vegetation and wetlands on the North Slope.

5.2.9 Sociocultural Systems

5.2.9.1 Summary of Impacts

The primary subsistence activity that could be adversely affected by the Proposed Action is bowhead whaling conducted by crews from Nuiqsut near Cross Island (Table 4-39). If moderate to major impacts to subsistence from the Proposed Action from summer construction at the Proposed LDPI site were realized (Section 4.4.1), then effects to Nuiqsut’s established sociocultural system of social organization, cultural values, and formal institutions could be moderate to major. If minor to major effects from small spills to subsistence harvest patterns are realized as anticipated, then BOEM anticipates minor to major effects to occur to the sociocultural system for Nuiqsut.

Impacts to subsistence harvest patterns for Kaktovik and Utqiaġvik are anticipated to be less for routine activities and small spills associated with the Proposed Action than are anticipated for Nuiqsut. BOEM expects negligible impacts to the sociocultural systems for Kaktovik and Utqiaġvik as a result of routine activities associated with the Proposed Action. For small spills, BOEM anticipates negligible impacts to sociocultural systems for Kaktovik and Utqiaġvik. For Kaktovik, however, small spills of crude or refined oil could have minor to moderate effects on sealing and waterfowl hunting (Table 4-32). If these impacts were realized due to a small spill, then social organization and cultural values could be adversely affected in Kaktovik because of the importance of seals, geese, and eiders in traditional practices; impacts to the sociocultural system could be minor to moderate if hunters were present at the location of the spill when it occurred.

5.2.9.2 Discussion of Other Relevant Actions

Past, present and reasonably foreseeable infrastructure development projects across the North Slope include oil and gas development projects, marine vessel traffic, community development and capital improvement projects, and gravel mines. These various development projects are described in Section 5.1.2 and Table 5-1 through Table 5-11. Other relevant actions described in Section 5.2.10.2 for subsistence harvest patterns also apply to the discussion of cumulative effects to sociocultural systems.

Climate change would most likely be the largest contributor to cumulative effects on sociocultural systems in the North Slope Borough (NSB) during the lifetime of the Proposed Action (Gamble et al., 2008).

5.2.9.3 Analysis of Cumulative Impacts to Sociocultural Systems

Past, present, and future oil and gas activities, community development projects, growth in tax revenue, vessel traffic, homeland security and Coast Guard activities, and regional recreation and tourism, would most likely have impacts to sociocultural systems in the NSB during the lifetime of the Proposed Action. Regional demographic trends toward growth and increasing diversity from outside the NSB are likely to continue as more oil and gas activities and community development projects occur. In-migration from transient labor pools could increase, while out-migration of Alaska Native residents could also increase. Increased local tax revenues from new onshore energy infrastructure would likely be used to expand capital improvement projects and expand local infrastructure and services such as housing; water and sewage treatment; power supply; communication networks; road construction and maintenance; construction of airstrips, docks, and healthcare facilities; and public safety and search and rescue operations. Cumulative impacts from these activities are expected to be long lasting and widespread, and both adverse and positive. For example, increased income could be used to purchase hunting and fishing equipment for subsistence activities, but development of new employment opportunities could bring outside labor to the NSB, which could threaten Iñupiaq cultural values and social organization. Some adverse cumulative effects could be offset by beneficial effects.

For Nuiqsut, moderate to major potential impacts to subsistence whaling from the Proposed Action (Table 5-13) (if not reduced or avoided through appropriate mitigation measures) could combine with moderate cumulative impacts from past, present, and future oil and gas activities, vessel traffic, and other offshore activities to create major cumulative impacts to the sociocultural system. This is due to the importance of the fall bowhead hunt to Nuiqsut’s sociocultural system. Past, present, and future capital improvements and community development projects in Nuiqsut could offset some adverse and major cumulative impacts. Offsets would most likely result in overall moderate to major cumulative impacts to Nuiqsut’s sociocultural system.

The Proposed Action is expected to make little to no additional or countervailing contributions to moderate cumulative effects for Utqiaġvik and Kaktovik. This is because routine activities of the Proposed Action are expected to have only negligible to minor effects to sociocultural systems and subsistence practices for Utqiaġvik and Kaktovik (Table 5-13).

Climate change in the NSB has impacted the timing of animal migrations, access to subsistence resources, failure of village infrastructure, erosion of village land bases, and loss of food storage capacity related to permafrost decrease and ice cellar failure (ANTHC, 2014). As diminished sea ice coverage accelerates over time, several additional drivers of subsistence disruption are likely to occur from altered habitat and changes in wildlife distribution. Climate change could have regional sociocultural effects through increased economic activities such as commercial fishing, recreational fishing, renewable energy development, tourism, recreation, and marine shipping. These activities could require substantial levels of skilled labor and expensive infrastructure, which could add adverse and beneficial impacts to existing sociocultural patterns in the region. Climate change could have long lasting and widespread and thus moderate impacts on social organization, cultural values, and formal institutions.

For Nuiqsut, moderate to major potential impacts to subsistence whaling from the Proposed Action (if not reduced or avoided through appropriate mitigation measures) could combine with moderate cumulative impacts from climate change to create major cumulative impacts to the sociocultural system. This is due to the importance of the fall bowhead hunt to Nuiqsut’s sociocultural system and changing whaling and weather conditions related to climate change that tend to make fall whaling more difficult. Increased economic activities in the NSB brought on by a changing climate such as new job opportunities in recreation and tourism or commercial fishing could offset some adverse and major cumulative impacts. Offsets would most likely result in overall moderate to major cumulative impacts from climate change to Nuiqsut’s sociocultural system.

The Proposed Action is expected to have little to no additional or countervailing contributions to moderate cumulative effects from climate change for Utqiaġvik and Kaktovik, because it would most likely have little to no impact on sociocultural systems and subsistence whaling for these two communities.

5.2.9.4 Conclusion

The Proposed Action could change cumulative impacts to Nuiqsut’s sociocultural system from moderate to moderate to major. For Nuiqsut, overall cumulative effects to the sociocultural system could be moderate to major.

For Utqiaġvik and Kaktovik, overall cumulative impacts to sociocultural systems are expected to be moderate with negligible contributions from the Proposed Action.

5.2.10 Economy

5.2.10.1 Summary of Effects of the Proposed Action

The Proposed Action is expected to have negligible beneficial effects on State employment, labor income, and revenues. The beneficial impacts on NSB employment and income are likely to range from negligible to minor, while the beneficial impacts on NSB revenues are expected to translate to moderate impacts on the NSB economy. The Proposed Action is likely to have little to no impact on the population base of the State of Alaska or the NSB. Table 5-12 (identical to Table 4-36) provides a summary of the effects of the Proposed Action on these economic measures.

Table 5-12 Effects of the Proposed Action on Economic Measures

Economic Measure	State RA	NSB RA	State Small Oil Spills	NSB Small Oil Spills
Employment / Wages	Negligible	Negligible to Minor	Negligible	Negligible
Revenue	Negligible	Moderate	Negligible	Negligible
Population	Negligible	Negligible	Negligible	Negligible

Note: RA = Routine Activities

Overall, the Proposed Action is expected to have a negligible beneficial impact on the State economy and a negligible to moderate beneficial impact on the NSB economy.

5.2.10.2 Description of Other Relevant Actions

The Proposed Action could add incremental benefits to the economy beyond those anticipated to result from present and reasonably foreseeable oil and gas exploration, development, and production activities. The employment, labor income, and revenues from past and current projects—especially from those in northern Alaska—have been a critical part of the economy for the State of Alaska and the NSB for decades. These activities not only provide a significant portion of State employment and labor income, but also property taxes on support infrastructure provide the vast majority of revenues for the NSB government. In recent years, there has been a decline in oil and gas activities in Alaska. The Proposed Action would add production to that now flowing through TAPS, but a single project would not be sufficient to reverse the longer-term decline in oil production and related activities.

Employment and income from construction and development of infrastructure tend to be concentrated in the relatively short “development” period for oil and gas projects. Years of oil activity have resulted in a large base of existing infrastructure, some of which can be used for future projects, with or without refurbishment or upgrades. Most existing projects are in the much longer production phase, during which operations and maintenance activities require a lower level of employment over the remaining project life. However, the work required for decommissioning of existing projects would provide very short periods with increased employment and income relative to that in the production period.

There are numerous oil and gas projects in the NSB and adjacent State waters. Oil and gas activity is expected to continue on the North Slope and in nearby waters. In addition to production from existing projects, Mustang, Alpine CD-5, Greater Mooses Tooth, and numerous small fields are expected to add production in the next few years. The Point Thomson project, which began initial production in July 2016, as well as the Alpine project, could foreseeably produce oil and gas beyond the life of the Proposed Action, and the State of Alaska could foreseeably construct and operate a natural gas pipeline to bring Point Thomson gas to market in the future. Section 5.1.2.1 includes a discussion of past, present, and reasonably foreseeable future projects, as well as related infrastructure that has been, or would need to be, developed to support oil and gas development projects. For a list of past and present oil and gas facilities in production, see Table 5-3. For lists of projects in development and discoveries likely to be developed in the reasonably foreseeable future, see Table 5-4 and Table 5-5.

Infrastructure needed to support the Proposed Action and other projects described above could include offshore and onshore pipelines, gravel mines, permanent roads, temporary ice roads, facilities supporting additional vessel and air traffic, power plants, docks and hovercraft hangers, water and sewer projects, waste handling facilities, and other support facilities. Most of these already exist, but many would have to be refurbished, upgraded, and/or expanded. Furthermore, to the extent the existing workforce and population cannot supply needed labor, additional facilities and services would be needed to accommodate new workers and their families. The work required to provide the infrastructure and services would add to State and NSB employment and income, although much of that work would be short-term and could be done by people who do not live in the communities where the work takes place. Such infrastructure increases (or helps to maintain) a longer-term property tax base for the State and for the NSB, which depends heavily on revenues from taxes on oil-related facilities. That NSB government revenue, in turn, provides employment and income to NSB residents. This is true for onshore facilities resulting from the Proposed Action and any infrastructure that remains in place to be used for future onshore or offshore oil and gas production.

In addition to activities supporting oil and gas activities, there are—and would continue to be in the future—community development projects, local and tribal association activities, recreation and tourism, and other sources of employment and income that support NSB residents and provide new or upgraded infrastructure. Many, but certainly not all, of these are directly or indirectly possible because of NSB property tax receipts related to oil and gas activities. Some of the reasonably foreseeable infrastructure enhancements that are not directly in support of the oil and gas industry include:

- Housing
- Systems for water supplies, waste storage and disposal, electricity, and communication
- Deep water ports to accommodate increased marine vessel traffic
- Dock and port space
- Roads
- Airstrips to accommodate larger planes
- Infrastructure for logistical, search and rescue, and military support for onshore and offshore development projects

Other activities in the Arctic may increase or start up in the duration of the Proposed Action. If sea ice of the polar ice cap continues to recede, marine shipping is likely to increase. Infrastructure may need to be moved, modified, or rebuilt, and employment patterns might change somewhat due to a longer drilling season for offshore projects. Tourism and recreation are small components of the current Arctic economy but could expand modestly. In addition, commercial fishing, recreational fishing, mining, and renewable energy development may start up and expand. NOAA currently has a moratorium on commercial fishing in the Arctic but this is subject to change. These activities could also have economic impacts.

5.2.10.3 Analysis of Cumulative Impacts on Economy

Current and reasonably foreseeable projects would extend existing employment and labor income opportunities into the future, providing employment for drilling and construction activities as well as for operations and maintenance during the production phase. There would most likely be little to no, and thus negligible, contribution from the Proposed Action to cumulative effects on employment and income. In addition, much of the employment and income supporting the Proposed Action and other oil and gas projects and required for construction of related infrastructure likely would go to workers commuting from southeastern Alaska or out of state, where impacts would be negligible, due to the large employment base in those areas. NSB businesses and residents have provided certain types of support activities for such projects for decades, and the reasonably foreseeable new projects identified above would generally sustain, rather than drastically increase, employment opportunities for current and future NSB workers.

The development of new infrastructure would most likely provide short-term peaks in employment. The infrastructure needed for current and future projects would provide a long-term and critical source of property tax revenues for the State and the NSB. The NSB government and local communities substantially depend on those revenues, even more so than on employment opportunities oil and gas activities provide.

A long-term warming trend leading to melting of sea ice and sea-level rise could affect the structure of the economy, possibly reducing opportunities for traditional subsistence harvests on which many residents depend (see Section 5.2.11) but perhaps increasing the need for labor to modify or move existing—or build new—housing and facilities. This could create employment or increase opportunities for local residents and businesses which are able to adapt to changing conditions in the economy brought about by climate change. There might also be additional employment opportunities serving modest increases in tourism and vessel and vehicle travel. Based on past trends in NSB employment, any new employment and income opportunities would most likely only benefit a small number of long-time NSB residents due to competition with people living elsewhere.

Peak employment and related income would occur over only a few years and most of the longer-term direct production jobs are likely to be filled by workers who commute from southeastern Alaska or other parts of the U.S. However, the Proposed Action, and current and other future projects, could maintain existing employment opportunities for NSB residents. The property tax revenues collected by NSB from the infrastructure put in place or maintained as a result of the Proposed Action and other projects could provide long-lasting and widespread additional beneficial effects for those living in the NSB (Table 5-12). Not only would supporting facilities remain in the tax base for decades, tax revenues could be used to build and maintain local schools, roads, and other public facilities.

5.2.10.4 Conclusion

There would most likely be little to no, and thus negligible, contribution from the Proposed Action to cumulative effects on employment and income. The Proposed Action is likely to contribute a relatively small proportion of the total impacts to the economy from all past, present, and reasonably foreseeable oil and gas activities. Additive effects from the Proposed Action are anticipated to be negligible to the State economy and negligible to moderate to the economy of the NSB.

5.2.11 Subsistence Harvest Patterns

5.2.11.1 Summary of Impacts

Table 5-13 provides a summary of impacts to subsistence harvest patterns from the Proposed Action.

Table 5-13 Impacts to Subsistence Practices for Nuiqsut, Kaktovik, and Utqiaġvik

Community	Source of Impact[1]	Whaling	Sealing	Caribou Hunting	Fishing	Waterfowl Hunting
Nuiqsut	Proposed Action	Moderate to Major	Minor	Negligible	Negligible	Minor
	Small Spills	Minor to Major	Minor to Moderate	Negligible	Negligible[2]	Minor to Moderate
Kaktovik	Proposed Action	Negligible	Minor	Negligible	Negligible	Minor
	Small Spills	Negligible	Minor to Moderate	Negligible	Negligible[2]	Minor to Moderate
Utqiaġvik	Proposed Action	Negligible	Negligible	Negligible	Negligible	Negligible
	Small Spills	Negligible	Negligible	Negligible	Negligible[2]	Negligible

Notes: [1] The Proposed Action includes routine construction, development, production, and decommissioning; a number of small spills (i.e., <1,000 bbl) and one large spill (i.e., ≥1,000 bbl) are assumed to occur during the 25-year life of the Proposed Action.
[2] BOEM anticipates negligible impacts on subsistence fishing from small spills for Nuiqsut, Kaktovik, and Utqiaġvik. However, for subsistence fishers and community residents, stress and negative perceptions of contaminated Arctic cisco, Arctic char, and broad whitefish could be minor to major depending on the location of small spills.

5.2.11.2 Discussion of Other Relevant Actions

Past, present, and reasonably foreseeable development projects across the North Slope include oil and gas development and production projects, community development and improvement projects, and gravel mining projects to support these developments and other construction and infrastructure projects (Section 5.1.2, Table 5-1 through Table 5-11).

Currently, there are numerous fields producing oil on the North Slope and in nearshore areas of the Beaufort Sea, and additional fields could be developed during the 25-year life of the Proposed Action. North Slope oil and gas activities include the construction and operation of onshore and offshore pipelines, gravel mines, permanent roads, winter ice roads, construction of support facilities, and transportation activities involving surface vehicles, aircraft, or marine traffic along the coast or within the barrier islands. These activities have potential to add to the effects to subsistence harvest patterns described for the Proposed Action. This is especially the case for bowhead whaling activities and coastal caribou hunting during July and August.

The Point Thomson project, located approximately 60 miles east of Prudhoe Bay and 60 miles west of Kaktovik, began initial production in July 2016. The Point Thomson development could foreseeably produce oil and gas beyond the life of the Proposed Action. The State of Alaska could foreseeably construct and operate a natural gas pipeline to bring Point Thomson gas to market in the future. This could have additional impacts on caribou herds and habitat in the region.

Community and regional development and improvement projects are ongoing and could accelerate in the future. Infrastructure necessary to support demand for efficient energy and modernization of existing communities would most likely be constructed. Reasonably foreseeable construction and development activities on the North Slope could include:

- Gravel mines
- Power plants
- Modern housing
- Airports, helipads, and hangers
- Marine transportation improvements
- Docks and hovercraft hangers

- Search and rescue facilities
- Water and sewer projects
- Solid waste handling facilities
- Roads
- Schools
- Other infrastructure and capital improvements

Subsistence harvesters across the North Slope could benefit in many ways from construction of these facilities, but might also experience long lasting and widespread adverse impacts to subsistence harvest patterns unless government agencies actively solicit local perspectives and traditional knowledge to guide development, and use the information in siting of infrastructure, work timing, and implement other means to avoid or reduce effects on subsistence activities and harvest patterns.

5.2.11.3 Analysis of Cumulative Impacts to Subsistence Harvest

The actions described above, in combination with anticipated growth in vessel traffic, aircraft traffic, offshore shipping and national security activities, and regional recreation and tourism would most likely have adverse, widespread, and long-lasting cumulative impacts to subsistence activities and harvest patterns. Moderate cumulative impacts would be related to displacement of hunters and subsistence resources, altered habitats, potential contamination of hunting and fishing areas and animals used for subsistence, changes to how people access fish and wildlife, avoidance of subsistence resources near industrial developments, and climate change.

Present and future onshore and offshore oil and gas development projects on the North Slope could lead to construction of additional industrial infrastructure. Construction, operation, and associated vessel and aircraft traffic for these projects could have long lasting and widespread impacts to subsistence. Property tax revenue to the NSB from the Point Thomson project and other onshore industrial infrastructure could create adverse and beneficial effects for subsistence harvesters living in the NSB that could be long lasting and widespread.

For Nuiqsut, moderate to major potential impacts to subsistence whaling from the Proposed Action (Table 5-13) (if not reduced or avoided through appropriate mitigation measures) could combine with moderate cumulative impacts from past, present, and future oil and gas activities, vessel traffic, and other offshore activities to create major cumulative impacts to subsistence practices, especially bowhead whaling. This is due to the importance of the fall bowhead hunt to Nuiqsut's subsistence way of life and sociocultural system. Past, present, and future capital improvements and community development projects, and increased tax revenues from oil and gas developments could offset some adverse and major cumulative impacts. Additive effects and offsets would most likely result in overall moderate to major cumulative impacts to subsistence for Nuiqsut.

The Proposed Action is expected to make little to no additional contributions to moderate cumulative effects for Utqiaġvik and Kaktovik. This is because routine activities of the Proposed Action are expected to have only negligible or minor effects to subsistence activities and harvest patterns for Utqiaġvik and Kaktovik (Table 5-13).

Many of the current and foreseeable capital improvements would be specific to certain villages and would most likely have short-term and localized, and thus minor, cumulative effects. However, some community development projects such as new or expanded airports and marine transport infrastructure could have regional level cumulative effects, both adverse and beneficial, that could be long lasting and widespread, and thus moderate. This is especially the case for developments that would allow more people to settle in the communities of the NSB. There could be added competition for hunting and fishing opportunities.

Subsistence harvesters across the North Slope could experience moderate beneficial effects from construction and operation of improved facilities and utilities in communities. They might also experience moderate adverse impacts to subsistence harvest patterns if community development projects are completed without input by local residents. Developers would need to actively solicit local perspectives and traditional knowledge to guide community development and to site facilities, develop project timelines, and implement measures to avoid or reduce effects to subsistence activities and harvest patterns. The Proposed Action will most likely have little to no added contribution to adverse cumulative effects from community development projects because it is located far from the communities. The Proposed Action will most likely have little to no additional beneficial effects because it will not substantially increase revenue or employment in the NSB.

Communities in the NSB are vulnerable to climate change through impacts to hunting, fishing, and cultural connections to lands and waters. Climate change has affected timing of animal migrations, access to subsistence resources, failure of village infrastructure, erosion of village lands, and loss of food storage capacity related to decreased permafrost and failure of ice cellars (ANTHC, 2014). Subsistence harvest opportunities may be affected by shifts in hunting seasons and harvest opportunities due to shifts in distribution or abundance of species used for subsistence purposes. Economic losses to communities due to increased travel times and fuel expenditures have occurred as fish and wildlife change their relative location and abundance. Changes in temperature, precipitation, landscape, and ice will most likely alter access to subsistence resources, including changes to wetlands or access to winter sea ice and frozen rivers used for travel by subsistence harvesters.

Climate change would most likely adversely affect caribou habitat and herds and marine mammal habitats and possibly abundance. Nuiqsut, Kaktovik, and Utqiaġvik rely upon caribou and marine mammals for subsistence. Reduced access to caribou and marine mammals and reduced success in harvests could be long lasting and widespread. Cumulative impacts to subsistence harvest patterns from climate change are anticipated to be moderate.

Loss of summer sea ice and an open Northwest Passage will continue to draw visitors to the region for recreation and tourism. Additional vessel traffic, especially cruise ships, small aircraft, and local barge and boat traffic, could impede subsistence harvests, because most visitor traffic would occur during prime harvest seasons for whales, seals, caribou, and fish. Pressure from increased recreational hunting and fishing and commercial hunting of big game could exacerbate adverse impacts to subsistence practices.

For Nuiqsut, moderate to major potential impacts to subsistence whaling from the Proposed Action (if not reduced or avoided through appropriate mitigation measures) could combine with moderate cumulative impacts from climate change to create major cumulative impacts to subsistence practices. This is due to the importance of subsistence practices to the sociocultural system and the vulnerability of the community to changing hunting and fishing conditions and changing weather conditions that make subsistence hunting and fishing more difficult.

The Proposed Action is expected to have little to no additional contributions to moderate cumulative effects from climate change for Utqiaġvik and Kaktovik, because the Proposed Action would most likely have negligible to minor impacts to subsistence practices for these two communities (Table 5-13).

5.2.11.4 Conclusion

The cumulative effects of oil and gas activities, community development, and climate change to subsistence harvest patterns would most likely be moderate. For Nuiqsut, the Proposed Action could change cumulative impacts to subsistence practices from moderate to moderate to major. For Nuiqsut, overall cumulative effects to subsistence could be moderate to major. For Utqiaġvik and Kaktovik, overall cumulative impacts to subsistence are expected to be moderate with negligible contributions from the Proposed Action.

5.2.12 Community Health

5.2.12.1 Summary of Impacts

Availability of, and access to, subsistence foods and other local subsistence resources are critical determinants of community health and cultural well-being in the NSB. Potential impacts to community health from the Proposed Action due to potential loss of subsistence bowhead harvests and other harvest opportunities could be moderate. Impacts of air pollution and emissions from routine construction, development, and production on community health are expected to minor. BOEM anticipates negligible impacts on community health related to water quality. Beneficial impacts to community health from revenue and economic growth are expected to range from negligible to moderate. Adverse impacts to community health related to economic growth would most likely be minor. Overall, impacts on community health as a result of the Proposed Action are anticipated to be negligible to moderate. Effects to community health from small accidental spills occurring during the life of the Proposed Action are expected to be minor.

5.2.12.2 Discussion of Other Relevant Actions

Past, present and reasonably foreseeable infrastructure development projects across the North Slope include oil and gas development projects, marine vessel traffic, community development and capital improvement projects, and gravel mines. These various development projects are described in Section 5.1.2 and Table 5-1 through Table 5-11. Other relevant actions described in Section 5.2.11 for subsistence harvest patterns also apply to the discussion of cumulative effects to community health.

Climate change would most likely contribute to cumulative effects to community health in the NSB during the lifetime of the Proposed Action (Gamble et al., 2008).

5.2.12.3 Analysis of Cumulative Impacts to Community Health

Past, present, and future actions, in combination with anticipated growth in vessel and aircraft traffic, national security activities, commercial shipping, and regional recreation and tourism, would most likely have adverse cumulative effects to community health for the NSB. These impacts could be long lasting and widespread, and thus moderate. Moderate cumulative impacts would be realized through displacement of subsistence resources, disruptions to subsistence activities, altered habitats, potential contamination of food resources, weakening of sharing networks, and possible avoidance of some resources by harvesters.

For example, future offshore development in Harrison Bay and north of the Colville River Delta could disrupt seal and migratory bird hunting for Nuiqsut. Onshore oil and gas activities could lower success in caribou hunting for Nuiqsut. These cumulative impacts could adversely affect community health through food insecurity, disruptions to social organization, and loss of cultural values related to a subsistence way of life.

Present and future development activities could generate new economic activity in the form of employment, labor income, commodity prices, and property tax revenues, which could further affect sociocultural systems and subsistence, and, by extension, community health in both adverse and beneficial ways. Increased local tax revenues from new infrastructure would likely be used to improve and upgrade local housing, schools, water and sewage treatment, power supply, communication networks, road construction, and medical and healthcare facilities. Beneficial effects of present and future actions could offset some adverse cumulative impacts to community health.

For the NSB, overall negligible to moderate impacts to community health from the Proposed Action (Section 5.2.12.1) are expected to contribute little to no cumulative impacts to health.

For Nuiqsut, moderate to major potential impacts to subsistence whaling from the Proposed Action (Table 5-13) (if not reduced or avoided through appropriate mitigation measures) could combine with moderate cumulative impacts from past, present, and future oil and gas activities, vessel traffic, and other offshore activities to create major cumulative impacts to community health. This is due to the importance of the fall bowhead hunt to Nuiqsut's food security, social organization, and cultural well-being, which largely determine overall health in Nuiqsut. Present and future infrastructure improvements and community development projects in Nuiqsut would most likely offset some adverse cumulative impacts to health. Offsets would most likely result in overall moderate but less than severe cumulative impacts to community health in Nuiqsut.

The Proposed Action is expected to make little to no additional contributions or offsets to moderate cumulative effects for Utqiaġvik and Kaktovik. This is because routine activities of the Proposed Action are expected to have only negligible to minor effects to sociocultural systems and subsistence practices for Utqiaġvik and Kaktovik (Table 5-13).

Climate change would most likely have widespread and long lasting adverse cumulative effects on community health in the NSB during the 25-year lifetime of the Proposed Action. As diminished sea ice coverage accelerates and temperatures warm over time, several additional drivers of impacts to subsistence harvest patterns, social organization, and cultural values could manifest as adverse impacts to community health such as food insecurity, decreased nutritional status, loss of traditional practices and sharing networks, or social and psychological stresses. For the NSB, the Proposed Action is expected to contribute little to no additional cumulative effects to community health related to climate change.

5.2.12.4 Conclusion

The past, present, and reasonably foreseeable future actions described above would most likely have moderate cumulative impacts to community health in the NSB. Overall, the Proposed Action is expected to contribute negligible cumulative effects to community health.

5.2.13 Environmental Justice

Past, present, and future actions affecting Nuiqsut and Kaktovik are most relevant because these are the EJ communities located nearest the Proposed Action Area.

Past, present, and future actions that could cumulatively affect Nuiqsut and Kaktovik include oil and gas activities, increased marine vessels and aircraft traffic, and climate change.

Nuiqsut is located in an expanding area of oil and gas exploration and development onshore (e.g., Alpine and Northwest NPR-A). The Point Thomson Project is located in the traditional hunting and fishing grounds of both Nuiqsut and Kaktovik. Nearshore and onshore oil and gas development along with seismic exploration activity and potential drilling operations offshore Kaktovik will most likely have adverse cumulative effects on these EJ communities that are long lasting and widespread.

For Nuiqsut, it is possible the Proposed Action could increase moderate cumulative effects to moderate to major cumulative effects if routine activities have moderate to major impacts to subsistence whaling (if not reduced or avoided through appropriate mitigation measures). This is the case for both subsistence whaling and the sociocultural system for Nuiqsut (Section 5.2.9.4 and Section 5.2.11.4). As a result, there could be disproportionately high and adverse cumulative effects to Nuiqsut.

Climate change would most likely cause disproportionate high and adverse environmental and health effects to subsistence harvesters in Nuiqsut, Kaktovik, and across the North Slope (ANTHC, 2014; Gamble et al., 2008; Trainor et al., 2007). The effects of climate change in the NSB would most likely be long-term and widespread, and thus moderate.

5.2.13.1 Conclusion

Residents of Nuiqsut could experience disproportionately high and adverse cumulative effects due to possible major cumulative impacts to the sociocultural system and subsistence activities and harvest patterns (Section 5.2.9.3 and Section 5.2.11.4). Residents of Kaktovik would most likely not experience disproportionately high and adverse cumulative effects.

5.2.14 Archaeological Resources

5.2.14.1 Summary of Impacts

Direct effects to historical and archaeological resources include activities that physically impact the conditions or the integrity of the resource. Anything that involves ground disturbance in a previously undisturbed area could be subject to archaeological surveys, analysis, reports, and consultation for compliance with Section 106 of the National Historic Preservation Act (NHPA) of 1966 as amended, as any of these activities could result in direct effects to surface or subsurface historic or archaeological resources, either on- or offshore.

Impacts to historic and archaeological resources resulting from implementation of the Proposed Action would not add to any existing disturbances in the Proposed Action Area and thus not contribute to any ongoing cumulative impacts to archaeological resources.

5.2.14.2 Discussion of Other Relevant Actions

Infrastructure necessary to support Arctic expansion and modernization of existing communities would continue to be constructed. Most, if not all, of these projects would require a Federal license, permit, funds or otherwise be linked to Federal involvement, and thus would be under the auspice of the NHPA and its implementing regulations. Climate change, with resultant loss of summer sea ice and an open Northwest Passage, would likely draw visitors associated with recreation and tourism industries. Many of these may well be outside of the purview of the NHPA, yet would have the potential to cause adverse impacts to historic and archaeological resources.

Climate Change is the reasonably foreseeable event with the greatest potential to both change the baseline and result in adverse effects to both on and offshore historic and archaeological resources. Melting permafrost, rising sea levels, shoreline erosion, storm surges, drying of lakes and ponds, and changing of river courses all have the present and reasonably foreseeable future effect of destroying, flooding, or altering the context and integrity of historic and archaeological resources. These adverse impacts would occur regardless of Federal oversight, and a great many historic and archaeological resources, previously unidentified and undocumented, could be lost.

5.2.14.3 Analysis of Cumulative Impacts

In general, impacts to archaeological resources would be managed under NHPA with associated inventory, assessment, evaluation of effects, and mitigation plans. With regard to climate change, adverse effects on historic and archaeological sites have been and will continue to be uncontrolled and undocumented. There are no comprehensive plans underway to organize broad scale efforts to identify, document, and assess vulnerable and threatened sites. Despite this drawback, it can be assumed that the number of historic and archaeological resources would increase through identification efforts resulting from federally-licensed, leased, permitted, and funded activities. The historic preservation process is fundamental to providing greater insight and understanding of the past. The discovery of any archaeological site in the Beaufort Sea, for example, would have profound significance in providing insight into the earliest human expansion to what is now North America. Thus, while effects on historical and archaeological sites would be major if they were to receive direct adverse impacts, the overall effect of knowledge gained from site identification during planning stages would represent a countervailing effect by contributing in a major way toward unlocking the secrets of the past.

5.2.14.4 Conclusion

The contribution of activities associated with the Proposed Action to cumulative effects on historic and archaeological resources would range from negligible to major, depending upon the ability to identify, avoid, or mitigate historic and archaeological resources during the early planning stages. With the safeguards already in place through NHPA and the Federal permitting process, the activities associated with the Proposed Action are unlikely to produce harmful effects. However, if an unknown site is impacted by the Proposed Action and the information that site could have provided is lost, then the overall contribution to cumulative impacts to archaeological resources would be major.

Chapter 6

Consultation and Coordination

List of Preparers

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CHAPTER 6. CONSULTATION, COORDINATION, LIST OF PREPARERS

6.1 Development of this EIS

The Liberty DPP FEIS was developed by BOEM, the lead agency, with five cooperating agencies. The Draft and released to the public on July 28, 2017 through a press release and posting on the Bureau's website at https://www.boem.gov/liberty/. The Final reflects BOEM's consideration of and response to public and cooperating agency comments received during the public comment period.

6.2 Consultation

BOEM has engaged in several consultation and coordination processes in regards to proposed activities in the Liberty Development and Production Plan. Below is a brief summary of how BOEM has satisfied, or will satisfy, its various consultation requirements.

6.2.6 Tribal Consultation

Executive Order 13175 requires Federal agencies to consult, on a government-to-government basis, with Federally-recognized Indian tribes (to include Alaska Native tribes) when developing Federal policies with tribal implications. The purpose is to "have an accountable process to ensure meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications."

BOEM determined that Development and Production activities in the Beaufort Sea could have tribal implications for the villages of Nuiqsut, Kaktovik, and Utqiaġvik. BOEM offered to consult with each of these tribal governments at venues within various North Slope villages, or alternatively, via telephone (an accepted communications practice among tribal members and within the villages of the North Slope Borough).

BOEM consulted tribal governments and ANSCA corporations as part of scoping activities in 2015. BOEM met with:

- Native Village of Kaktovik
- Native Village of Nuiqsut
- Native Village of Utqiaġvik
- Iñupiat Community of the Arctic Slope (note: also a Participating Agency)
- Arctic Slope Regional Corporation (ASRC)
- Nuiqsut – Kuukpik Corporation
- Kaktovik – Kaktovik Iñvirgiupiat Corporation
- Utqiaġvik – Ukpeaġvik Iñupiat Corporation (UIC)

BOEM extended both the 2016 public scoping period and the 2017 public comment period to accommodate requests from North Slope communities for additional time to provide comments. BOEM also participated in the Alaska Federation of Natives' Annual Convention and the Elders & Youth Convention to solicit further input on the project. BOEM consulted with the ASRC, a 10 percent working interest partner with Hilcorp and British Petroleum Exploration, Alaska.

During the 2017 public comment period, BOEM conducted consultations with:

- Native Village of Nuiqsut
- Native Village of Utqiaġvik
- Alaska Eskimo Whaling Commission (on behalf of the Iñupiat Community of the Arctic Slope)

- Arctic Slope Regional Corporation (ASRC)
- Nuiqsut – Kuukpik Corporation
- Utqiaġvik – Ukpeaġvik Iñupiat Corporation (UIC)

BOEM had planned to conduct consultations in Kaktovik, but was unable to visit the village due to weather. BOEM offered to travel to the village at another time, or schedule a consultation over the phone, but was turned down due to lack of interest.

The primary issues raised during consultation were:

- Subsistence: one major concern to North Slope communities are the potential impacts to bowhead whale migration routes and the potential impacts to subsistence whaling if bowheads are deflected due to project activities. In response to these concerns, HAK contracted an acoustic modeling report with the guidance of NMFS to evaluate the potential impacts to the bowhead whales from the Liberty Project.
- Oil Spills: the potential impacts of a very large oil spill would be extremely damaging. BOEM described the collaboration between BSEE, USCG, and the State of Alaska, to ensure that the Liberty Oil Spill Response Plan is appropriate and sufficient for the Liberty reservoir. BOEM also included the Solid Ice Condition in the DEIS to analyze the potential impacts of allowing drilling into the reservoir only during solid ice conditions, should it be carried forward in the Record of Decision for the project.
- Economics: North Slope communities expressed interest in the potential positive economic effects of the project. Several stakeholders requested to move different aspects of the project into State waters or lands to allow for taxation which would benefit the North Slope Borough.

In addition, BOEM contacted tribal governments and ANSCA corporations to provide updated timeline information in response to the FAST Act requirements.

6.2.7 ESA Section 7

Section 7(a)(2) of the ESA requires each federal agency to ensure that any action that it authorizes, funds, or carries out is not likely to jeopardize the continued existence of a listed species or result in the adverse modification of designated critical habitat. To satisfy its ESA obligations, BOEM and its cooperating agencies initiated formal consultation processes with NMFS and USFWS concerning activities described in the proposed DPP. Biological Opinions were issued on July 31, 2018 from NMFS and July 13, 2018 from USFWS.

6.2.8 Essential Fish Habitat Consultation

The Magnuson-Stevens Fishery Conservation and Management Act (as amended) requires Federal agencies to consult with NMFS regarding actions that may adversely affect designated Essential Fish Habitat (EFH). BOEM prepared an EFH assessment that identified potential adverse effects to designated EFH from activities proposed in the DPP. NMFS provided feedback, including the addition of potential mitigation measures to prevent the spread of invasive species. The EFH consultation concluded on January 25, 2018.

6.2.9 Section 106, National Historic Preservation Act Consultation

The National Historic Preservation Act requires Federal agencies to consult with the appropriate State Historic Preservation Officer (SHPO) regarding any agency undertaking with the potential to affect historic properties. On June 2, 2017, BOEM transmitted a “no effects” determination to the Alaska State Historic Preservation Office (AK SHPO) through a letter detailing the Liberty Development and Production Plan (Proposed Action) and all Action Alternatives (Alternatives 3-5). On July 6, 2017, BOEM received a concurrence from the AK SHPO of no historic properties affected by the Proposed Action or Action Alternatives.

6.3 Document Preparers

BOEM staff with expertise in the appropriate scientific, economic, and sociocultural disciplines contributed to the development of this EIS and the analysis herein. Table 6-1 lists the primary individuals involved in preparing and reviewing the Liberty EIS.

Table 6-1 Primary Contributors to this EIS

Name	Title
Lauren Boldrick	Project Manager
Jeff Brooks	Sociocultural Specialist
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The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island communities.

The Bureau of Ocean Energy Management Mission

The Bureau of Ocean Energy Management (BOEM) manages development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.