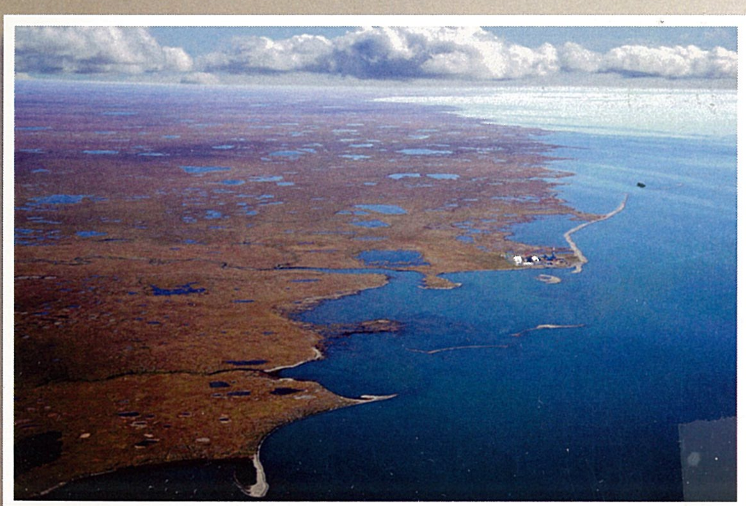

POINT THOMSON PROJECT EIS

Draft Environmental Impact Statement

TOC - Chapter 3

VOLUME I

November 2011

US Army Corps of Engineers

POINT THOMSON PROJECT EIS

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Draft Environmental Impact Statement

United States Army Corps of Engineers

Alaska District, Alaska Regulatory Division CEPOA-RD

Post Office Box 6898

JBER, AK 99506-0898

November 2011

Draft Environmental Impact Statement
Point Thomson Project

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Project Location:	North Slope, Alaska
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Date Draft EIS Filed with EPA:	November 10, 2011
Date by Which Comments Must be Received:	January 3, 2012

Abstract

The U.S. Army Corps of Engineers, Alaska District, Regulatory Division (Corps) received a permit application from the Exxon Mobil Corporation and PTE Pipeline LLC (Applicant) to discharge dredged and/or fill material into waters of the United States (US) and to construct structures in navigable waters of the US, in connection with the their proposed Point Thomson Project. The Corps, as part of its permit application review process, developed this Draft Environmental Impact Statement (EIS) in compliance with the National Environmental Policy Act (NEPA). The Applicant's proposed project involves infrastructure development to produce liquid hydrocarbon resources (natural gas condensate and oil) from the Thomson Sand Reservoir near Point Thomson, Alaska, a local geographic landform. The proposed project includes

construction of gravel pads, roads, and an airstrip; a gravel mine; pipelines; a marine docking facility; seasonal ice roads and pads; and production infrastructure. The project area is located on the Beaufort Sea coast of Alaska's Arctic Coastal Plain, 60 miles east of Prudhoe Bay and 60 miles west of Kaktovik.

Alternatives evaluated in this Draft EIS include a No Action Alternative and four action alternatives consisting of a combination of well and hydrocarbon processing pad configurations. The Central Pad would be the largest pad in all the action alternatives and the primary location for construction, staging, drilling, processing fluids, and operational activities. Each action alternative would have a minimum of five wells capable of either extraction or injection (natural gas recycling). Additionally, one disposal well would be drilled at the Central Processing Facility (CPF). Production and injection wells would be drilled using directional drilling techniques to reach the reservoir, which is mostly offshore. The East and West Pads would include well drilling to initially delineate and evaluate the reservoir and then to determine whether the rim of oil surrounding the gas reservoir would be viable for production. The gravel pads and airstrip would be connected by gravel roads or seasonal ice roads. Access to the CPF from Deadhorse, AK would be by a combination of a seasonal ice road, seasonal barging, and/or all season gravel road. Each alternative would include a configuration of infield gathering lines to bring produced fluids from the well pads to the CPF. An export pipeline would transport natural gas condensate and/or crude oil to a common carrier export pipeline with a connection to the Trans Alaska Pipeline System at Prudhoe Bay for shipment to market.

This Draft EIS analyzes potential impacts to the human and the natural environments that could result from the Applicant's proposed project and the alternatives developed. Alternatives were developed based on comments received from the public and resource agencies during the scoping phase of the Draft EIS. All of the action alternatives are compared to the environmental impacts associated with the No Action Alternative, which would primarily involve long-term monitoring of the existing wells at the Point Thomson site. The Draft EIS also presents the Applicant's proposed design measures to avoid or minimize impacts from the proposed project. These design measures have been included in the analyses of impacts. The Corps encourages the public and agencies to propose additional mitigative measures to avoid, minimize, or compensate for potential impacts to the environment.

Responsible Official for EIS: Reinhard W. Koenig

Reinhard W. Koenig
Colonel, Corps of Engineers
District Engineer

Contents

Tables

Figures

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Appendices

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Acronyms and Abbreviations

°	degrees
°C	degrees Celsius
°F	degrees Fahrenheit
AAAQS	Alaska Ambient Air Quality Standards
AAC	Alaska Administrative Code
ARRC	Alaska Railroad Company
ac	acre
ACIA	Arctic Climate Impact Assessment
ACMP	Alaska Coastal Management Program
ACP	Arctic Coastal Plain
ACS	American Community Survey
ADCCED	Alaska Department of Commerce, Community, and Economic Development
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADHSS	Alaska Department of Health and Social Services
ADLWD	Alaska Department of Labor and Workforce Development
ADNR	Alaska Department of Natural Resources
ADOR	Alaska Department of Revenue
ADOT&PF	Alaska Department of Transportation and Public Facilities
ADT	average daily trips
AEA	Alaska Energy Authority
AEWC	Alaska Eskimo Whaling Commission
AF	Arctic Foothills
AFMP	Arctic Fisheries Management Plan
AFN	Alaska Federation of Natives
agl	above ground level
AHDR	Arctic Human Development Report
AHRS	Alaska Heritage Resources Survey
AIA	Anchorage International Airport
AIRFA	American Indian Religious Freedom Act
AKNHP	Alaska Natural Heritage Program
ANC	Anchorage International Airport
ANCSA	Alaska Native Claims Settlement Act
ANHP	Alaska Natural Heritage Program
ANILCA	Alaska National Interest Lands Conservation Act
AO	Arctic Oscillations
AOGCC	Alaska Oil and Gas Conservation Commission

AOGCM	atmospheric-ocean global climate models
AOHA	Alaska Office of History and Archaeology
API	Alaska Petroleum Institute
Applicant	Exxon Mobil Corporation
Arctic Refuge	Arctic National Wildlife Refuge
ARPA	Archaeological Resources Protection Act
ARRC	Alaska Railroad Corporation
AS	Alaska Statute
ASNA	Arctic Slope Native Association
ASRC	Arctic Slope Regional Corporation
ASSt	Arctic Small Tool tradition
ATSDR	Agency for Toxic Substances and Disease Registry
ATV	all-terrain vehicle
AWC	Anadromous Waters Catalog
BA	Biological Assessment
BACT	best available control technology
bbl	barrel
BCB	Bering-Chukchi-Beaufort
BCC	Birds of Conservation Concern
Bcfd	billion cubic feet per day
BIA	Bureau of Indian Affair
BLM	Bureau of Land Management
BMI	Body Mass Index
BMPs	best management practices
BOD	biochemical oxygen demand
BOEMRE	Bureau of Ocean Energy Management, Regulation, and Enforcement
BOWFEST	Bowhead Whale Feeding Ecology Study
BP	before present
bpd	barrels per day
BPIFWG	Boreal Partners in Flight Working Group
BPXA	BP Exploration (Alaska)
CAA	Clean Air Act
CAH	Central Arctic Herd
CCP	Central Compressor Plant
CCP	Comprehensive Conservation Plan
CDP	census-designated place
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act

CESQG	conditionally exempt small quantity generator
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH_4	methane
CIFAR	Cooperative Institute for Arctic Research
cm/yr	centimeters per year
cm/sec	centimeters per second
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
COPD	chronic obstructive pulmonary disease
Corps	U.S. Army Corps of Engineers
CORRACTS	Corrective Action Tracking System
CPF	Central Processing Facility
CPUE	catch per unit effort
CWA	Clean Water Act
cy	cubic yards
DA	Department of the Army
DASAR	directional autonomous seafloor acoustic recorders
dB	decibel
dBA	A-weighted decibel
DCS	digital cellular service
DEIS	draft environmental impact statement
DEW	distant early warning
DMLW	Division of Mining, Land, and Water
DMTS	DeLong Mountain Transportation System
DO	dissolved oxygen
DOD	Department of Defense
DOI	Department of Interior
DOT	Department of Transportation
DPS	distinct population segments
EA	Environmental Assessment
EEZ	Economic Exclusive Zone
EFH	essential fish habitat
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency
ER	Environmental Report

ERNS	Emergency Response Notification System
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FERC	Federal Energy and Regulatory Commission
FIA	Fairbanks International Airport
FLIR	forward-looking infrared
FONSI	Finding of No Significant Impact
fps	feet per second
FR	Federal Register
FRP	Facility Response Plan
FRPL	Free and Reduced-Price Lunch
FS	featured species
ft^3	cubic feet
GHG	greenhouse gas
GMT	Greater Mooses Tooth
GMU	Game Management Unit
GPS	Global Positioning System
HAP	hazardous air pollutant
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEC	Health Effects Categories
HFC	hydrofluorocarbons
HFE	hydrofluorinated ethers
HIA	Health Impact Assessment
HLA	Harding Lawson Associates
HP	high pressure
HRZ	Highly Radioactive Zone
HSM	horizontal support member
Hz	Hertz
HUD	Housing and Urban Development
IAP	Integrated Activity Plan
IBA	Important Bird Areas
IBC	International Building Code
ICAS	Inupiat Community of the Arctic Slope
ICS	Incident Command System
IFC	International Finance Corporation
IFR	instrument flight rules
IHA	Incidental Harassment Authorization
IHLC	Inupiat History, Language, and Culture Division

IHS	Indian Health Services
IMR	infant mortality rate
IPCC	Intergovernmental Panel on Climate Change
IRS	Internal Revenue Service
JPO	Joint Pipeline Office
KC	Kuukpik Corporation
kHz	kilohertz
KIC	Kaktovik Iñupiat Corporation
KOP	key observation point
KSOP	Kuukpik Subsistence Oversight Panel
kt	knots
kV	kilovolt
kW	kilowatt
L_{50}	hourly median noise
LC_{50}	lethal concentration of 50 percent
LD_{50}	lethal dose of 50 percent
L_{dn}	Day-Night Average Noise Level(s)
LEDPA	least environmentally damaging practicable alternative
LEK	local environmental knowledge
L_{eq}	equivalent noise level(s)
LER	local equipment room
LFA	Lead Federal Agency
L_{min}	Minimum Sound Pressure Levels
L_{max}	Maximum Sound Pressure Levels
L_{nat}	natural ambient noise
LOA	Letter of Authorization
LP	low pressure
LQG	large quantity generator
LRD	long-reach directional
m	meters
MAAT	mean annual air temperatures
MACT	Maximum Achievable Control Technology
MAR	minimally attended radar
mcy	Million cubic yards
MCL	maximum contaminant level
MG	million gallons
mg/l	milligrams per liter
MHW	mean high water

mi^2	square miles
MLLW	mean lower low water
MMBtu	million British thermal units
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
mmscfd	million standard cubic feet per day
mph	miles per hour
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSL	mean sea level
MW	megawatts
N_20	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAO	North Atlantic Oscillations
Navaid	navigational aid
NBS	Northern Beaufort Sea
NCDC	National Climatic Data Center
ND	not dated
NDVI	Normalized Difference Vegetation Index
NEPA	National Environmental Policy Act
NETL	National Environmental Technology Laboratory
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NF_3	nitrogen trifluoride
NFRAP	No Further Remedial Action Planned
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
N_2O	nitrogen dioxide
NO_x	nitrogen oxide(s), including NO and NO_2
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPFMC	North Pacific Fisheries Management Council
NPL	National Priorities List
NPR-A	National Petroleum Reserve – Alaska
NPS	National Park Service
NRC	National Research Council
NRCS	National Resources Conservation Service

NRHP	National Register of Historic Places
NSB	North Slope Borough
NSPS	New Source Performance Standards
NSR	New Source Review
NTU	nephelometric turbidity unit
NWI	National Wetland Inventory
O_3	ozone
O&M	operation and maintenance
OCC	Operations Control Center
OCS	Outer Continental Shelf
OCSEAP	Outer Continental Shelf Environmental Assessment Program
ODPCP	Oil Discharge Prevention and Contingency Plan
OFC	Office of the Federal Coordinator
OHA	Office of History and Archeology
OHMP	Office of Habitat Management and Permitting
OPA	Oil Pollution Act
ORL	Owner Requested Limit
OSRO	oil spill response organizations
PA	Programmatic Agreement
PA	public address
PACS	Potentially Affected Communities
PADS	PCB Activity Database System
Pb	lead
PBCH	Polar Bear Critical Habitat
PBWIP	Polar Bear Wildlife Interaction Plan
PCB	polychlorinated biphenyls
PCS	process control system
PDEIS	Preliminary Draft Environmental Impact Statement
PDO	Pacific Decadal Oscillation
PF	power facility
PFC	perfluorocarbons
PFD	permanent fund dividend
PGA	peak ground acceleration
PH	Porcupine Herd
PM	particulate matter
PM_{10}	particles of 10 micrometers (microns) or less
$PM_{2.5}$	particles less than 2.5 micrometers (microns) in aerodynamic diameter
POL	petroleum oil lubricants

POW-D	Brownlow Point
ppm	parts per million
ppmw	parts per million by weight
ppt	parts per thousand
project	Proposed Point Thomson Project
PSB	Priority Shorebirds
PSD	Prevention of Significant Deterioration
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
PTU	Point Thomson Unit
PWD	Public Works Department
QCEW	Quarterly Census of Employment and Wages
QI	Qualified Individual
RCG	Regulatory Control Group
RCRA	Resource Conservation and Recovery Act
RD	Resource Development
RFFA	reasonably foreseeable future action
RFI	Request for Information
RHA	Rivers and Harbors Act
RMG	Resource Management land
ROD	Record of Decision
ROW	right of way
RS	Revised Statute
SARA	Superfund Amendments and Reauthorization Act
SBS	Southern Beaufort Sea
SCADA	Supervisory Control and Data Acquisition
SDC	Steel drilling caisson
SDH	social determinants of health
SDWA	Safe Drinking Water Act
SF6	sulfur hexafluoride
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SITREP	Situation Report
SLiCA	Survey of Living Conditions in the Arctic
SO_2	sulfur dioxide
SOI	Shell Oil Incorporated
SOI	Statistics of Income

SPCC	Spill Prevention Control and Countermeasures
SPCO	State Pipeline Coordinator's Office
SPL	sound pressure level
SPMT	self-propelled modular transporters
SQG	small quantity generator
SRRS	short-range radar site
SSC	species of special concern
State	State of Alaska
STI	sexually transmitted infections
SWE	snow-water equivalents
SWF/LF	Solid Waste Facilities/Landfill Sites
SWPPP	Storm Water Pollution Prevention Plan
TAPS	Trans Alaska Pipeline System
TB	Technical Brief
TDS	total dissolved solids
TERA	Troy Ecological Research Associates
TH	Teshekpuk Herd
TLUI	Traditional Land Use Inventory
TMDL	total maximum daily load
TNHA	Tagiugmiullu Nunamiullu Housing Authority
tpy	tons per year
TRIS	Toxic Chemical Release Inventory System
TSD	treatment storage and disposal
TSS	total suspended solids
TWUP	temporary water use permits
µg	micrograms
U.S.	United States
UAR	unattended radar
UCU	unified coding unit
UHF	ultra high frequency
UIC	underwater injection control
ULSD	ultra low sulfur diesel
USAF	United States Air Force
USC	United States Code
USCG	United States Coast Guard
USDOT	United States Department of Transportation
USDW	underground source of drinking water
USFWS	United States Fish and Wildlife Service

USGS	United States Geological Survey
Vc	crustose lichens
Vd	fruticose lichens
VFR	visual flight rules
VHF	very high frequency
VOCs	volatile organic compounds
VSM	vertical support member
WAH	Western Arctic Herd
WL	Watch List
w/m^2	watts per square meter
WQS	water quality standards
YOY	young-of-the-year
$\mu g/m^3$	micrograms per cubic meter
µPa	micropascals
µS/cm	microsiemens per centimeter
µS/m	microsiemens per meter

Chapter 1. Purpose and Need

1.1 PROJECT DESCRIPTION

Exxon Mobil Corporation and PTE Pipeline LLC (the Applicant) submitted an application to the U.S. Army Corps of Engineers, Alaska District, Regulatory Division (Corps) for authorization to fill wetlands and waters of the U.S. under Section 10 of the Rivers and Harbors Act (RHA) and Section 404 of the Clean Water Act (CWA) for the Point Thomson Project in Alaska. This chapter provides an overview of the Point Thomson Project, and identifies the purpose of and need for the project (Section 1.2) as required by the National Environmental Policy Act (NEPA) and Section 404 of the CWA.

1.1.1 Project Background

The State of Alaska first leased land for oil and gas exploration in the Point Thomson area in 1965 and approved the Point Thomson Unit in 1977. In April 2002, the U.S. Environmental Protection Agency (EPA) published a Notice of Intent (NOI) to prepare an environmental impact statement (EIS) in response to the Applicant's proposed development plans for the Point Thomson Unit and surrounding areas. The EPA was the lead federal agency (LFA) because the plans called for the potential designation of ocean-dredged material disposal site(s), which would have required EPA authorization under Section 102 of the Marine Protection, Research, and Sanctuaries Act (MPRSA). Preparation of the 2002 EIS was discontinued before its completion at the request of the Applicant.

In 2006, the Alaska Department of Natural Resources (ADNR) began an effort to terminate the Point Thomson Unit and leases, claiming the leaseholders had failed to drill, develop, and produce the Point Thomson Unit and leases in adequate time. Several years of appeals between the State of Alaska and the Point Thomson Unit Operator, Exxon Mobil Corporation, and working interest owners resulted in a court ruling that overturned the State's decision to revoke the Point Thomson Unit. The State of Alaska separately terminated the Point Thomson leases. The State issued a Conditional Interim Decision on January 27, 2009, reinstating two of the leases that were in dispute, pending new development at Point Thomson that would "provide for the drilling and producing from wells by 2014."

The Applicant subsequently developed a proposed project, based on its February 2008 Plan of Development. The proposed project would require authorization from the Corps under Section 10 of the RHA and Section 404 of the CWA but would not be subject to Section 102 of the MPRSA. Because the authorization from the Corps is now the major federal action, the Corps is the lead federal agency for this Draft EIS[1].

1.1.2 Project Description Summary: The Applicant's Proposed Action

The Applicant submitted a Project Description and draft Department of the Army (DA) permit application to the Corps and other agencies in October 2009. The final DA permit application is included in Appendix A. A brief description of the proposed project is provided below, and a complete description of the Applicant's proposed project appears in Chapter 2, *Alternatives*, and in the *Point Thomson Project Description* (ExxonMobil 2009a).

[1] The Corps published an NOI to prepare an EIS for the proposed Point Thomson Project in the Federal Register on Friday, December 4, 2009. Federal Register, Volume 34, Number 232, Pg 63737-63738.

The proposed project is located on the northern edge of Alaska's Arctic Coastal Plain (ACP), 60 miles east of Prudhoe Bay and adjacent to the Beaufort Sea (Figure 1.1-1). The Inupiaq place names for locations shown on Figure 1.1-1 and presented in text are provided in Appendix B. The Applicant's proposed project includes a central gravel pad for wells and facilities, two satellite gravel pads for wells, an airstrip, a service pier, a sealift facility and barge ***mooring dolphins***, a gravel mine site, infield gravel roads, and ***infield gathering pipelines***. The central pad would support processing and compression facilities, housing for workers, and support infrastructure for the satellite pads–one to the east and one to the west of the central pad. Offshore portions of the reservoir would be developed using ***long reach directional drilling***. A 22-mile-long export pipeline would be constructed to transport hydrocarbon liquids from Point Thomson to existing common carrier pipelines at the Badami Development to the west. The project would also include infrastructure such as communications towers and staging facilities at Badami, Prudhoe Bay, and/or Deadhorse.

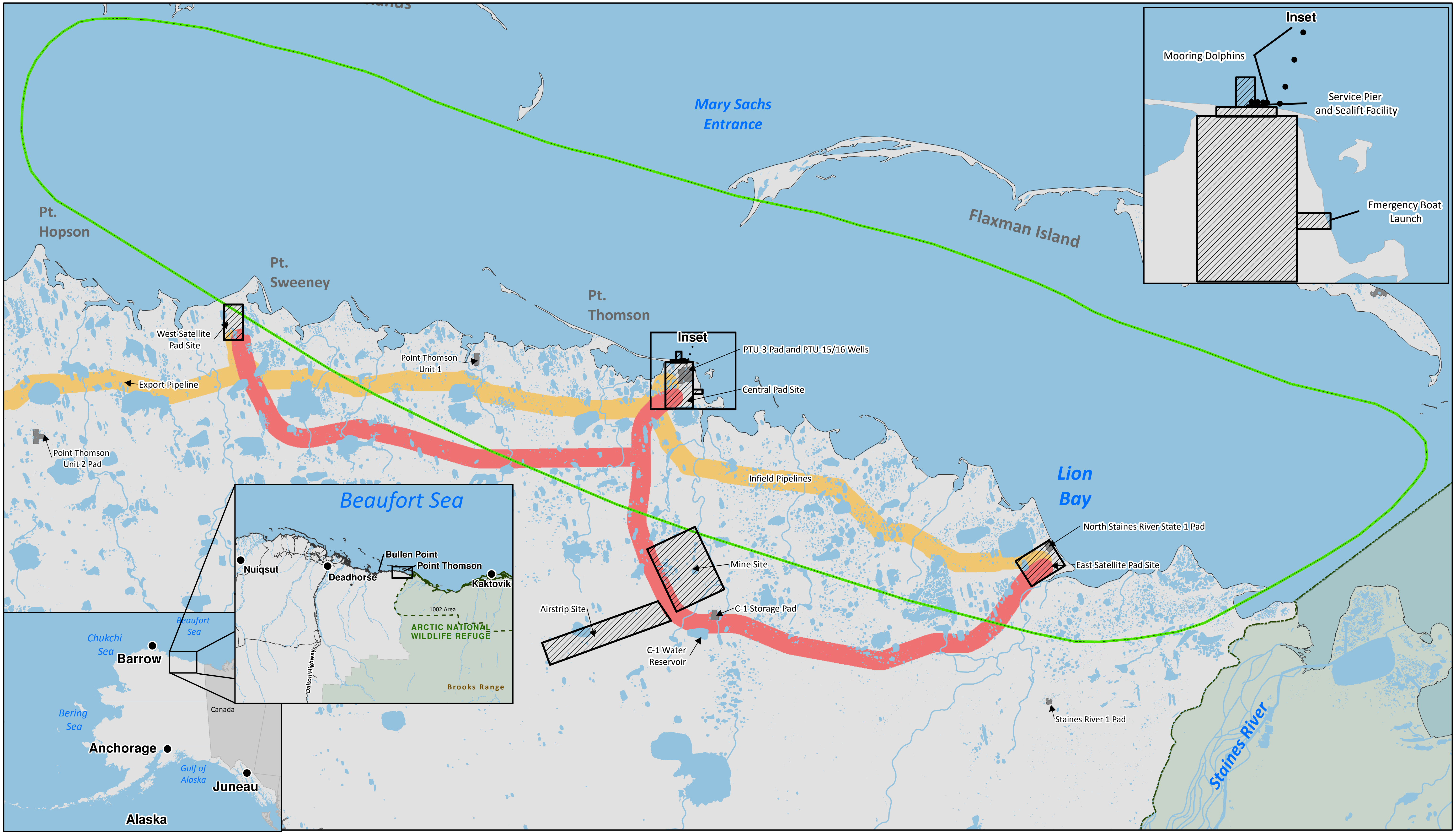

Figure 1.1-1

Point Thomson Project Location and Features

Date: 21 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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1.2 PURPOSE AND NEED

In accordance with NEPA, an EIS "shall briefly specify the underlying purpose and need to which the agency is responding" (40 CFR 1502.13). When considered together, the "purpose" and the "need" for the project establish the basic parameters for identifying the range of alternatives to be considered in an EIS.

The Corps understands the purpose of the Applicant's proposed project is to produce liquid hydrocarbons from the Thomson Sand Reservoir and further evaluate and delineate the reservoir and evaluate the Brookian Group sandstones. The need for the proposed project is to provide for increased domestic hydrocarbon production.

Corps regulations[2] require three ways of examining the underlying goals, or purpose, of a project: the Applicant's stated purpose and need, a "basic" purpose defined by the Corps specifically for addressing a project's water dependency, and an "overall" purpose, which is defined by the Corps and takes into account the Applicant's stated purpose and need (see Figure 1.2-1).

Interpreting the Applicant's Stated Purpose and Need. The Applicant's stated purpose and need is an expression, typically in the Applicant's own words, of the underlying goals for a proposed project. The Corps takes an applicant's purpose and need into account when determining the Corps' overall purpose. The Applicant's purpose and need is described in Section 1.2.1 below.

Defining the Corps' Basic Project Purpose. The Corps uses the basic project purpose to determine water dependency [40 CFR 230.10(a)(3)]. If a project is not water dependent, other alternatives that would not result in impacts to ***special aquatic sites*** are presumed to be available. The Section 404(b)(1) Guidelines say that practicable alternatives to nonwater-dependent activities are presumed to be available and to result in less environmental loss unless clearly demonstrated otherwise by the applicant [40 CFR 230.10 (a)(3)]. Section 1.2.2 below defines the Corps' basic project purpose as applied to the Applicant's proposed project.

The 404(b)(1) Guidelines are the substantive criteria that the Corps uses to evaluate a permit (see Appendix C, *Draft 404(b)(1) Evaluation*). The 404(b)(1) Guidelines establish two rebuttable presumptions: first, for a non-water-dependant project, the Guidelines presume that alternatives exist which do not require discharge into a special aquatic site. Second, the Guidelines presume that "upland" alternatives result in less environmental loss than lowland or wetland alternatives.

Defining the Corps' Overall Project Purpose. The Corps uses the overall project purpose to define alternatives for evaluation in an EIS and in the evaluation of the least environmentally damaging practicable alternative (LEDPA) under the Section 404(b)(1) Guidelines. According to Corps guidance in its 2009 Standard Operating Procedures, "The overall project purpose should be specific enough to define the applicant's needs, but not so restrictive as to constrain the range of alternatives that must be considered under the Section 404(b)(1) Guidelines. Defining the overall project purpose is the district's responsibility. However, the applicant's needs and the type of project being proposed should be considered." The Corps' overall project purpose more specifically addresses the applicant's purpose and need than does the Corps' basic project purpose. The Corps' overall project purpose, as applied to the Applicant's proposed project, is defined in Section 1.2.3 below.

[2] 33 CFR 325 Appendix B "NEPA Implementation Procedures for the Regulatory Program"; 40 CFR 230.10(a)

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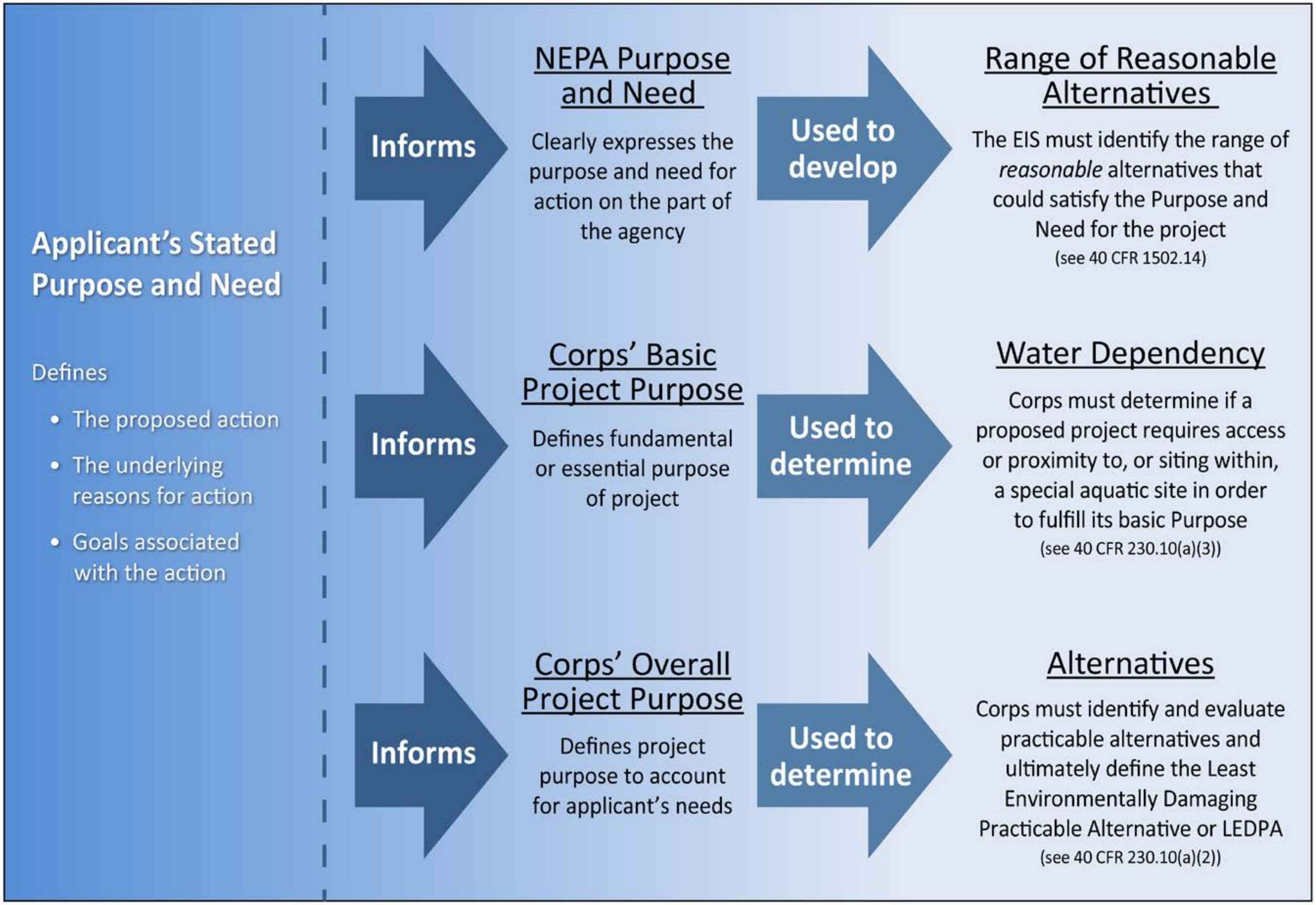

Figure 1.2-1: Applicant's Stated Purpose and Need

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1.2.1 Applicant's Stated Purpose and Need

The Applicant's stated purpose and need is a statement that defines the intent and underlying goals for a proposed project. The Applicant provided the project purpose and need in the Project Description dated October 19, 2009 and updated it for the Final Permit Application (Appendix A). The Applicant's stated purpose and need are as follows:

The Project will initiate commercial hydrocarbon production of the Thomson Sand Reservoir by the winter season of 2015-16. The Project will deliver liquid hydrocarbons to the TAPS [Trans Alaska Pipeline System] *Pump Station No. 1 at Prudhoe Bay for shipment to market. Initial production of liquid hydrocarbons is expected to be approximately 10,000 bpd* [barrels per day]. *The Project will delineate and evaluate hydrocarbon resources in the Point Thomson Unit* [PTU].

ExxonMobil as PTU operator and the PTU owners have committed to the production of liquid hydrocarbons from the Thomson Sand Reservoir by winter season 2015-16. The ADNR has recognized this commitment and has authorized production consistent with this schedule. The State's position is that production is required at the earliest feasible time. The proposed Project will achieve this important purpose.

Production of liquid hydrocarbons at Point Thomson serves other public purposes and needs. Development of this resource will help the United States (U.S.) meet domestic energy demand and reduce dependence on foreign sources of oil. Production at Point Thomson will help offset declining production from Alaska's North Slope reservoirs, and will help maintain the throughput of TAPS.

The Project will provide economic benefits to the state, North Slope Borough (NSB), and local communities through the creation of new jobs and tax revenues. The Project will provide an important source of employment for Alaska businesses, workers, and local residents. This will include both temporary jobs during drilling, engineering, procurement and construction, and long-term jobs supporting permanent operations. The Project will be a source of new revenue for the State of Alaska and the NSB, helping to offset declining revenue from existing hydrocarbon production and facilities.

ExxonMobil believes the Project represents the best plan for field development, considering geological, resource, commercial, and legal uncertainties. A principal goal of the Project is to establish a design footprint that facilitates future full development of the reservoir and delineation of the hydrocarbon resources of the Point Thomson Unit with the least practicable environmental impact. The Project's design and flexibility accommodates foreseeable options for production by winter season 2015-16 and beyond.

The Project features a three-pad configuration, the optimal development design for resource recovery, delineation and conservation, and encompasses the smallest footprint necessary for these purposes. The configuration of the Project is designed to delineate and produce reservoir resources by using LRDD [long-reach directional drilling] *techniques from onshore pads. While more direct access to the reservoir would be provided by offshore platforms, the approach chosen minimizes impacts in marine waters. The CPF* [Central Processing Facility] *is located on an expanded existing Central Pad, incorporating the recently drilled PTU-15 and PTU-16 wells.*

Development of the Point Thomson field resources beyond winter season 2015-16 is dependent on many factors that cannot be determined at present. Point Thomson is the largest discovered, undeveloped natural gas field in Alaska. No pipeline exists to bring Alaska North Slope natural gas to *market, and there is substantial uncertainty about whether or when such a pipeline may be constructed. Nevertheless, Point Thomson natural gas reserves are essential to the development of a gas pipeline. Should such a pipeline be built, natural gas from Point Thomson would be an important energy source for the U.S. and Alaska. Development of the Project can be expected to facilitate potential construction of a natural gas pipeline by providing an infrastructure footprint for potential future production of gas. However, gas production and delivery into a pipeline is not part of the project.*

1.2.1.1 Background Information on the Applicant's Stated Purpose and Need

The following paragraphs provide further information on the elements of the Applicant's purpose and need stated above.

Alaska state government and the NSB government are funded largely through royalties and taxes on hydrocarbons and oilfield property (DOE 2007; State of Alaska 2009). Declines in oil production have the potential for large effects to Alaska state public funds and any offsetting of declines or additions of infrastructure, as proposed, will serve the State's interest in producing state-owned hydrocarbons for the benefit of its residents.

One of the purposes of the proposed project is to further the evaluation of hydrocarbon resources to determine whether they can be produced in a commercial manner and to gather information needed to develop the optimum plan for producing the resource. The primary hydrocarbon resource at Point Thomson is natural gas and condensate from the Thomson Sand Reservoir. Oil is another hydrocarbon resource that may be present in two distinct geologic intervals, the Thomson Sand oil rim and the Brookian hydrocarbon sands. Evaluating these hydrocarbon resources includes identifying and assessing the location, size, and characteristics of the reservoirs and fluids contained therein and determining the commercial viability of producing those resources. Short-term and long-term flow tests will be required to further define the formation fluids and producing characteristics and to understand how the reservoir properties vary between wells.

The proposed project can stand alone as a gas cycling operation, in which condensate is extracted from the natural gas and the dry gas returned to the reservoir, irrespective of whether or when the Thomson Sand natural gas is produced for sale. The Applicant intends to produce and sell the gas condensate, with initial production targeted at 10,000 bpd from a central well, while maintaining the ability to produce natural gas in the future should the required infrastructure be put in place to transport natural gas to market. The Point Thomson development has the potential to produce hydrocarbons for sale on the open market, thereby meeting the Applicant's need to provide a financial return for its investors.

Hydrocarbons from the North Slope have contributed a substantial share of U.S. domestic production since the 1970s—as high as 25 percent, now reduced to 17 percent or less with declines in oil production (DOE 2007). In the near-term, production at Point Thomson will help offset current declines in North Slope production, while maintaining efficiency of the TAPS. In the long-term, domestic hydrocarbon resource development and production will continue to play a strong role in offsetting future foreign imports (DOE 2009).

1.2.2 Corps' Basic Project Purpose and Water Dependency

The Point Thomson Project's basic project purpose as defined by the Corps is to produce and transport hydrocarbon liquids, and to ***delineate*** and test for oil and natural gas extraction. In general, recovery and transport of hydrocarbon resources do not require access or proximity to a special aquatic site. Therefore, the Corps finds that the basic purpose of the project is not water dependent.

The Thomson Sand Reservoir itself is located beneath wetlands and other waters of the US, with the majority of the reservoir being located offshore. Access to the hydrocarbon reservoir, a zone with defined limits capable of being extracted, necessarily limits the location of potential drilling/well pads. Therefore, due to the location of the Thomson Sand Reservoir, and limited practicable alternatives to development of that resource, it is acknowledged that this project would affect special aquatic sites. The Corps, at its discretion, may authorize activity (such as the infilling of wetlands) that is not water dependent if the applicant can show that alternative upland locations are not available, that the activity is in compliance with other Section 404(b)(1) Guideline requirements, that the action is not contrary to the public interest, and that all other applicable regulatory requirements are met (Corps 2009).

The size and layout of the Applicant's proposed pads and facilities are designed to meet the overall project purpose as identified above. The Applicant stated in its purpose and need that the proposed footprint would also facilitate ***full-field development*** , though some the additional equipment, manpower and increases to proposed infrastructure would be needed beyond what is proposed in this Draft EIS to recover and produce additional hydrocarbon resources from the reservoir (Appendix D, RFI 52). It is not, however, feasible to determine the extent of infrastructure modifications for full-field production until further delineation of the hydrocarbon resources of Point Thomson have been accomplished as planned under the proposed project. The discussion and analysis of impacts associated with full-field development are discussed in the cumulative impacts sections of this document.

This Draft EIS may serve as a foundational NEPA document for future development. For example, future projects may tier from this document, or may use this document as a basis for a supplemental EIS.

1.2.3 Corps' Overall Project Purpose

The Point Thomson Project's overall project purpose as defined by the Corps is to produce liquid hydrocarbons from the Thomson Sand Reservoir and further evaluate and delineate the reservoir and evaluate the Brookian Group sandstones.

1.3 AGENCY RESPONSIBILITIES

The Corps is the lead federal agency for this Draft EIS. Cooperating agencies are the EPA, U.S. Fish and Wildlife Service (USFWS), and the State of Alaska. Cooperating agencies have jurisdiction over some part of the project by law, or have special expertise in regard to a potential environmental impact to be addressed in an EIS. Responsibilities include assisting the Corps in identifying issues of concern and providing meaningful and timely comment and input throughout the NEPA process.

U.S. Army Corps of Engineers. The Corps decisions to be made are centered on issuing or denying permits:

- Section 10 of the RHA permit for the mooring dolphins and other structures affecting navigable waters
- Section 404 of the CWA permit for the placement of fill into wetlands and waters of the US

The Corps initiated the NEPA process and this Draft EIS as part of its permit review process. The Corps will evaluate comments received on this Draft EIS and comments received as part of its permit review. It will then prepare a Record of Decision (ROD) which will describe, in detail, the Corps' evaluation of the permit application.[3] If the permit is granted, the ROD will also include any conditions attached to the Corp approval. As part of the review and consideration of the Point Thomson Project permit application, the Corps is required to consider the following: 1) Compliance with the Section 404(b)(1) Guidelines,[4] 2) The Public Interest Review, and 3) Compliance with relevant Federal laws and regulations.

U.S. Environmental Protection Agency. As currently defined, the project would not require EPA-issued permits or authorizations. However, EPA authority includes oversight of many project-related actions pursuant to the CWA, the Clean Air Act (CAA), the Resource Conservation and Recovery Act (RCRA), the Safe Drinking Water Act (SDWA), and the Oil Pollution Act (OPA).

U.S. Fish and Wildlife Service. USFWS decisions to be made are centered on its responsibilities in enforcing the Endangered Species Act (ESA; marine mammal and bird species are subject to the act). Specifically, the USFWS will provide consultation (recommendation) as required under Section 7 of the act. In addition, the USFWS has an interest because the proposed project is located adjacent to the Arctic National Wildlife Refuge (Arctic Refuge), which is managed by the USFWS. The project may affect wildlife and human activity within the refuge as indicated in Chapter 4 of this Draft EIS.

State of Alaska. The State of Alaska, through its Department of Natural Resources, will make decisions to approve or deny permits and leases for use of state land, including submerged lands of the Beaufort Sea. The area of the Applicant's existing and proposed oil and gas leases and all proposed project components for all alternatives are located on state land. The Thomson Sand hydrocarbons belong to the State of Alaska and are to be recovered on the State's behalf under terms of oil and gas leases.

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[3] In a Statement of Findings "the decision options available to the Corps, which embrace all of the applicant's alternatives, are issue the permit, issue with modifications, or deny the permit. Modifications are limited to those project modifications within the scope of established permit conditioning policy (See 33 CFR 325.4). The decision option to deny the permit results in the no action alternative (i.e., no activity requiring a Corps permit)." [procedure 7, 33 CFR 325 appendix B]. "In those cases involving an EIS, the statement of findings will be called the record of decision." [procedure 18].

[4] 40 CFR 230.10(a): "No discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences."

1.4 SCOPING SUMMARY

The scoping process helps to establish the framework for the environmental study and facilitates the development of the reasonable range of feasible alternatives to be evaluated in the Draft EIS. The goal of scoping is to provide opportunities for the public and agencies to provide input on the proposed project. The lead federal agency uses scoping comments to identify the nature and extent of potential issues and impacts.

Plans were developed early in the NEPA process to define how the public and agencies would be engaged to maximize their involvement during scoping. The Public Involvement Plan for this Draft EIS outlined the ways in which the public would be included in the process and defined the outreach tools (e.g., project mailing list, newsletters, Web site, meetings) and the implementation schedule for public outreach. A Coordination Plan was developed that defined the process for engaging agencies both during scoping and at critical milestones throughout the NEPA process.

Scoping activities for the Point Thomson Project Draft EIS were primarily focused on the communities of Kaktovik, Nuiqsut, Barrow, Anchorage, and Fairbanks. Approximately 80 people attended the 5 public scoping meetings in these communities. The Corps identified the villages of Kaktovik, Nuiqsut, and Barrow for scoping meetings because of the proximity to the proposed development area and potential for outreach to potentially impacted parties. Anchorage and Fairbanks were included because of the statewide interest in developing the project and potential indirect effects on these communities. The Corps also held separate scoping meetings for agencies with regulatory jurisdiction over land or development, or with a permitting nexus. Agency meetings were held in Barrow, Anchorage, and Fairbanks. A government-to-government teleconference was held with Tribal representatives from Kaktovik Village, the Native Village of Nuiqsut, the Native Village of Barrow Inupiat Traditional Government, and the Inupiat Community of the Arctic Slope.

During the formal scoping period from January 11, 2010 to February 25, 2010, more than 300 issue-specific comments were identified in the communication received from the public and agencies. Comments were received in the following formats:

- Mail: six letters (two public and four agency letters)
- Fax: one comment form
- Electronic (e-mail, project Web site): seven
- Individuals providing oral comments during scoping meetings: 24
- Project comment forms: five

In general, comments received were related to one or more of the following eight major issues categories:

- Alternatives
- Environmental consequences
- Subsistence
- Erosion and coastal processes
- Noise and visual impacts

- Threatened and endangered species
- Water quality, hydrology, and drainage
- Cumulative impacts

In addition to the major issues categories, the project team also received comments pertaining to the following areas:

- Archeological and historical resources
- Land use and ownership
- Transportation
- Environmental justice
- Human health impact
- Wilderness
- General comments regarding opposition or support for the proposed project

Scoping comments were used in conjunction with the Applicant's proposed purpose and need to develop the full range of alternatives presented in Chapter 2. Specific public and agency input received during scoping was used to inform aspects of the alternatives developed. This input included:

- concern about coastal erosion at pad sites;
- suggestions to reduce road construction;
- concern over the project impacting the Arctic Refuge;
- questions about how impacts to wetlands would be minimized and/or mitigated;
- concern about noise impacts to bowhead whales;
- the idea of moving project components away from the coast to protect subsistence activities.

More detailed information on the scoping process and comments can be found in the Point Thomson Project EIS Scoping Summary Report (Appendix E).

1.5 PERMITS, LICENSES, AND OTHER APPROVALS

Permits, decisions, and approvals required by federal and/or state agencies are listed in Table 1.5-1. This list is not comprehensive and other permitting and approval needs may arise throughout the duration of the project. Federal and state agencies will be consulted throughout the project by the Applicant and the Corps (as necessary) to ensure that permitting needs are addressed. Appendix F, Compliance, provides more detailed information regarding the permits and regulatory approvals needed for the project.

Table 1.5-1: Permits, Decisions, and Approvals Required by Federal and/or State Agencies

Regulatory Action	Regulatory Agency*	Project Activity
Federal Actions		
NEPA Compliance/Environmental Impact Statement	Corps; Lead NEPA Agency	Review of environmental impacts of entire project, including construction and operations
Department of the Army Section 10 Permit	Corps	Work in navigable waters
Department of the Army Section 404 Permit	Corps	Placement of fill onto wetlands
National Historic Preservation Act (NHPA) Section 106 determination	Corps	Potential impacts of entire project
Compliance Review Pursuant to Section 404 of the CWA	EPA	Placement of fill into wetlands
NPDES/APDES General Permit	EPA/ADEC	Wastewater and stormwater discharges
Spill Prevention, Control, and Countermeasure Plan	EPA	For construction, drilling, and operations
Facility Response Plans	EPA, USDOT	For construction, drilling, and operations
Hazardous Waste Management Plans	EPA	Hazardous waste management for EPA-regulated waste
Underground Injection Control Well Permit	EPA	For development of a UIC disposal well
Incidental Take of Marine Mammals (Polar Bear and Walrus)	USFWS	Annual letter of authorization (LOA) for construction and operations
Section 7 Endangered Species Act Consultation	USFWS	Consultation for spectacled eider, Steller's eider, and polar bears
Essential Fish Habitat Consultation	NMFS	Essential fish habitat
Section 7 Endangered Species Act Consultation	NMFS	Consultation for bowhead whales, for operations and construction

Table 1.5-1: Permits, Decisions, and Approvals Required by Federal and/or State Agencies

Regulatory Action	Regulatory Agency*	Project Activity
State Actions		
Plan of Development	ADNR, DOG	For project development
Plan of Operations	ADNR, DOG	For project operations
Air Quality Control (PSD*) for Construction	ADEC	Project air emissions compliance for Project construction, drilling, and first year of operations
Title V Air Permit for Operations	ADEC	Project air emissions compliance beginning after first year of operation
Drilling Permit	AOGCC	Drilling
Drilling Waste Storage and Solid Waste Disposal Facility	ADEC	Waste management
Pipeline Right-of-Way Lease	ADNR, SPCO	Export pipeline construction, operations, and abandonment on state land
Oil Discharge Prevention and Contingency Plan	ADEC	Drilling and operations
Land Use Permit	ADNR, DMLW	Miscellaneous land use (e.g., ice roads)
Temporary Water Use Permit	ADNR, DMLW	Water use for ice roads, drilling, gravel mine filling, domestic, and construction activities
Material Sales Contract	ADNR, DMLW	Gravel mining
Title 16 Fish Habitat Permit	ADF&G	Mine site development, ice road water withdrawal, and stream crossings
Cultural Resources Management Plan	ADNR, SHPO	Clearance prior to commencing construction
Borough Actions		
Development Permits	NSB	For construction and operations within the NSB

* Acronyms and Abbreviations:

ADEC: Alaska Department of Environmental Conservation
ADF&G: Alaska Department of Fish and Game
ADNR: Alaska Department of Natural Resources
AOGCC Alaska Oil and Gas Conservation Commission
Corps: U.S. Army Corps of Engineers
DMLW: Division of Mining, Land, and Water
DOG: Division of Oil and Gas
EPA: Environmental Protection Agency
NEPA: National Environmental Policy Act
NMFS: National Marine Fisheries Service
NSB: North Slope Borough
PSD: Prevention of Significant Deterioration
SHPO: State Historic Preservation Office
SPCO: State Pipeline Coordinators Office
USDOT: U.S. Department of Transportation
USFWS: U.S. Fish and Wildlife Services

Chapter 2. Alternatives

This chapter outlines the process used to determine the range of reasonable alternatives to the proposed action and presents each alternative to be considered in this Draft EIS. Several alternatives to the Applicant's proposal were evaluated for their ability to meet the overall project purpose as presented in Chapter 1, feasibility, and responsiveness to the issues and concerns identified during public scoping. This evaluation process concluded with a range of reasonable project alternatives, including:

- Alternative A: No Action
- Alternative B: Applicant's Proposed Action
- Alternative C: Inland Pads with Gravel Access Road
- Alternative D: Inland Pads with Seasonal Ice Access Road
- Alternative E: Coastal Pads with Seasonal Ice Roads

2.1 REGULATORY SETTING FOR ALTERNATIVES ANALYSIS

Both the Council of Environmental Quality's (CEQ) NEPA Implementation Procedures (40 CFR 1502.14) and the Corps' NEPA Implementation Procedures (33 CFR 325, Appendix B) require consideration of a range of reasonable alternatives for a proposed action. Defining a range of reasonable alternatives is a key element for subsequent analyses in an EIS. The CEQ (1981) describes the alternatives as being the "heart of the environmental impact statement," and alternatives that are considered *reasonable* under NEPA include those alternatives "that are practical or feasible from a technical and economic standpoint and using common sense." NEPA regulations require that agencies consider a range of reasonable alternatives to the proposed action, including consideration of a "No Action" alternative; the regulations do not, however, require consideration of every conceivable variation of an alternative (40 CFR 1502.14).

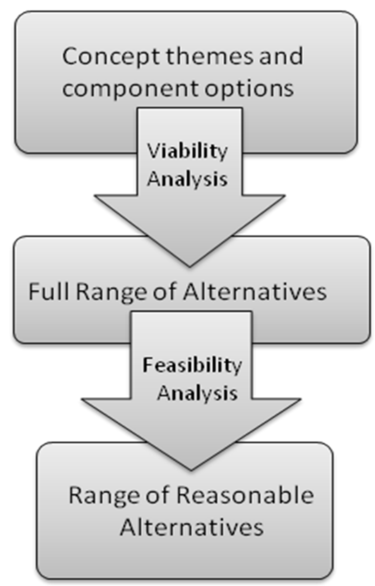
The substantive criteria used by the Corps to evaluate a permit are the Section 404(b)(1) Guidelines (40 CFR 230) promulgated by the EPA. The 404(b)(1) Guidelines indicate that the analysis of alternatives for NEPA environmental documents will in most cases provide the information required to evaluate the alternatives under the guidelines (40 CFR 230.10 [a][4]). The guidelines require the evaluation of "practicable alternatives," and define an alternative as practicable "if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes" (40 CFR 230.10 [a][2]).

The Corps and cooperating agencies evaluated and screened the alternatives mindful of both the NEPA requirements and the 404(b)(1) Guideline requirements. As a result, the range of reasonable alternatives identified by the Corps in this Draft EIS forms the starting point for the evaluation of practicable alternatives to the Applicant's proposed project and determination if the Applicant's proposed project is the LEDPA. The Corps and cooperating agencies examined the full scope of possible alternatives and components and systematically arrived at the range of reasonable alternatives in the Draft EIS. Through this process, the Corps believes that it has captured all of the alternatives and components necessary to determine whether the Applicant's proposed project is the LEDPA.

2.2 ALTERNATIVES DEVELOPMENT

The Corps implemented a structured multistep process to develop and screen alternatives for the Point Thomson Project, with a goal to consider the broadest range of possible alternatives and identify the range of reasonable alternatives that would advance for comparative analysis in this Draft EIS. Each step of this process was designed to build on the previous step by using more refined and detailed information. The intent of the iterative process was to eliminate infeasible and unreasonable concepts and alternatives as early in the process as practical to allow the Corps and the cooperating agencies to focus on more feasible concepts and alternatives. Evaluation criteria were identified early in the alternatives development process for each step. The Corps and cooperating agencies worked together at each step of the development and screening process that occurred over the course of numerous workshops and meetings. The Corps sought the consensus of the cooperating agencies before proceeding to each next step.

The initial step in the process was identification of possible alternative concepts for achieving the purpose of the project (see Chapter 1). During public scoping a number of potential concerns and issues associated with the Point Thomson Project were identified and many alternative concepts for addressing the project purpose were suggested. The Corps and agencies used those suggestions to develop a broad set of alternative concepts. These concepts were then assessed based on their *viability*, which encompasses their ability to meet the Corps overall purpose, the technological feasibility of the concept, the extent to which the concept would ultimately accommodate full-field development, and a general assessment of the concept's environmental risks. The conceptual themes and a more detailed description of the initial viability analysis criteria can be found in Sections 2.2.1 and 2.2.3.



The concepts that were not eliminated during the viability analysis were advanced to the next step of the alternatives development process. The Corps conducted workshops with the cooperating agencies to refine the set of evaluation criteria, and defined the concepts to create specific alternatives. The Corps also utilized a formal Request For Information (RFI) process (Appendix D) with the Applicant to attain additional details about aspects of the Applicant's proposed project as well as technical information in support of the Corps' and cooperating agencies' alternative concepts. In all cases, information provided by the Applicant was reviewed and verified by the Corps. These defined alternatives were again assessed by the Corps and cooperating agencies, as described in Section 2.2.3, to determine their feasibility.

The remaining alternatives were then more closely refined and detailed descriptions of each alternative were developed. This Draft EIS documents the Corps' detailed evaluation of the environmental impacts of this final set of alternatives.

2.2.1 Conceptual Theme Development

A series of public and agency scoping meetings were held to provide all interested parties with the opportunity to comment and provide input on the proposed project. In January 2010, the Corps held public scoping meetings in Fairbanks, Anchorage, Kaktovik, Nuiqsut, and Barrow. The Corps also held agency scoping meetings in Fairbanks, Barrow, and Anchorage to obtain input from the tribal governments, local governments, and state and federal agencies. The scoping comments were documented in the *Point Thomson Project EIS Scoping Summary Report* (Appendix E).

Subsequent to the public and agency scoping meetings, the Corps and cooperating agencies held a series of alternatives development meetings between March and June 2010 (see Table 2.2-1). These meetings were held to identify issues raised during scoping, develop conceptual themes to address issues that arose during scoping, and identify additional data needs to develop a full range of alternatives. Conceptual themes came from a variety of sources, including alternatives identified during the 2002 Point Thomson EIS effort, the Applicant's proposed action, and alternatives or components identified during the public and agency scoping process. This collaborative process identified the following nine conceptual themes:

Concept 1: No Action. As required by the CEQ, the EIS must consider as an alternative the possibility of not permitting the project. In Concept 1 the Applicant, having capped its exploratory wells and removed all construction and drilling equipment from the site, would implement a program to monitor the wells.

Concept 2: Applicant's Proposed Action. The Applicant proposed constructing three coastal drilling pads, one of which would include a processing facility to extract condensate from natural gas. Concept 2 would include an aboveground export pipeline to existing infrastructure at Prudhoe Bay, and would use barges, ice roads, and an airstrip to transport equipment to and from Point Thomson. Gravel roads would provide transportation within the field.

Concept 3: Minimize Coastal Impacts. In response to the desire to protect marine life and avoid impacts to coastal habitat, Concept 3 would move the three well pads approximately one half mile inland, with a separate pad for condensate processing located 2 miles inland. This concept would rely on ice and gravel roads to Point Thomson, an airstrip, and gravel infield roads. It would also include an aboveground export pipeline to existing Prudhoe Bay infrastructure.

Concept 4: Minimize Infrastructure. Concept 4 was designed to limit the infrastructure at Point Thomson, and would consist of three coastal well pads, with processing facilities located at one of the pads. The processing facility would be either operated onsite or automated for operation from Badami to further reduce onsite infrastructure needs. This concept would include barge and ice road transport to the site, an ice airstrip or reduced capacity airstrip, and an aboveground export pipeline to Prudhoe Bay. Infield roads would be seasonal ice roads with no gravel roads.

Concept 5: Maximize Reservoir Access. Because the majority of the reservoir is located under the Beaufort Sea, offshore development would provide the maximum access to the reservoir. This concept would include building an island for drilling and processing, and using either drill ships or well pads on barrier islands to access the reservoir. A buried subsea pipeline would export condensate to Prudhoe Bay.

Concept 6: Limit Activity Near the Arctic National Wildlife Refuge. Because the easternmost reach of the proposed project is located near the Arctic Refuge, the public and agencies expressed concern about impacts to the Arctic Refuge from development activities. Concept 6 would include only two coastal pads (with no eastern pad near the Arctic Refuge), a processing facility located in the gravel mine, and export of condensate via a subsea pipeline to Prudhoe Bay.

Concept 7: Maximize Production. Concept 7 was intended to produce the maximum volume of condensate from the beginning of production. This concept was similar to the Applicant's proposed three-pad facility layout and related infrastructure. The primary difference was that the production would increase from 200 million standard cubic feet per day (mmscfd) to 450 mmscfd. Centrifugal compression technology would be used to compress processed gas for reinjection. Barges and ice roads would transport equipment to Point Thomson, and an aboveground pipeline would export condensate to Prudhoe Bay.

Concept 8: Minimize Onsite Activity. This concept was intended to reduce to the maximum degree possible the activity at Point Thomson by locating only three well pads at Point Thomson. Personnel and processing facilities would be located at BP Exploration (Alaska), Inc.'s (BPXA) Badami facility. Personnel, equipment, and supplies would travel to and within Point Thomson via ice road. An aboveground gathering line would connect the wells to the Badami processing facility, and a second line on the same supports would return processed gas to Point Thomson for reinjection.

Concept 9: Accommodate Significant Future Development. The agencies anticipated natural gas production (in addition to gas cycling) as a reasonably-foreseeable future action. Concept 9 was intended to allow the maximum footprint for potential future gas production activities, thereby avoiding the need for additional construction activity in the future. The concept included three large coastal pads, infield gravel roads, and a barging facility in the form of a dock or a causeway. An aboveground export pipeline would connect the field to Prudhoe Bay.

2.2.2 Component Options

Component options included facility layouts, pieces of equipment, or strategies that could be used in combination with other components to support a function within a conceptual theme. For example, Concept 4 included an option for either light duty gravel roads or seasonal ice roads for transport within Point Thomson. Use of component options allowed the agencies to develop concepts that minimized impacts associated with that theme while simultaneously creating a feasible project.

In the following sections describing the screening process, individual components will be identified as they are dismissed from consideration or incorporated into alternatives.

Table 2.2-1: Alternatives Development and EIS Coordination Team Meetings					
Meeting Date	Participation				Purpose
	Corps	USFWS	EPA	DNR	
March 9, 2010	X	X	X	X	Alternatives Development Workshop I: Reviewed identified scoping issues. Discussed purpose and need.
March 16, 2010	X	X		X	Alternatives Development Workshop II: Continued alternatives discussion.
March 23, 2010	X	X	X	X	Alternatives Development/Screening Criteria Workshop III: Continued alternatives discussion.
March 30, 2010	X	X	X	X	Alternatives Development Workshop IV: Discussed and identified the alternatives screening criteria.
April 6, 2010	X	X	X	X	Components and Alternatives Meeting: Continued developing the alternatives and their components to allow for a more straight-forward comparison of the alternatives.
April 8, 2010	X	X	X	X	Components and Alternatives Meeting: Continued the April 6 meeting.
April 13, 2010	X		X		Components and Alternatives Meeting: Reviewed RFIs and continued developing the alternatives for the screening criteria process.
April 29, 2010	X	X		X	Components and Alternatives Meeting: Reviewed the revised alternatives table with corresponding maps. Refined the alternatives and identified additional information needs.
May 6, 2010	X	X	X	X	Components and Alternatives Meeting: Reviewed revised alternatives table with corresponding maps. Refined the alternatives and identified additional information needs.
May 12, 2010		X	X	X	Alternatives and RFI Review Meeting: Refined draft alternatives and discussed RFIs.
May 25, 2010	X	X	X		Alternatives and RFI Review Meeting: Refined draft alternatives and discussed RFIs.

2.2.3 Viability Analysis

Once the conceptual themes were identified and assigned a suite of component options to accomplish the theme, the Corps and cooperating agencies evaluated each theme's viability by posing a series of yes/no questions as detailed below. Table 2.2-2 summarizes the results of the viability analysis.

- Does the conceptual theme or component satisfy the Corps overall purpose to:
  - Produce gas liquids?
  - Delineate the size and boundary of the reservoir in greater detail than currently exists?
  - Evaluate the resource in terms of:
    - reservoir connectivity (e.g., whether the reservoir is one homogenous deposit or many smaller, discontinuous pockets),
    - gas quality, and
    - production potential?
- Does the conceptual theme or component seem technologically feasible, based on a preliminary understanding of the technology?
  - Is the component capable of being built or accomplished?
  - Has the technology been successfully proven for similar uses?
- Does the theme or component provide for full-field development?

  While the current proposed action is intended to produce gas condensate, one important element of the Applicant's stated purpose is to evaluate the resource for future natural gas production. The Corps and cooperating agencies acknowledge full-field production of condensate, natural gas, oil, or a combination of the three as a reasonably foreseeable future action. A viable concept should not preclude future development and the final development strategy should provide adequate infrastructure for probable future production.
- Does the theme or component seem reasonable in terms of permit experience?

  Before initiating a detailed analysis of environmental impact, the Corps and cooperating agencies consider the collective experience regarding permit processing for similar concepts and potential actions. This assessment is based on the context of regulatory precedent rather than impact analysis, and poses the questions:
  - Have regulatory agencies permitted similar projects in the recent past?
  - Do the potential projected benefits of the conceptual theme, compared to other conceptual themes, justify expending additional resources on more intense analyses?
- Is the concept distinct from other concepts?

  The Corps and the cooperating agencies used scoping comments to develop distinct approaches to address specific issues while satisfying the project purpose. The concepts were also compared to each other during the screening process to ensure they were not redundant and offered a real choice or unique solution.

Table 2.2-2: Viability Analysis Results

The Concept	Satisfies the Purpose and Need to: Produce Condensate	Satisfies the Purpose and Need to: Delineate the Reservoir	Satisfies the Purpose and Need to: Evaluate the Resource	Technologically Feasible	Allows for Full-field Development	Seems Reasonable in Terms of Permit Experience: Positive Regulatory Precedent	Seems Reasonable in Terms of Permit Experience: Potential Benefits Support Additional Analyses	Unique and Distinct from Other Concepts
Concept 1: No Action	No	No	No	Yes	No	N/A	N/A	Yes
Concept 2: Applicant's Proposed Action	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Concept 3: Minimize Coastal Impacts	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Concept 4: Minimize Infrastructure	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Concept 5: Maximize Reservoir Access	Yes	Yes	Yes	Yes	Yes	No	No	Yes
Concept 6: Limit Activity Near the Arctic Refuge	Yes	No	No	Yes	No	Yes	Yes	Yes
Concept 7: Maximize Production	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Concept 8: Minimize Onsite Activity	Yes	Yes	Yes	No	Yes	No	No	Yes
Concept 9: Accommodate Significant Future Development	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

2.2.4 Concepts and Component Options Eliminated

Based on the results of the viability analysis, four concepts and four components were eliminated from further investigation as alternatives because of their inability to accomplish the project purpose, technological infeasibility, excessive environmental risk, or redundancy.

2.2.4.1 Concept 5: Maximize Reservoir Access

The Applicant's early development plans considered but dismissed development from a barrier or manmade island (ExxonMobil 2009a), based on the offshore location of the majority of the reservoir. For the current EIS effort, the possibility of offshore development was discussed as a conceptual theme that would limit impacts to the terrestrial environment while adding impacts to the offshore and coastal environments. Offshore development was dismissed as a concept due to the added environmental risks in the arctic environment and the availability of technology, in the form of long-reach directional drilling, that would allow the Applicant to access a majority of the reservoir from onshore well pads, thereby avoiding the offshore impacts altogether.

Moreover, following the April, 2010, *Deepwater Horizon* oil spill, the Interior Department has become more critical of offshore drilling in all waters (Lundgren 2010), even requesting that BPXA's Liberty development, located on the manmade satellite island at Endicott, delay drilling for a year to undergo additional plan reviews (Bradner 2010).

Concept 5 was eliminated from further consideration because it involved adding otherwise avoidable impacts to the offshore and coastal environments while not providing significantly greater access to the reservoir than that provided by onshore alternatives.

2.2.4.2 Concept 6: Limit Activity Near the Arctic Refuge

Concept 6 would have located the nearest of its two drilling pads approximately 6 miles from the Arctic Refuge, and potentially muted the sound of the processing facility by locating the facility within the completed gravel mine. Directional drilling technology would need to reach out over 30,000 feet to access the eastern extent of the reservoir from the location proposed in this concept. Current directional drilling technology in reservoir conditions similar to those found in the Thomson Sands only has a proven reach of approximately 13,000 feet (Appendix D, RFI 63). Eliminating an eastern well site would prevent access to approximately one third of the known gas resource. Therefore, this concept was eliminated because the technology does not exist to support its development and because it would not satisfy the project purpose to delineate the reservoir and evaluate the resource.

2.2.4.3 Concept 8: Minimize Onsite Activity

Concept 8 proposed locating the gas processing facility and personnel support facilities at Badami. In general, gas cycling is a two-part process that consists of 1) removing the "wet" portion of the gas (called condensate) from the produced gas and 2) compressing the processed "dry" gas back to reservoir pressure (approximately 10,000 pounds per square gauge [psig] for Point Thomson) and injecting the gas back into the reservoir. The two processes of separation and compression are closely integrated in gas cycling projects. It was determined that separating the two by even a few miles would be impractical and technologically infeasible (Appendix D, RFI 64).

The practicability of collocating the processing and compression facilities at Badami was also investigated. By locating the facilities at Badami, however, Concept 8 would require more than 20 miles of product pipeline from the well pads, and similar lengths of high pressure pipeline to transport processed and recompressed gas back to Point Thomson for injection. The compressor would need to discharge at extremely high pressures to transport the gas over 20 miles back to Point Thomson and still maintain wellhead pressures of 10,000 psig. The increased fuel consumption for electric power for compression would increase air emissions and the stored potential energy in more than 20 miles of injection pipeline would be significant, increasing the risks associated with a pipeline failure. Concept 8 was eliminated from further consideration because it was not considered practical and technologically feasible and because it did not seem reasonable in terms of environmental risk.

2.2.4.4 Concept 9: Accommodate Significant Future Development

Concept 9 was eliminated from consideration because it mirrored the Applicant's Proposed Action but enlarged the gravel fill of the pads, with no change to the technological capability of the facilities on the site to assist in future development. The Corps and cooperating agencies confirmed the difference between the two concepts was not sufficient to warrant development of separate alternatives.

2.2.4.5 Component: Pipelines Buried in the Tundra

This component was considered as an alternative to the aboveground pipelines used in several concepts. The goal of this component was to minimize impacts to caribou movement, potential for bullet strike, and visual impacts of pipelines across the tundra.

While world-wide industry standard practice is to bury hydrocarbon pipelines, the Arctic environment is unique among development areas because the pipe would be buried in ground that is frozen year-round. Multiple issues have been observed and can cause substantial impacts or risks to pipeline integrity, including soil thawing and differential settlement (thaw settlement), upheaval buckling, reduced effectiveness of corrosion protection, inability to visually inspect pipelines, and changes to surface drainage.

Soils in the Point Thomson area are ice rich and burying high temperature pipelines in below-freezing ground could increase the likelihood of the thaw settlement effects described above (Appendix D, Technical Brief [TB] 5). Even after the aboveground TAPS was designed for thaw-unstable areas, and had buried pipeline only in thaw-stable areas, thaw settlement caused two oil spills along the TAPS in June 1979, and required a permanent rerouting of the pipeline in 1985 (APSC 2010). While pipelines can be insulated to slow the heat transfer from pipeline to soil, even heavy insulation cannot completely prevent thawing around the pipeline over the course of pipeline life. Upheaval buckling can also occur where the soils above the pipeline cannot sufficiently restrain the pipeline and the pipeline buckles as a result of upward pressures (Appendix D, TB 5).

Corrosion protection can be problematic when considering a buried pipeline. While subarctic pipelines use cathodic protection systems to suppress the metal's natural tendency to corrode, such protection systems rely on the reactions between the pipeline and the ground around it. As explained above, buried hydrocarbon pipelines in the Arctic must be insulated to minimize thaw settlement, and the combination of frozen ground and insulation prevents or slows the reactions necessary to prevent external corrosion of the pipeline (Appendix D, TB 5).

Leak detection systems have improved significantly since construction of TAPS was completed in the 1970s. The technology now exists to detect even a small leak in an oil pipeline, as demonstrated in BP's use of the LEOS system on its Northstar buried subsea pipeline (BPXA 2008). Despite these technological advances, however, no leak detection system is fail-safe; the most significant oil spill in recent North Slope history, from Prudhoe Bay oil transit lines in March 2006, was identified by visual inspection rather than automated leak detection, and regulators on the North Slope have been reluctant since that time to permit belowground onshore pipelines for which in-line inspection results cannot be visually confirmed.

This component was dismissed for further consideration because of the challenges inherent in safely operating and maintaining buried hydrocarbon pipelines in the Arctic.

2.2.4.6 Component: Badami Power Generation

This component would involve using power from existing generators currently located at Badami, 22 miles to the west. Power would be transmitted to Point Thomson via 69 kilovolt (kV) transmission lines along the export pipeline route, with a goal of reducing both footprint and noise from generators at Point Thomson.

Currently, power resources at Badami could potentially produce 26 megawatts (MW), including emergency-generated power that cannot be considered for standard use (Appendix D, RFI 73). If even half of its output were required for its own operation, Badami would not be able to supply the 25 MW required at Point Thomson during times of anticipated peak energy use (Appendix D, RFI 73). Additionally, the 69 kV lines would introduce the possibility of weather interrupting power flow to Point Thomson. Because of the isolated nature of the Point Thomson site, the project would require emergency generators to support the personnel camps and well control in the event of a loss of power.

This component was dismissed from further consideration because existing power generation capacity at Badami is insufficient to supply anticipated needs at Point Thomson.

2.2.4.7 Component: Automated Facility with Offsite Controls

This component was introduced to minimize the footprint of the Central Pad by locating personnel housing offsite and operating all processing operations remotely. Unattended operation of small oil and gas facilities is common for single-well pumping or gas compression units. Typically, these units are visited daily by an operator who checks operating parameters, verifies that fluid levels are correct, and performs daily maintenance activities. Facility shutdown could be implemented remotely by operator action within the control system; however, most process and generation facilities also design a backup hardwired trip into their control and operating philosophy.

Facility automation has not been used before for a project of the size and scale of the proposed Point Thomson facility, which includes separation, compression, and injection. In addition to the technological challenges of automating the facility, the goal of completely removing personnel housing and support facilities from the central processing site is unrealistic, due to the number of people who would need to be onsite daily to monitor and maintain the facilities (Appendix D, RFI 71). For these reasons, facility automation was eliminated from further consideration.

2.2.4.8 Component: Buried Subsea Export Pipelines

Introduced in both Concepts 5 and 6, buried subsea pipelines pose many of the challenges of pipelines buried in tundra with regard to inspectability and temperature control.

When designing a subsea pipeline in an Arctic environment, the lines must be buried deeper than they might be on land because they are also subject to ice scour or gouging if the heavy tip of an iceberg or ice sheet drags or bobs, digging several feet into the seafloor.

While it is technologically feasible to construct a buried subsea pipeline to carry product to existing export infrastructure, the predictable potential impacts to the offshore environment can be completely avoided with onshore alternatives that may have mitigable impacts with lower significance and consequence. With this consideration, the buried subsea export pipeline was removed from further consideration.

2.3 SCREENING OF THE FULL RANGE OF ALTERNATIVES

The evaluation for viability resulted in the development of a full range of alternatives that met the stated purpose and need for the project and were responsive to the issues identified during the scoping process. The full range of alternatives brought forward from the conceptual stage consisted of five alternatives. One alternative, Alternative 3, was further refined to Alternatives 3a and 3b, resulting in essentially six alternatives considered within the full range. Four of these alternatives, 3a, 3b, 4, and 5, carried forward conceptual theme goals. Below are brief descriptions of the concepts moved forward as alternatives:

Alternative 1: No Action. The CEQ requires consideration of the No Action Alternative, understanding that a no-action alternative will not meet the purpose and need of the proposed project. Therefore, this alternative was advanced despite its “no” responses to the screening criteria for purpose, need, and accommodation of full-field development.

The No Action Alternative would require the Applicant to continue to send personnel to the site periodically to monitor the capped wells that were drilled in 2010 (Appendix D, RFI 75).

Alternative 2: Applicant’s Proposed Action. The Applicant’s Proposed Action would include three coastal pads with a total of five production/injection wells drilled using directional drilling techniques, gravel roads connecting well pads, infield pipelines on vertical support members (VSMs), a gravel airstrip that would accommodate a Lockheed-Martin C-130 Hercules (C-130) aircraft, processing and compression facilities located on a Central Pad, and an aboveground export pipeline to Badami. The development would use barging, seasonal ice roads, and fixed- and rotary-wing aircraft to move equipment and personnel to and from Point Thomson during construction, drilling, and operations.

Alternative 3a: Inland Pads with Gravel Access Road. Alternative 3a had a goal of minimizing impacts to coastal resources. This alternative retained the existing coastal central pad as a well pad, created a separate pad for condensate processing and compression 2 miles inland, and located an east and west well pad a half mile inland from the coastline. This alternative would include gravel roads between each of the pads, infield pipelines on VSMs, a gravel airstrip of sufficient length to accommodate a C-130 aircraft, and an aboveground export pipeline to Prudhoe Bay. The aboveground pipeline would follow the route of a gravel access road and tie in at Endicott.

During construction, equipment would be transported to the site via ice roads. A gravel road would be installed from existing Prudhoe Bay infrastructure to Point Thomson that would allow year-round access to Point Thomson for the duration of field life. There would be no barging facilities associated with this alternative.

Alternative 3b: Inland Pads with Seasonal Ice Access Road. Alternative 3b mirrored Alternative 3a, but omitted the building of an all-season gravel road from Prudhoe Bay to Point Thomson. Instead, the Applicant would use a seasonal ice road to move supplies and equipment from Prudhoe Bay to Point Thomson. Because of the lack of a gravel access road, the aboveground export pipeline would tie in at Badami, rather than Endicott, and the alternative would use existing common carrier pipelines to bring hydrocarbons to market.

Alternative 4: Coastal Pads with Seasonal Ice Roads. This alternative had the goal of minimizing the infrastructure footprint at Point Thomson. This alternative includes three pads, (two drilling and one combined drilling and process pad located on the coast), pads and airstrip connected in the winter by ice roads, infield pipelines on VSMs, a seasonal ice road and summer barging to transport equipment and supplies to and from Point Thomson, and an aboveground export pipeline to Badami. The inland airstrip would be sized to accommodate a DeHavilland Twin Otter and would be supplemented by an ice extension to accommodate a C-130 during the hydrocarbon drilling season between December and April as conditions would allow.

Alternative 5: Coastal Pads with Centrifugal Compression. Alternative 5 stemmed from Concept 7 (Maximize Production) and includes all infrastructure associated with Alternative 2. It differs from that alternative in that it would require greater processing capacity and would replace the reciprocal compression technology proposed by the Applicant with centrifugal compression technology.

Once the full range of alternatives was identified, the team worked to further refine the alternatives in anticipation of performing a comparative screening. During the alternative refinement process, the Corps invited the Applicant to provide technical review of the agency-developed alternatives. Through a series of workshops (Table 2.3-1), TBs, and the RFI process, the Applicant provided information regarding logistics, technological capabilities, and other details required to advance alternatives from preliminary scenarios to more detailed alternatives for comparative screening.

Table 2.3-1: Alternatives Refinement and EIS Coordination Team Meetings

Meeting Date	Participation: Corps	USFWS	EPA	DNR	Applicant	Purpose
June 3, 2010		X		X	X	Coordination Team Alternatives Presentation to the Applicant: First presentation to the Applicant of the alternatives and the alternatives development process.
June 10, 2010	X	X	X	X	X	Coordination Team Alternatives Meeting with the Applicant: Opportunity for Applicant to raise questions based on their review of the alternatives presented in the June 3 meeting.
July 1, 2010	X		X	X	X	Alternatives Refinement Workshop: Discuss Applicant's current understanding of and responses to the existing alternatives. Discuss additional information required to complete alternatives development and identify additional workshops to respond to agencies' information needs.
July 12, 2010	X		X	X	X	Discipline-specific Alternatives Workshop: Applicant presents briefs on the following topics: project sequencing, logistics, and modularization.
July 20, 2010	X		X	X	X	Discipline-specific Alternatives Workshop: Discussion of infield gravel roads and the East and West Pad design.
July 29, 2010	X		X	X	X	Discipline-specific Alternatives Workshop: Discussion of compressor processing options.
August 12, 2010	X		X	X		Agency Screening Workshop: Review full range of alternatives and discuss application of screening criteria.

The EIS development team engaged a comparative screening process (Table 2.3-2) that helped determine whether these more thoroughly and technically-developed alternatives could be feasibly implemented. As part of this process, the criteria developed for the viability analysis in Section 2.2.3 were reapplied to identify and eliminate components that appeared to satisfy the purpose of the project but that, after additional research, did not enable production, delineation, or resource evaluation. Alternatives and component options that were not technologically feasible or were redundant also were eliminated from further consideration. The comparative screening processes further refined which alternatives and/or component options would best meet the Corps overall project purpose, and ultimately resulted in the range of reasonable alternatives.

Table 2.3-2: Feasibility Analysis Results

The Alternative	Satisfies the Corps Overall Project Purposes: Produce Condensate	Satisfies the Corps Overall Project Purposes: Delineate the Reservoir	Satisfies the Corps Overall Project Purposes: Evaluate the Resource	Technologically Feasible	Unique and Distinct from Other Alternatives
Alternative 1: No Action	No	No	No	Yes	Yes
Alternative 2: Applicant's Proposed Action	Yes	Yes	Yes	Yes	Yes
Alternative 3a: Inland Pads with Gravel Access Road	Yes	Yes	Yes	Yes	Yes
Alternative 3b: Inland Pads with Seasonal Ice Access Road	Yes	Yes	Yes	Yes	Yes
Alternative 4: Coastal Pads with Seasonal Ice Roads	Yes	Yes	Yes	Yes	Yes
Alternative 5: Coastal Pads with Centrifugal Compression	Yes	Yes	Yes	Yes	No

2.3.1 Alternatives and Components Eliminated

Based on the results of the comparative screening process, one alternative and five components were eliminated from further investigation. The following sections summarize why the alternatives and components were eliminated.

2.3.1.1 Alternative 5: Coastal Pads with Centrifugal Compression

This alternative was designed to accomplish the goals of Concept 7, which was to maximize production. Alternative 5 used the development plan and infrastructure requirements of Alternative 2, and did not differ sufficiently from Alternative 2 to warrant consideration as an alternative. Alternative 5 was eliminated for redundancy; however, centrifugal compression technology was advanced for additional analysis as a component option.

2.3.1.2 Component: Gathering Lines Buried in Infield Gravel Roads

This component entailed burying 8-inch infield gathering pipelines in the infield gravel roadbeds. Electrical and communications cables would also be buried, either in the road or the road shoulder. This component remained after the initial dismissal of in-tundra buried pipelines and received additional analysis for feasibility.

There are two main conceptual designs for burying pipelines beneath roads on the North Slope. One option is to bury the pipeline within the road prism, but above the tundra. This option presents major concerns associated with potential mechanical damage from vehicular traffic. Risks are introduced by the possible loss of soil cover above the pipe during normal road usage and road maintenance activities. Loss of cover may reduce the capability of the surrounding soils to restrain pipe movement, resulting in upheaval or buckling of the pipe. In an extreme case, upheaval may expose the pipe and result in damage from vehicles or road maintenance equipment. In addition, culvert installation becomes problematic in the road prism, and could require an extensive road footprint to allow for sufficient road to convey water through the road and enough soil to sufficiently carry a pipeline (Appendix D, TB 7).

The second option would be to bury the pipeline below the road prism, trenched into the tundra, with a gravel road constructed over the top. In this case, danger from vehicular traffic would be reduced and culvert installation would be less problematic. However, thawing of permafrost can occur, causing instability of the pipeline foundation and possible loss of pipeline integrity (Appendix D, TB 7). The ice-rich soils in the Point Thomson project area are particularly prone to thawing. Pipe and ditch insulation are possible, but as discussed earlier with pipelines buried in tundra, use of insulation is not a fail-safe solution to preventing soil thaw and may also result in external corrosion of the pipeline (Appendix D, TB 7).

Burying pipelines in the road prism also introduces the same corrosion and leak detection challenges discussed earlier in Section 2.2.4.5.

This component was dismissed from further consideration given the technological challenges and pipeline integrity uncertainties associated with warm product within pipelines buried under roadways. These uncertainties include the stability of buried pipelines in the ice-rich soil at Point Thomson, potential for pipeline upheaval and buckling through normal road use, and the problematic maintenance and functioning of protective systems such as corrosion protection and leak detection needed to ensure integrity of the pipelines.

2.3.1.3 Component: Ice Airstrip Extension

The airstrip extension was originally considered for use in Alternative 4, which was intended to minimize the amount of fill required at Point Thomson. In this component, the gravel airstrip would be 3,700 feet long by 170 feet wide, which would accommodate personnel aircraft but not large cargo aircraft. Under this component, the shorter gravel airstrip would be supplemented in the winter with an ice extension to reach a total length of 5,600 feet by 200 feet. The supplemental extension would accommodate a C-130 that could be used to import blowout containment equipment in the event of an incident during the hydrocarbon drilling season between November and April. However, the ice extension would not likely be buildable and in service until January or February, depending on seasonal conditions favorable to such construction.

Additional analysis indicated that leveling an ice airstrip to an existing gravel airstrip would be technically more difficult than building an all-ice airstrip each year. Additionally, if the seasonal, all-ice airstrip were on sea ice, it would require no additional permitting (Appendix D, RFI 62). Because a simpler alternative accomplishes the same goal as the airstrip extension with less required gravel fill, this component was eliminated from consideration.

2.3.1.4 Component: Light Duty Infield Roads

This component was introduced as part of Alternative 4 to minimize the amount of fill required while still providing year-round personnel access between the Central Pad, the outlying pads, and the airstrip. Rather than a nominal 5-foot-thick gravel road that accommodates large equipment, a light duty road would consist of 3 feet of gravel and 2 inches of insulation, and would accommodate only small vehicles such as crew cabs and maintenance trucks.

This component was eliminated from consideration because it has not been used successfully for long term projects on the North Slope; the insulation poses a significant challenge when remediating the area at the end of field life, and the road type does not provide a substantial infield mobility increase over seasonal ice roads (Appendix D, RFI 93).

2.3.1.5 Component: Centrifugal Compression

Initially introduced in Concept 7 and advanced in Alternative 5, centrifugal compression has been used elsewhere on the North Slope for gas reinjection to improve field hydrocarbon recovery and in other reinjection capacities elsewhere in the world (Appendix D, RFI 65b). It has not, however, been proven in similar gas cycling applications at the flow rates and pressures proposed for the Point Thomson Project. Research into existing centrifugal compression units found that there could be units built to satisfy the capacity requirements of the proposed Point Thomson Project, but that they would be unproven prototypes and would not ultimately meet the turndown, operating flexibility, and system redundancy requirements of the proposed project (Appendix D RFI 65b, TB 2).

While centrifugal compression was dismissed from consideration for the current project's gas cycling function, selection of reciprocal compression for condensate production does not preclude the future use of a centrifugal compressor in the event that Point Thomson is developed for natural gas production (Appendix D, RFI 65b).

2.3.1.6 Component: Only Seasonal Infield Ice Roads

Alternative 4 initially relied on seasonal ice roads (historically available from January/February through April each year) between all facilities at Point Thomson, including the Central Processing Facility, drill sites, airstrip, and gravel mine. When ice roads cannot be used, transport between pads could only be provided by helicopter. Because of the high volume of helicopter traffic that would be required to move personnel from a year-round airstrip to the Central Pad personnel camp (Appendix D, RFI 62) and the limitations placed on helicopter transport by weather (HDR 2010a), this component was determined to be impractical and was therefore eliminated from further consideration. Instead, Alternative 4 was progressed with a gravel road between the airstrip and the central pad, while retaining all other infield road components as seasonal ice roads.

2.3.2 Range of Reasonable Alternatives

After the comparative screening, the five remaining alternatives were renamed in order to allow the reader to clearly track the progression of the alternatives through the development process. The reasonable alternatives are renamed as follows:

Alternative A – No Action	**Formerly Alternative 1**
Alternative B – Applicant's Proposed Action	**Formerly Alternative 2**
Alternative C – Inland Pads with Gravel Access Road	**Formerly Alternative 3a**
Alternative D – Inland Pads with Seasonal Ice Access Road	**Formerly Alternative 3b**
Alternative E – Coastal Pads with Seasonal Ice Roads	**Formerly Alternative 4**

These alternatives were further refined to include additional logistical and development information. As the alternatives were analyzed for the EIS, components making up the alternatives were further refined.

2.4 ALTERNATIVE DESCRIPTIONS

As well as providing the full range of reasonable alternatives for NEPA, the five alternatives also establish the range of practicable alternatives that will be evaluated to determine the LEDPA per Corps guidance related to Section 404(b)(1) of the Clean Water Act (40 CFR Part 230). The following sections present detailed descriptions of each of the five reasonable alternatives.

2.4.1 Alternative A: No Action

NEPA regulations require consideration of the No Action Alternative, which can be used as a benchmark for comparison of the environmental effects of the various alternatives. The No Action Alternative would result from the Corps not issuing a permit for gravel fill and other construction activities regulated by the agency under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Without a Corps permit, gravel could not be placed outside of the boundaries of existing pads and the existing pads are not large enough to support evaluation and production of hydrocarbons as planned. The No Action Alternative would not meet the purpose of the project to develop the hydrocarbon resources within the Point Thomson unit as described in Chapter 1.

Two wells (PTU-15 and PTU-16), designed to function as either production or injection wells, were drilled and capped on the central pad. Protective wellhead covers approximately 16 feet tall and 8 feet in diameter were installed on PTU-15 and PTU-16 (see Figure 2.4-1) and rig mats remain onsite. All other equipment and camp structures were demobilized in 2011. If the No Action Alternative is selected, the wells would continue to be monitored in accordance with Alaska Oil and Gas Conservation Commission (AOGCC) regulations and prudent operator practices until the time that they are closed or brought into production in a future project. Monitoring activities would include up to four helicopter trips to the site each year.

Figure 2.4-1: Aerial View of the Existing Pad and Well Caps (left)
and South Facing Profile View of the Well Caps (right)

Under the No Action Alternative, the Applicant would suspend project engineering and planning activities for the evaluation of Thomson Sand and other hydrocarbon resources at Point Thomson. Evaluating the resources is integral to development and would require onsite support infrastructure and processing facilities that could not be built without a Corps permit (see Section 2.4.2 for evaluation description). The Applicant would evaluate project components to determine how the project could be redesigned to make permitting possible. If the No Action Alternative is selected through this NEPA process, the Applicant would continue to evaluate actions available, appropriate, and reasonable to develop Point Thomson in a way that could be permitted, and would endeavor to maintain land interest held in state oil and gas leases (Appendix D, RFI 75).

2.4.2 Components Common to All Action Alternatives

The action alternatives would result in building facilities associated with the exploration and recovery of hydrocarbon liquids. All action alternatives would include the following components: gravel pads to support drilling and production operations, gravel and/or ice roads and airstrips to support transportation needs, and export and infield pipelines.

Each of the action alternatives would deliver condensate and any producible oil to TAPS Pump Station No. 1 at Prudhoe Bay for shipment to market. Initial average production of condensate is expected to be 10,000 barrels per day (bpd). If and when the wells on the East and West Pads (described below) are deemed viable, the production of hydrocarbon liquids (oil in addition to condensate) may increase, though the extent of the potential increase would be determined by reservoir delineation and evaluation activities.

While the action alternatives are distinct alternatives, several components are common to each action alternative. These commonalities are largely due to the use of standard North Slope construction methods and design measures, and are listed below.

2.4.2.1 Common: Production Pads

Each alternative has a unique configuration of pads for drilling and production. Each, however, would have a minimum of four production wells, one injection well, and one disposal well arranged as follows:

- One production and one injection well on the Central Well Pad
- One production well on the East Pad
- One production well on the West Pad
- One additional production well on one of the three well pads
- One disposal well on the Central Processing Pad

While each of the action alternatives would have the six wells mentioned above, each of the well pads—Central, East, and West—would be designed to accommodate eight wells, for a total of 24 spaced 40 feet apart on each pad.

Each of the production wells would be designed to access the reservoir using both traditional and long-reach directional (LRD) drilling from a 180-foot-tall Nabors drill rig specially outfitted for the Point Thomson Project. The current 13,000 foot limit of existing LRD technology would enable each of the action alternatives to access offshore portions of the reservoir from onshore well pads. The wells on the East and West Pads would be used initially to delineate and evaluate the reservoir, and to determine whether the rim of oil surrounding the gas reservoir would be viable for production.

The equipment used to evaluate the oil rim and the reservoir would be located at the Central Processing Facility (CPF), gathering line installation would occur while the East and West Pad wells were being drilled. After completion of the wells, well test data would be reviewed to determine the viability of developing the reservoir oil rim (ExxonMobil 2011a). The processing facility would be able to accommodate 10,000 bpd of oil if development of the oil rim is determined to be possible (ExxonMobil 2009a).

If the oil rim is not viable for production, the gathering lines from the outlying pads would be used to cycle gas to test ***reservoir connectivity***, evaluate condensate recovery, and provide service for gas production and expanded cycling in future projects (Appendix D, RFI 95). By injecting dry gas into the reservoir and monitoring pressures at the different wells, the Applicant would be able to determine to what extent the reservoir is connected as one large source or whether it is made up of independent smaller reservoirs.

In each alternative, the East and West Pads would be connected by infield gathering pipelines to the CPF. The CPF is where product from the wells would be separated and liquid condensate would be recovered. After processing, dry gas would be injected into the reservoir and any byproduct liquids would be injected into the ***Class I disposal well.***

Central Processing Pad

Each alternative has a centrally-located pad that houses its camps, processing facilities, water treatment facilities, and main storage areas. In some alternatives, the Central Processing Pad and Central Well Pad are on the same gravel footprint, while other alternatives separate the drilling and processing facilities on two distinct gravel pads.

Main Processing and Utility Modules

The CPF would separate gas, hydrocarbon liquids, and ***formation water*** extracted by the production wells. Full wellstream production would be processed at an estimated rate of 200 mmscfd, from which the condensate would be separated and stabilized to meet export pipeline specifications. Once the condensate is removed, the separated gas would be compressed and injected into the Thomson Sand through the injection well at the Central Well Pad.

A single flare stack with one high-pressure (HP) and one low-pressure (LP) “tip” would accommodate flaring just west of the main portion of the Central Processing Pad (see Figure 2.4-2). Two blue flames, one on each tip, would burn constantly, similar to the pilot light in an oven. With wind, the pilot flame may be approximately 10 feet wide and up to 1 foot high; during a windless period, the pilot flame may be approximately 2 feet wide and 8 feet tall (Appendix D, RFI 1). Active flaring would occur to safely burn natural gas that occasionally needs to be released when pipelines and facilities are depressurized for maintenance. Emergency flaring would occur during a process upset, or in an emergency situation (ExxonMobil 2011b). Both the pilot and flare flames would be visible at night, though the blue pilot flames would not likely be visible during daylight (Appendix D, RFI 1).

The flare stack would not exceed the height of 150 feet above the ground surface (ExxonMobil 2009a). In an emergency situation, the maximum gas flow rate to the HP flare tip would be approximately 250 mmscfd; the maximum gas flow rate to the LP flare tip would be less than 20 mmscfd (ExxonMobil 2010a).

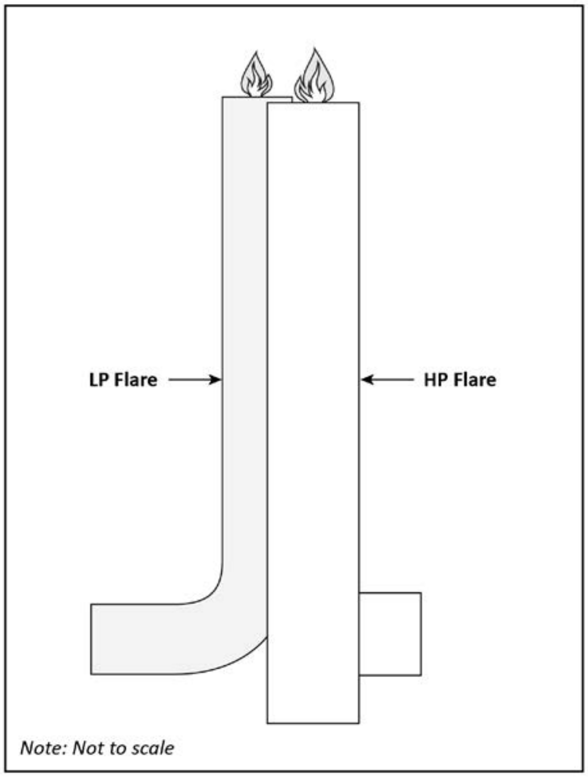


Figure 2.4-2: Combined High/Low Pressure Flare Stack

Support Facilities

Associated support facilities on the Central Processing Pad include offices, warehouses and workshops, maintenance buildings, temporary construction/drilling and permanent operations personnel camps, treatment systems for drinking water and wastewater, waste management facilities, communication facilities, electric power generation and distribution facilities, and an emergency response boat launch ramp.

- **Storage:** The warehouse facilities on the Central Pad would provide a dry and warm storage area, as well as individual maintenance shops for vehicles and electrical, instrumentation, and mechanical support systems. Storage and staging pads in Deadhorse would also be used during construction.
- **Camps:** Each alternative would require camps for construction, drilling, and operations. Temporary camp modules would be self contained and include potable and wastewater systems. They would be located on gravel pads or single-season ice pads (ExxonMobil 2010a). A permenant operations camp would be located on the pad with the CPF. All camp modules would contain kitchens, laundry, recreational facilities, and sleeping quarters.

A minimum of two infield construction camps would be required to house up to 600 construction crew members. In the first construction season of each alternative, a temporary 140-bed export pipeline construction camp would be required; its location would depend on the pipeline route in that alternative. In the second pipeline construction season, crew members would be housed at one of the two main construction camps (HDR 2011a). These construction camps would demobilize with the construction crews and equipment.

A temporary drilling camp would arrive onsite with the drill rig and would house the 140-person drilling staff; it would demobilize with the drill rig at the end of the drilling phase (HDR 2011a).

The permanent operations camp would be designed to hold up to 140 staff members, though the average operations crew would be 80 personnel (HDR 2011b) during standard operations. This camp would arrive with the facility modules in each alternative. Utility modules associated with the operations camp would include a potable water treatment system, potable water tanks, a wastewater treatment system, storage tanks for raw water and fire abatement, and water pumps for fire fighting.

- **Water storage:** Sufficient water storage tanks would be installed to support fire suppression systems and to meet raw water and potable water demands. Typical freshwater requirements for the construction camp would be 55 gallons per person per day, and 100 gallons per person per day during operations (HDR 2011c).

- **Water treatment system and waste disposal.** The Class I disposal well would be located on the Central Processing Pad to support drilling and facilities operations. Domestic wastewater and solid waste would be approximately 20,000 to 40,000 gallons per day during construction and drilling. During operations, camps would be expected to generate 18,240 gallons per day of domestic wastewater (Appendix D, RFI 41).

  During construction, domestic wastewater would go through ***secondary treatment*** and be discharged to the tundra under a process governed by general permits. Once the Class I disposal well is drilled, domestic wastewater and drill cuttings would be disposed via that well. During operations, all treated wastewater would be injected into the Class I disposal well. In the event that the Class I disposal well was temporarily not operating, treated domestic wastewater would be discharged to the tundra under an NPDES/APDES general permit and all other wastewater would be stored or hauled to another facility until the disposal well was running.

  Produced water from the CPF, effluent from the wastewater treatment system, and fluids from operations and maintenance would be routed to the Class I disposal well for well injection. The Class I disposal well would also be used as the disposal well for drilling cuttings. Grind and inject facilities would be constructed and located on the Central Processing Pad to ensure authorized wastes were sufficiently processed for injection via the Class I disposal well.

  During the operations phase, a camp incinerator would be installed and used for the disposal of burnable solid waste. Solid waste that cannot be recycled, reclaimed, incinerated, or injected would be transferred to the NSB owned and operated Oxbow landfill located in Deadhorse or to another appropriate facility.

  Appropriately-designed storage areas for all wastes, including hazardous wastes, would be constructed and managed to comply with all permit stipulations and applicable regulatory requirements. More information on waste disposal can be found in Section 5.24, Risk and Impact Assessment for Spills.

- **Communications:** During construction, the temporary construction camps would require voice and data telecommunications service. Temporary satellite dishes at each camp/office site (Central Pad, pipeline tie-in site, and any ice road camps) would be approximately 35 feet tall and could be placed on the ground or atop the camp (55-foot total elevation if atop the camp). Microwave communication to remote locations via satellite earth station sites may also require elevating radio antennae above existing ground clutter and vehicle traffic. Additionally, the project may require two-way radio communication between construction, operations, and safety groups during construction. This communication would require one or more additional radio repeater sites, likely midway between Point Thomson and the pipeline tie-in site (ExxonMobil 2010a).

During operations, a 160-foot communication tower with associated equipment would be constructed at the Central Pad. An additional 200-foot communication tower would be constructed at the pipeline tie-in site. Fiber optic and copper cable would be used to provide voice, data, digital cellular service (DCS) signals, and basic process control system (PCS) signals between modules/locations at the Central Pad and to/from the outlying well pads. Conventional analog repeater systems would be dedicated to support emergency response activities (including spill response) at the Central Pad and along the pipeline route. A separate communication building would house all radio frequency equipment at the Central Pad.

- **Power generation:** Diesel-powered electrical generators would supply power during construction and drilling. Construction and drilling power requirements are estimated to be less than 1,000 kilowatts (kW). For operations, four gas-fired turbine generators (7,000 kW each) would be located on the Central Pad. Transformers would be provided at each pad location to provide the required voltage for the activities on that pad.

- **Safety zones, storage, and fuel storage:** The Central Processing Pad would include a safety zone, construction laydown area, a number of storage and tank areas for diesel and methanol storage tanks, and a cold storage area with associated pipe racks, cable racks, and storage equipment. Tanks and storage area requirements, including size and number of tanks, would be confirmed as design of the facilities progress; the descriptions of the action alternatives identify notable or unique storage needs for that alternative. If required, tanks and associated instrumentation would be heat-traced and insulated to avoid freezing.

  Diesel fuel is required to support equipment and some facilities during all phases of the project. A diesel fuel storage area would be located on the Central Processing Pad or Central Well Pad to support construction and drilling activities. The infield activities of the first construction season in each action alternative would require approximately 1.5 million gallons of diesel fuel supplied by truck over the course of the first winter and stored in 60 stackable, 25,000-gallon temporary fuel tanks on the existing Central Pad footprint. These tanks would be constructed in Fairbanks and trucked to Point Thomson early in the first construction season. Some of the temporary diesel fuel storage area used for construction may be converted to use for permanent storage during operations, at which point a secondary containment foundation for the diesel tanks would be constructed, in contrast to the removable secondary containment pool used during construction. During operations, project facilities would use produced gas to the greatest extent possible, and external fuel needs would be reduced.

  A methanol storage tank would be located on each of the well pads. Methanol is required for hydrate formation inhibition and freeze protection of the wells and production and injection lines, as well as to protect the process facilities during startup and shutdown. Methanol and other production-related chemicals (e.g., corrosion inhibitor, emulsion breaker) would be stored onsite.

Central Well Pad

Two wells, PTU-15 and PTU-16, were completed in 2010. These wells, as with all the proposed wells, were spaced at least 40 feet apart and were designed to function as either production or injection wells. After the third and fourth production wells were drilled at East and West Pads, respectively, a fifth production well could be drilled on any of the Central, East, or West Well Pads, based on information obtained from the previous four wells. While the current condensate production project would require up to four wells on the

Central Well Pad (up to three production wells and one injection well), the area would accommodate up to eight wells for future projects.

Emergency response boat launch: In addition to wells, each alternative would feature an emergency response boat launch at the Central Well Pad. The boat launch would consist of an approximately 110-foot-long gravel ramp leading from the pad to a gravel-and-concrete launch. The launch would be 24 feet wide and would consist of 60 feet gravel overlain by concrete planks to a point approximately 3.5 feet below mean lower low water (MLLW; see Figure 2.4-3; ExxonMobil 2011b).

In each action alternative, the launch ramp would enter the water in a sheltered inlet to provide a safe launching area for emergency response personnel. A review of the bathymetry of the inlet revealed a 3-foot-deep channel in the generally 1.5-foot deep inlet (HDR 2011d). This channel would allow the emergency response contractor's response boats, which range in draft from 1 foot to 3 feet (Alaska Clean Seas 2010), to pass from the protected area into open water to respond to a spill.

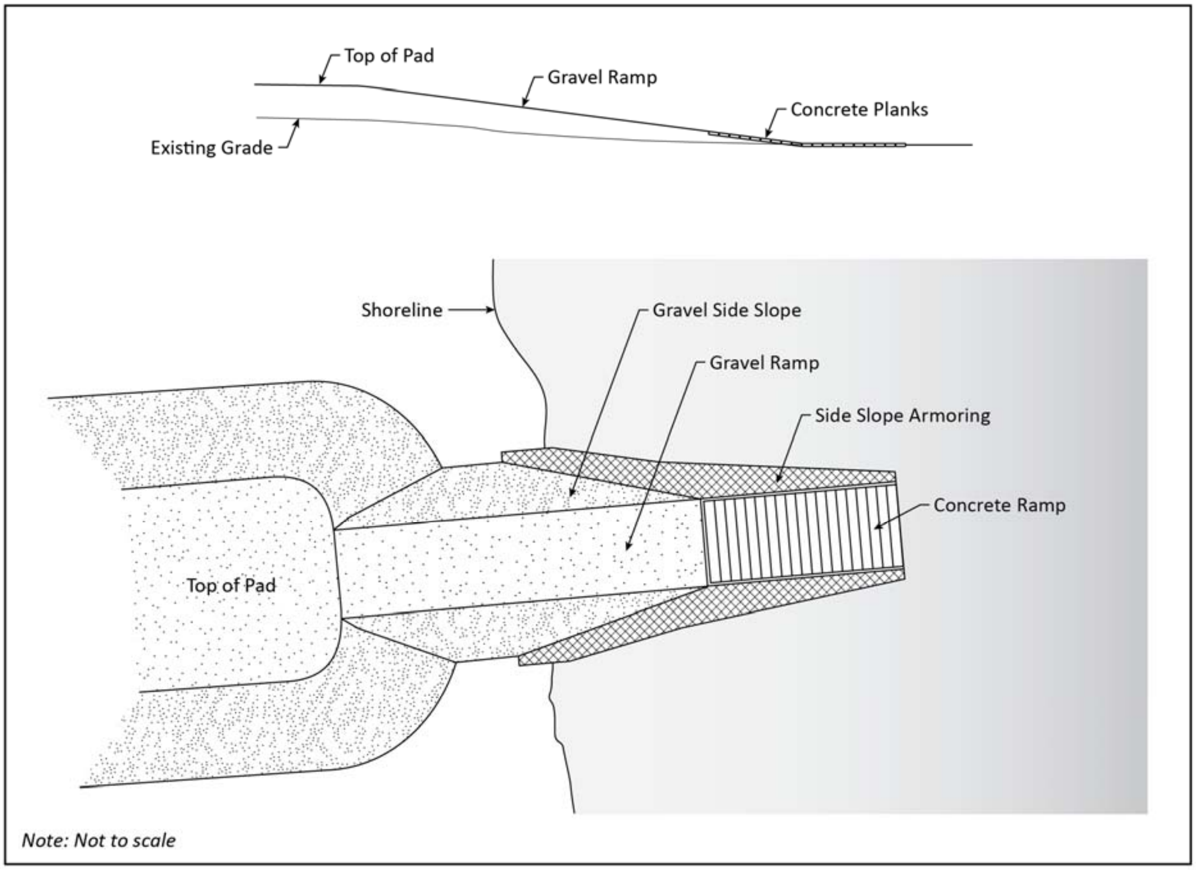


Figure 2.4-3: Emergency Boat Launch Ramp Example Drawing

East and West Pads

The East and West Pads would be constructed to contain production wells and associated facilities and to allow drilling the delineation/development wells that would target the oil rim. Each pad would accommodate up to eight wells.

- During drilling, much of the East and West Pad areas would be occupied by facilities and services to support drilling, including diesel fuel storage, temporary camps, and utilities.
- Personnel camps for operations would be located on the Central Pad, though they could also be located on the East and West Pads depending on the needs of the alternatives.
- Permanent flares would not be installed at the East and West Pads, though temporary flaring may be necessary during drilling completion and the testing of wells.
- During construction and drilling, power for the pads would be generated by onsite diesel-powered generators. During operations, power would come via cables from the generators at the CPF. In each alternative, the power cables to the outlying pads would be located in cable trays on the supports for the gathering pipelines. These cable trays would also have a minimum 7-foot clearance between the bottom of the tray and the tundra surface.
- Equipment on the pads during operations would include the ***Christmas tree*** and the valves and piping manifolds associated with the pipeline connection to the processing facilities, including ***pig launching*** facilities. Other equipment would include a methanol injection tank and pump package to put the well in condition for startup after shutdown.

Pad and Infield Infrastructure Maintenance

Maintenance for all infield pads, airstrips, and infield gravel roads would occur on an ongoing basis. A grader and compactor would be used weekly or as needed during the summer to maintain gravel integrity. In addition, a snow blower and grader would operate as needed to remove snow during the winter.

2.4.2.2 Common: Pipelines

Each alternative would include a configuration of infield gathering lines to bring ***produced fluids*** from the well pads to the CPF for processing, and an export pipeline to bring condensate to a connection with TAPS. These pipelines would include “Z” type offsets to allow for thermal expansion (see Figure 2.4-4). They would be elevated on VSMs with a minimum 7-foot clearance between the bottom of the pipe and the tundra surface. The 7-foot clearance would allow free passage by wildlife and subsistence hunters on snow machines.

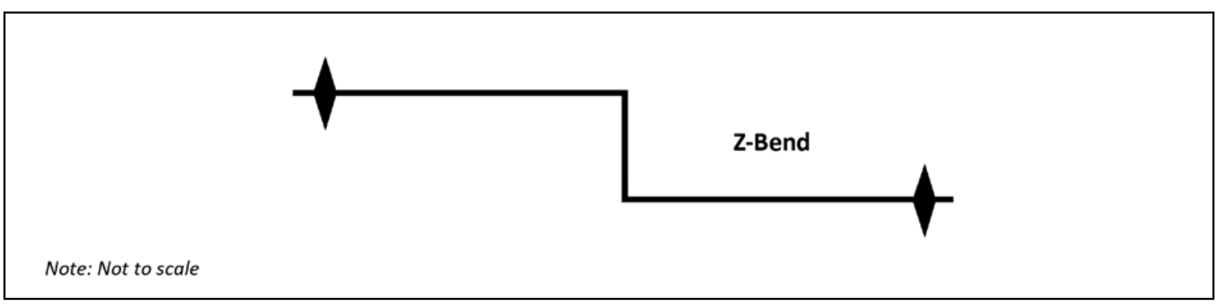


Figure 2.4-4: Example “Z”-type Horizontal Offset for Thermal Expansion of a Pipeline

Export Pipeline

The length and route of the export pipeline would vary by alternative, but in each case would be made of carbon steel and insulated. The design flow rate would be 70,000 bpd with a design pressure of 2,035 psig, which indicates the need for a 12-inch export pipeline. As previously stated, initial production would be approximately 10,000 bpd.

Most stream and water body crossings along the pipeline route would be constructed above-grade using VSM, though some export pipeline routes may require bridges that are described under those alternatives. Where the pipeline would cross the existing or proposed gravel roads, it would be installed in casings through the roadbed gravel using standard design practices for the Alaska North Slope (ExxonMobil 2009a).

Piping facilities associated with the export pipeline would include pig launchers/receivers, isolation valves, metering equipment, leak detection equipment, data acquisition equipment, and control/safety systems. A pig launcher and custody transfer meter module would be located at the CPF. A single module would house a pig receiver, surveillance meter, control unit, and generator at the tie-in location.

Infield Gathering Lines

The number and length of gathering lines would vary by alternative. Each gathering line would be made up of an approximate 8-inch heat-traced pipeline plus insulation, which would accommodate production from a single well. Gathering lines would be externally coated to reduce glare from the pipeline and contrast against the surrounding landscape. Like the export pipeline, the infield pipelines would be elevated on VSMs with a 7-foot clearance between the bottom of the pipe and the tundra surface. VSMs would be installed at regular intervals along the pipeline routes, and all infield stream crossings would be accommodated by the spacing of the VSMs.

The infield gathering lines would be configured to allow the launching and receiving of pigs for in-line inspection of the pipeline and ***maintenance pigging***. Pig launcher and receiver facilities would be located at the well pads. Fiber optic communications cables and power cables would also run along the infield gathering pipelines between the CPF and well pads, supported in trays on the horizontal support members (HSMs).

Pipeline Construction and Maintenance

The export pipeline and infield gathering pipelines would be constructed during the winter from tundra ice roads, with small ice pads located along the ice road for materials storage and staging. The pipe would be joined into long sections, coated as necessary to prevent external corrosion, and insulated prior to its arrival at the project area. Pipe sections would be staged along the route and welded together prior to their placement on the VSMs. In the summer following construction, all pipelines would be hydrostatically tested, or filled with water and pressurized to more than 100 percent of their design operating pressure. This test would identify any stress points or breaches along the pipeline that could be repaired or replaced prior to filling the pipeline with hydrocarbons during operations.

Water from hydrostatic testing of all pipelines would be treated according to the NPDES/APDES permit before being discharged to the tundra. If treated hydrostatic test water were to exceed the effluent limits, then the wastewater would be disposed of down the Class I disposal well or hauled to another permitted facility for disposal.

Export and infield gathering pipelines that could not be visually inspected from a road would be monitored weekly using fixed-wing aircraft or helicopters. In most cases, the aerial surveillance would occur on a year-round basis. The exception to this might be times when it is necessary or desirable to conduct on-the-ground inspections using off-road vehicles or ice roads in close proximity to the roads or pads. Such ground-based inspections would not be expected to occur more than one or two times a year. To the extent feasible, the aerial surveys would be conducted as part of other regular helicopter travel to and from Point Thomson.

2.4.2.3 Common: Access and Transportation

During construction, personnel, equipment, and supplies would be transported to and within Point Thomson by air, land, and in some alternatives, sea. Each alternative would use ice roads, airstrips, and gravel roads during construction. General information regarding the considerations and construction of each type of infrastructure is provided below, and specific configurations are provided in the individual alternative description. Because only two of the five action alternatives utilize barges for the transport of goods and equipment, a discussion of barge infrastructure is provided in the descriptions of those alternatives.

Ice Roads

Ice roads are one of the fundamental ways to get goods, equipment, and people around the North Slope in winter. Ice road construction is weather-dependent, and generally begins in late December or early January, though prepacking of the snow can begin as early as October. The main ice road would generally be ready by mid-February and would be thick enough to accommodate normal trucks for up to 300,000 pounds. The ice road season lasts from approximately February through April, though it can be longer or shorter depending upon the year's weather. For drill rig transport, the ice would need to be thicker (and wider) and would generally take an additional three weeks to prepare. Ice roads are restricted to no more than a 2 percent slope for transportation of drill rigs. Additional information regarding the construction, operation, and maintenance of ice roads can be found in Appendix G, North Slope Construction Methods.

Each alternative would use ice roads for access to Point Thomson during construction, as well as to enable its gravel infrastructure and pipeline construction. The tundra ice roads for materials and personnel transportation and for pipeline construction would each be approximately 6 inches thick, and roads for module transport would be approximately 1 foot thick, though in each case the actual road thickness would depend on the topography of the area. The width of each type of road is described in the alternative descriptions. In addition to access roads, "tie-back" ice roads would also be required along the pipeline right-of-way (ROW) to connect the pipeline construction road (work pad) with the Point Thomson access ice road.

Each alternative would also have infield ice roads during construction. These roads would also be 6 inches thick, and would generally be 35 feet wide (ExxonMobil 2011a) unless otherwise noted in the alternative description. They would be used to support the construction of the bridges along the infield gravel roads and of the infield gathering pipeline network, and to access water for ice road construction. Other minor ice roads would be constructed during the construction season and as needed during operations according to existing ice road permitting requirements.

Some alternatives would require the use of ice roads for movement of the drill rig either between well pads infield or during demobilization at the end of the drilling phase. These drilling ice roads are detailed in the descriptions of the alternatives that use them.

Airstrips

Each alternative includes a gravel airstrip for year-round, fixed-wing aircraft access to Point Thomson. Such airstrips are key elements for the transport and safety of personnel, supplies, and emergency response. While the size and location of the airstrip would vary by alternative, each would include a helipad, runway lighting, an airport control building, an airstrip ***apron***, and navigational aid (Navaid) pads adjoining the airstrip. Runway lighting would include lights elevated up to two feet that would be on constantly when the airstrip was operational (Appendix D, RFI 4), all powered from lines buried in the airstrip apron. The Navaid pads would include up to four towers for communication and data transmission: one 30-foot tower, two 45-foot towers, and one 55-foot tower with antennae (ExxonMobil 2010a).

Prior to the airstrip becoming available, the primary emergency evacuation method would be helicopter to Deadhorse and medical evacuation from Deadhorse to Fairbanks or Anchorage. Once operational, the airstrip in each action alternative would enable direct transport, including medical evacuation, between Point Thomson and Fairbanks or Anchorage. Typically-sized aircraft using the runway would include the 19-passenger Beechcraft 1900D or a deHavilland Twin Otter for personnel and light freight transport.

Gravel Roads

The number, type, and route of gravel roads would depend on the alternative, though each alternative includes a road from the Central Processing Pad to the airstrip to accommodate frequent personnel transport. The gravel roads, whether infield or access, in each alternative would be 32 feet wide at the crown with a 2:1 slope on each side, resulting in an average footprint width of 58 feet HDR 2011c). Roads would be 7 feet thick on average, though that depth would vary as required to maintain grade on uneven terrain.

Gravel road installation would occur during winter construction seasons using typical North Slope equipment and methods (see Appendix G, North Slope Construction Methods). Maintenance of the gravel roads would include periodic watering for dust suppression.

Road Stream Crossings

The ice and gravel roads in each alternative would cross streams and creeks in the project area. Ice roads would be grounded across streams. Gravel road stream crossings would be accommodated by culverts, though larger streams may require bridges. Culverts would be installed after the initial road installation during winter construction or low-flow conditions in late summer. They would be supported by seasoned gravel, and would be designed for a 50-year flood event. Additional culverts would be added to the roads in late summer if observations during spring breakup identify that the roads not allowing sufficient water flow through the area. Bridges would consist of pipe piling supports with sheet piling abutments and precast concrete decks. The road routes in each alternative would determine the number and location of bridges for that alternative. These crossings are identified in Section 5.6, Hydrology.

2.4.2.4 Common: Other Infrastructure

Gravel Source

The primary gravel source for the project would be from a new gravel mine site. The size of the new gravel mine would be determined by the gravel requirements of the alternative. The mine's precise location and layout would depend on both the alternative and the results of an analysis of core samples prior to construction of the mine, though each alternative suggests a general area in which the mine would be located.

To access the gravel, a surface layer of organic and inorganic material called "overburden" would need to be removed and stockpiled on ice pads. The gravel would be mined frozen (standard North Slope practice) during the winter season using explosives. Mining operations would include blasting and mechanical excavation to a depth ranging between 40 and 50 feet below the overburden, depending on the gravel content of the mine. At the end of the mining season, the overburden would be replaced in the mine at the end to ***oversummer***. The same process would occur in an adjacent area of the mine the following winter (HDR 2011e). Each alternative assumes the need for two consecutive seasons of gravel mining to provide sufficient gravel for initial construction and a maintenance stockpile.

Mined gravel would either be placed in a stockpile area or directly on the site it is to be used. Gravel that is placed on the tundra to provide substructure for facilities must be seasoned, or farmed, in place. Gravel farming entails overturning the gravel to remove the moisture and to allow compaction. Farming would be ongoing during the construction phase.

Over the course of the summer, the gravel mine would fill slightly with water and would require 1 to 2.5 weeks to dewater in the fall. The water, because it is untreated natural seepage, would be pumped out of the mine into the natural drainage under an EPA general permit.

The new gravel mine site would be rehabilitated, including replacement of the overburden, contouring, and creating stable side walls. Once filled with water, the new mine site reservoir could be used as either a primary or secondary source of water for the project, depending on the alternative.

Additional Pads

In addition to the primary pads for facilities and drilling, a variety of supplemental pads would be required by each alternative, including:

- **Gravel Storage Pad.** A gravel storage pad would be constructed adjacent to the gravel mine for storing mined gravel for future maintenance needs. The storage pad would be accessible via the gravel mine access road.
- **Temporary Construction Camp Ice Pads.** The Applicant would locate construction camps either on a single-season ice pad or on gravel pads as they become usable. The pad would accommodate a total of 500 personnel housed in two 200-bed and one 100-bed modular camp structures. While the camps themselves may eventually house up to 600 personnel when construction and drilling activities overlap, it is anticipated that the larger, permanent camps would be used at that time and would be located on the new gravel pad, rather than on a single-season ice pad.

  In addition to the potential infield construction camp ice pads, the installation contractor for the export pipeline in each alternative may require a temporary ice pad to house its construction crew. The size of the crew and the location of/need for the pad would depend on the route and length of the export pipeline as described in each alternative.

- **Alaska State C-1 Exploration Well Pad.** This existing area, also called the C-1 storage pad, would be used as a secondary equipment and materials storage pad for all alternatives. The existing gravel fill at this pad encompasses 4 acres. This pad footprint would not be enlarged, but more gravel would be laid on top of the existing gravel.
- **Water Source Access Pad.** An access pad of less than 1 acre would be constructed next to the existing Point Thomson area water source (C-1 mine site). This pad would be used to support year-round water withdrawal during construction.

In addition to ice roads, ice pads would be used to support construction works. These would include approximately 2- to 3-acre ice pads along the ice roads to stage materials for bridge and pipeline construction, ice pad extensions required to support construction activities on the Central or Central Processing Pad, and ice pads adjacent to the gravel mine for the temporary storage of overburden removed from the mine.

Water Needs and Sources

During construction, freshwater would be required for the construction and maintenance of ice roads and pads, the compaction of gravel for new roads and pads, dust suppression on gravel infrastructure, and camp use. The required freshwater would be supplied from existing, year-round water sources located between

Endicott and the Point Thomson Project area. Sources in the vicinity of the Central Pad include currently-permitted lakes and the existing C-1 mine site reservoir; other sources could be permitted as needed to support construction. Sources in the vicinity of Badami include the permitted Shaviovik Pit, Turkey Lake, and Badami Reservoir, as well as other permitted and possible future permitted sources. Sources in the vicinity of the Endicott causeway landfall include the Duck Island Mine Site and Sag Mine Site C (Vern Lake), as well as other permitted and possible future permitted sources.

Drilling water needs include camp use and water used to create drilling fluids, or "muds." These drilling muds are compounds used to lubricate and cool the drill bit as the well bore is being drilled. During the drilling of surface holes, or the area between the ground surface and the hydrocarbon layer, muds are mixed using water. Once the hydrocarbon layer has been breached, the muds are mixed using mineral oil-based drilling fluids, so water use for drilling would decline after surface drilling was complete.

Operations water use would consist largely of camp water and routine maintenance activities such as dust suppression on gravel roads or the construction and maintenance of any operational ice roads required by the alternative. These needs would fluctuate based on the level of activity of a particular year, and the water needs listed for operations in each alternative represent a conservative average use estimate. Camp water use during construction and drilling would be approximately 55 gallons per person per day, and that water use would increase to 100 gallons per person per day during operations (HDR 2011c).

Water for drilling and operations would come from a primary source identified for each alternative, and would be supplemented as necessary using water from sources that are currently permitted by the DNR or would be identified and permitted as they were needed. Please see Section 5.6, Hydrology, for a discussion of surface water recharge, and Appendix F for additional information regarding the length and requirements of the temporary water use permitting process.

2.4.2.5 Common: Logistics and Sequencing

The logistics and sequencing of the alternatives vary greatly, though each follows a standard pattern phasing within the project. Construction in each action alternative would begin with a mobilization, using various modes of transportation, of equipment, supplies, and personnel to the project site. The construction phase of project development would include gravel mining; infrastructure installation, including roads, pads, airstrips, and pipelines; and facilities transport, installation, and ***commissioning***. In each alternative, the drill rig and drilling camp would arrive onsite once the well pads were ready for use, generally during the last year of onsite construction. The operations phase would begin as soon as the first wells were complete and sending condensate to the CPF. In each alternative, first production would occur while the final wells were being drilled. As a result of this phased project execution, and because drilling never occurs independent of other construction or operational activities, discussions of drilling needs within the alternative descriptions frequently overlap with the discussion of construction or operations activities that would occur concurrent with drilling.

Drilling Sequence

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

2.4.3 Alternative B: Applicant's Proposed Action

Alternative B would configure the drilling and production facilities onto three gravel pads to facilitate evaluation of all hydrocarbon resources and provide flexibility for future natural gas production should the currently-proposed project prove that larger-scale natural gas production was viable. This alternative would locate the onshore gravel pads near the coastline, incorporating portions of two existing gravel pads (see Figure 2.4-5 and Figure 2.4-6). To facilitate the transport of large facility modules to Point Thomson, a sealift facility composed of onshore bulkheads and offshore mooring dolphins would be constructed. See Table 2.4-1 for other key features of Alternative B.

Table 2.4-1: Alternative B — Summary

Theme	Applicant's Proposed Action
Pads	• Central (Well/Processing) Pad (55 acres) • East Pad (15 acres) • West Pad (17 acres) • Badami auxiliary pads (1 acres)
Transportation to/from Field	Construction • Air – helicopter (all years) and gravel airstrip (Year 2 and beyond) • Seasonal tundra ice road (52 mi) between the Endicott Spur Road and Point Thomson for transporting materials and supplies (ongoing) • Seasonal tundra ice road (30 mi) for VSM and export pipeline construction (2 years) • Seasonal sea ice road (47 mi) for supplemental materials and equipment transport (up to 3 years, optional each year) • Tundra-safe, low ground pressure vehicles when allowed • Coastal barging access via service pier with mooring dolphins • Sealift and barge bridge landing with bulkheads and mooring dolphins Drilling • Air, barge, and tundra-safe, low ground pressure vehicles as described under construction • Seasonal tundra ice road (52 mi) for drilling resupply (2 years) Operations • Air, barge, and tundra-safe, low ground pressure vehicles as described under construction • Ice access road as needed (conservatively every 5 years)
Module Transport	To Point Thomson by sealift barge
Infield Transport	• Ice roads during construction (23 mi, 2 years) • Gravel roads (12 mi)
Infield Pipelines	8-inch gathering pipelines (10 mi)
Export Pipeline	12-inch export pipeline, tie-in at Badami (23 mi)
Primary Water Source	Existing C-1 reservoir
Other Infrastructure	• New gravel airstrip (5,600 feet x 200 feet) and associated facilities (43 acres) • Infield gravel mine • Additional pads for gravel stockpiling, storage, and water access • Seasonal ice pads for temporary storage and camps during construction
Compressor Type	Reciprocal

POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Oil and Gas Development Unit
- Existing Facilities
- Water Body
- Existing Pipeline
- Existing Road

Proposed Project Layout

- Tundra Ice Road
- Sea Ice Road
- Gathering Pipeline
- Export Pipeline
- Road Centerline
- Potential Water Source
- Airstrip
- Gravel Mine
- Gravel Pads
- Ice Pads

The data displayed is concept level and has not been engineered.

0 2.5 5 Miles

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Figure 2.4-5
Alternative B - Applicant's Proposed Action
Sheet 1 of 2

Date: 21 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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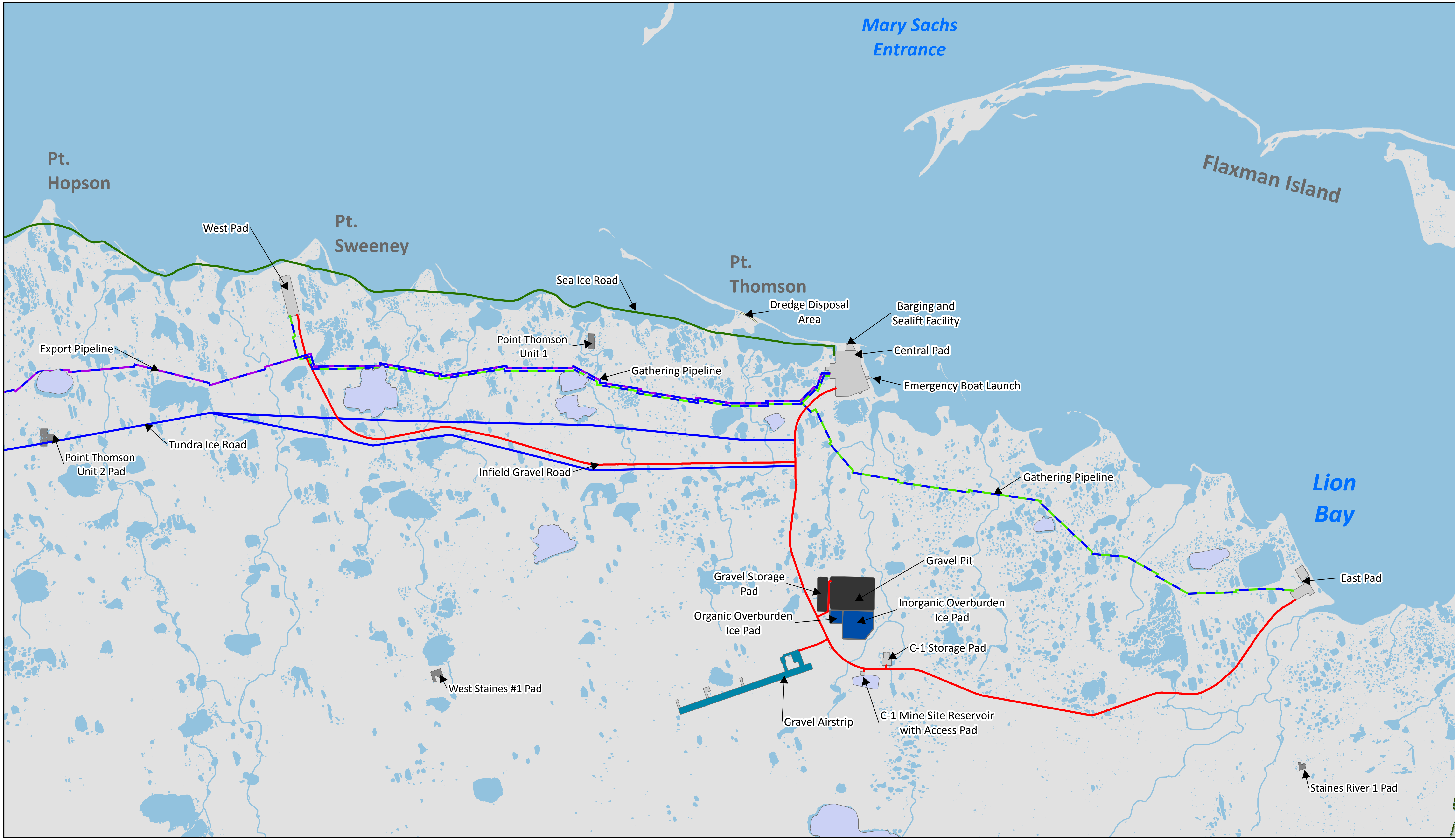

POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Existing Facilities
- Water Body

Proposed Project Layout

- Tundra Ice Road
- Sea Ice Road
- Gathering Pipeline
- Export Pipeline
- Road Centerline
- Potential Water Source
- Airstrip
- Gravel Mine
- Gravel Pads
- Ice Pads

The data displayed is concept level and has not been engineered.

0 1 2 Miles

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Figure 2.4-6
Alternative B - Applicant's Proposed Action
Sheet 2 of 2

Date: 21 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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2.4.3.1 Alternative B: Production Pads

In Alternative B the existing gravel pads at the Central Well Pad and East Pad locations would be improved and enlarged and a new gravel pad (the West Pad) would be constructed. These onshore gravel pads would be connected by a 12-mile infield gravel road network and 10 miles of infield gathering pipelines. Additional pads, which include a small water source pad, a gravel mine stockpile pad, the C-1 storage pad, and auxiliary pads at Badami, are described in Section 2.4.3.4 under "Additional Pads."

Central Pad

Alternative B would collocate the Central Well and Central Processing Pads into a single footprint called the Central Pad and would be located at the site of the existing 12-acre PTU-3 gravel pad. The 55-acre Central Pad would be the largest of the three gravel pads and would be the primary storage for construction, drilling, and operations. The Central Pad would include the infrastructure to support remote operations and drilling. This infrastructure would include four key areas: (1) the main processing and utility modules; (2) drilling infrastructure; (3) associated support facilities; and (4) safety zone and construction laydown area. A drill rig camp would also be located on the pad near the drill rig during drilling. Due to its proximity to the coastline, slope protection would likely be needed on three sides of the pad.

- **Drilling/Well Infrastructure.** One production well, one injection well, and one Class I disposal well would be located on the Central Well Pad, which is a designated area of the larger Central Pad. The PTU-15 and PTU-16 wells were completed in 2011 and could function as either production or injection wells. The fifth production well could be located on any of the Central, East, or West Pads, based on information obtained from the other four wells.
- **Support Facilities.** Support facilities include those common to all action alternatives (please see Section 2.4.2.1). Unique support components for Alternative B include:
  - **Pioneer camp:** Because of the proximity of the start of construction to issuance of the ROD, Alternative B includes a pioneer camp that would be transported to the project site by tundra-safe, low ground pressure vehicles in late fall. This pioneer camp would be located on existing gravel, would house up to 160 personnel, and would be demobilized in late fall of Year 2 once the construction camp modules arrived.
  - **Construction camps:** Alternative B construction camps would have capacity for up to 520 personnel. Construction camps would demobilize in Year 5.
  - **Communications:** Temporary satellites dishes for voice and telecommunications would be located at the Central Pad, Badami, and any ice road camps. Radio repeater sites for two-way radio communications would likely be located midway between Badami and the Central Pad (ExxonMobil 2010a).
  - **Fuel resupply:** Diesel fuel would be resupplied annually by tanker trucks (winter) and/or barge (summer).

East and West Pads

The East and West Pads would each be located approximately 4 miles from the Central Pad. The size of the East and West Pads would be approximately 15 acres and 17 acres, respectively. The East Pad would be located on and adjacent to the existing North Staines River State No. 1 Pad. The North Staines River State No. 1 Pad contains an area that was impacted by a previous diesel spill (see Section 3.24 Contaminated Sites and Spill History). Known contamination at the East Pad would need to be addressed as part of the negotiations with the current lease holder and prior to construction. The West Pad would be located on an undeveloped site near the coastline west of the Central Pad. Additional features of the East and West Pads are described in Section 2.4.2.1.

2.4.3.2 Alternative B: Pipelines

Export Pipeline

A 23-mile elevated export pipeline would be constructed from the Central Pad to connect to the existing common carrier pipeline at Badami. The existing Badami common carrier pipeline connects to TAPS at Endicott, and continues to Pump Station No. 1 in Prudhoe Bay. The proposed pipeline route from Point Thomson to Badami is generally located more than a mile inland. The pipeline would cross the existing Badami facilities road and the proposed infield road to the West Pad, and would be installed in casings through the roadbed gravel at those locations.

Piping facilities associated with the export pipeline would include pig launchers/receivers, isolation valves, metering equipment, leak detection equipment, data acquisition equipment, and control/safety systems. A pig launcher and custody transfer meter module would be located at the CPF on the Central Pad. A pig receiver and surveillance meter module would be located at the Badami junction and would require the construction of a new gravel pad at Badami. Also located at the Badami junction would be a control module and a 120 kW generator. The Applicant would purchase power for the pigging module from the Badami operator, and would use the onsite generator only in the event that operations at Badami ceased for an extensive duration (HDR 2011d).

Infield Pipelines

Approximately 10 miles of infield gathering pipelines would be constructed to deliver the produced hydrocarbons from the East and West Pads to the CPF for processing. The VSMs between the East and Central Pad would accommodate a single 8-inch gathering line, and VSMs between the Central and West Pad would accommodate both the 8-inch gathering line and the 12-inch export pipeline (ExxonMobil 2011b). The proposed pipeline support design would be T-shaped, with one HSM atop one VSM; the VSMs would not be sized to bear the weight of additional pipelines (see Figure 2.4-7). Any future gas production at Point Thomson would require the construction of a second set of gathering pipelines with their own supports (ExxonMobil 2011b).

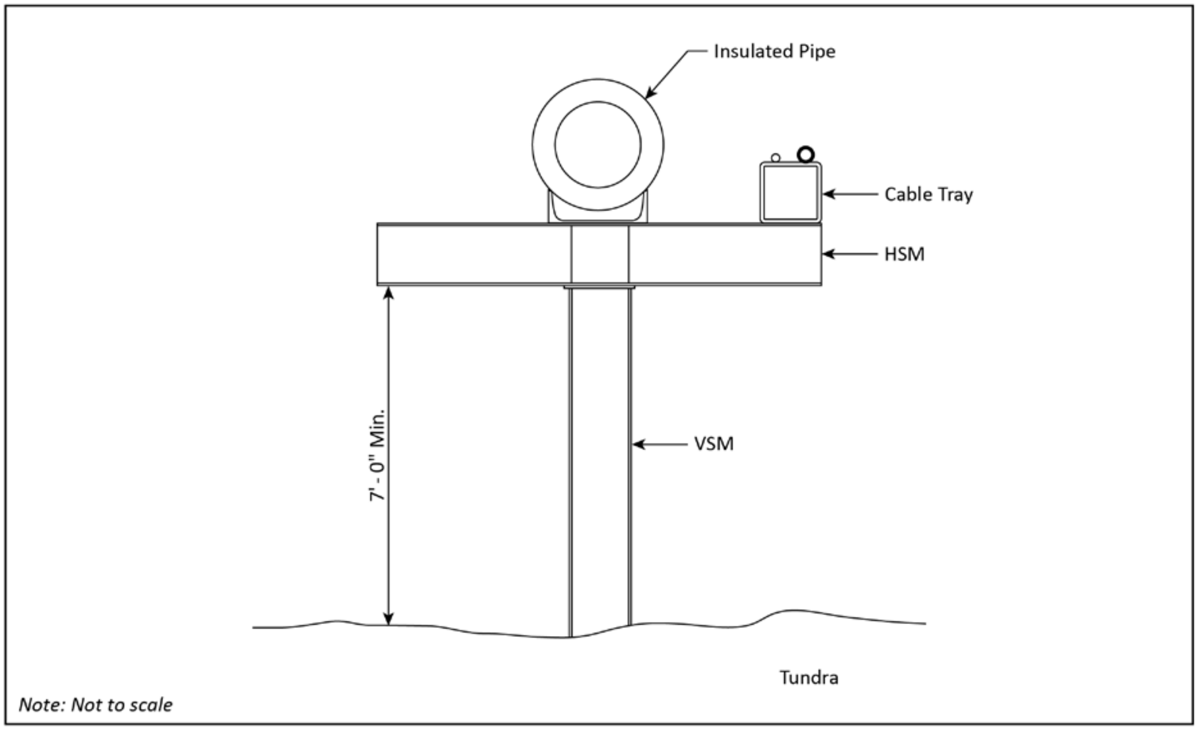

Figure 2.4-7: T-shaped Pipeline Support Structure

Pipeline Construction and Maintenance

Construction of the export pipeline would occur during two seasons. VSMs and HSMs would be installed first, beginning from the Badami end, during the first winter of construction. The pipe of the export pipeline would be installed the next winter season. The two-season construction scheme allows for a reduced ice road width because the road would not have to be shared with the concurrent activities of installing both the VSMs and export pipeline. The infield pipelines would be built in Year 3 (ExxonMobil 2011a).

2.4.3.3 Alternative B: Access and Transportation

Transportation modes for Alternative B are summarized in Table 2.4-2. Large modules would be brought to Point Thomson via sealift barge; small modules would be trucked to Prudhoe Bay and then transported to Point Thomson via ice road. Some modules may be staged in Deadhorse awaiting ice road opening.

Table 2.4-2: Alternative B — Transportation Modes for Materials, Equipment, and Personnel by Phase

	Ice Road	Gravel Road	Barge	Airplane	Helicopter
Construction					
Personnel	To/From (TF), Infield (IF)	IF	—	TF[a]	TF, IF
Materials and Equipment[b]	TF, IF	IF	TF	TF	TF, IF
Drilling					
Personnel	TF, IF	IF	—	TF	TF
Materials and Equipment[b]	TF	IF	TF	TF	TF
Operations					
Personnel	TF	IF	—	TF	TF, IF
Materials and Equipment[b]	TF[c]	IF	TF	TF	TF, IF

[a] The airstrip could be used for personnel and equipment transportation late in the second year of construction.

[b] While a wide variety of transportation modes would be used, the mode used would ultimately be determined by the size of the equipment needed and the time at which it was needed, e.g., the size of the permanent camp in this alternative requires barge transport to Point Thomson.

[c] Alternative B would not likely have an access ice road each year; if an ice road were constructed, however, it would be used as a resupply route for the duration of the ice road season.

The total number of trips to Point Thomson by mode and phase of the project is detailed in Table 2.4-3. Trip numbers in construction and drilling are cumulative for the phase and calculated based on the activities required for that phase. Trips for operations are estimated annually, and would likely increase or decrease depending on the activities being performed in a given year. Because infield traffic levels would be directly related to daily activities in each phase of the project, no estimates for infield traffic levels were developed for this analysis. Additional discussion of the logistics of Alternative B can be found in Section 2.4.3.5.

Table 2.4-3: Alternative B — Round Trips to Point Thomson by Mode and Phase

	Construction (total for phase)	Drilling (total for phase)	Operations (annual)
Land Transport (ice road)	4,510	5,200—6,250	0
Barge	170 coastal 10 sealift	20—100	15
Fixed-wing Aircraft	990	400	545
Helicopter	990	0	4

Source: ExxonMobil 2011a, Tables 1A and 1B.

Ice Roads

During construction, at least two primary seasonal ice access roads would be constructed. The first would be a tundra ice road (52 miles) or sea ice road (47 miles) that would extend between the Endicott Spur and Point Thomson for transporting materials and supplies. The second ice road would be a 30-mile tundra ice road built to support export pipeline construction between Badami and Point Thomson. This ice road would only be constructed for two pipeline construction seasons. Because each road would accommodate only standard traffic and equipment, the tundra ice roads would be approximately 35 feet wide, and the optional sea ice road would be up to 75 feet wide (ExxonMobil 2011a).

Also during construction, approximately 23 miles of infield ice roads would be constructed between the pads and water sources to support infield infrastructure construction. The infield ice roads would be used for standard vehicle and equipment traffic, and would be 35 feet wide and generally 6 inches thick, though variations in local topography may require increased thickness along portions of the road.

The infield gravel roads for Alternative B would be completed in Year 2 (see Sections 2.4.3.3 and 2.4.3.5), so no infield ice roads would be required during drilling. An ice road from the Endicott Spur to Point Thomson would be constructed through Year 6 to accommodate drilling needs. After Year 6, the annual resupply of equipment, fuel, and supplies would occur by air or by barge.

There would be no planned ice roads either to or within Point Thomson during operations. During the course of the projected 30-year operation of the Point Thomson field, however, large equipment or future modules may be needed that could not be delivered by air or wait until open water in the summer. On those occasions, conservatively estimated at once every 5 years, an ice road would be built between the Endicott Spur and Point Thomson, and after delivery of the required item, the road would be used for the duration of the season for winter resupply.

Barge

Marine access enables the transport of equipment and materials to Point Thomson during the open water seasons when ice roads are not available or when heavy loads exceed aircraft capacity. Depending on nearshore ice conditions, the open water season is generally from late July/early August through the end of September. This season is not entirely available for barging due to the subsistence whaling activity. The Applicant has voluntarily signed a Conflict Avoidance Agreement with the Alaska Eskimo Whaling Commission (AEWC) that affects barging activity. Through the agreement, the Applicant agrees to avoid barging during the Village of Kaktovik's and Nuiqsut's whaling season (generally from August 24 to September 23), to the greatest extent possible, in order to minimize potential impacts to subsistence hunting (ExxonMobil 2011b). When barging during the whaling season is needed, the Applicant will follow the protocols outlined in the Conflict Avoidance Agreement to avoid or minimize interactions with whaling vessels and whales.

Under Alternative B, two forms of barging would be available to access Point Thomson: coastal barges and oceangoing (sealift) barges.

Service Pier for Coastal Barges

Coastal barging was used to support the previously completed drilling activity using over-the-beach barge access near the Central Pad location. This form of access created barge weight limits and offloading challenges; therefore, as part of the project, a service pier would be built during the winter season to provide a better offloading facility for coastal barges. The pier would extend offshore approximately 70 feet and have a concrete deck supported by steel girders and six offshore vertical piles (ExxonMobil 2010a). Additionally, the Applicant would install four mooring dolphins to secure incoming barges. These mooring dolphins would remain in place for the duration of field life (ExxonMobil 2011b).

Coastal barges would be used to deliver small modules, foundation materials, and construction equipment to the jobsite to support construction, and would run as often as possible, depending on whaling activity and the weather, to take full advantage of the open water season. Coastal barging would also provide a means for the resupply of bulk materials and for the removal of wastes and excess equipment. To maintain a 4-foot water depth for the weight of these loads, and provide a stable base for barge offloading, the seafloor would be dredged and screeded (leveled) in an approximate 300-foot by 330-foot area seaward of the service pier (ExxonMobil 2011b). The barges would approach the pier parallel to the shore and, if they are side-loading barges, would offload in that position. If the barges were ramped, or front-loading barges, they would also approach the pier parallel to the shoreline, and be winched into a position perpendicular to the shore for offloading (see Figure 2.4-8; HDR 2011d). Periodic maintenance dredging and screeding would be required for the duration of service pier use (ExxonMobil 2011b).

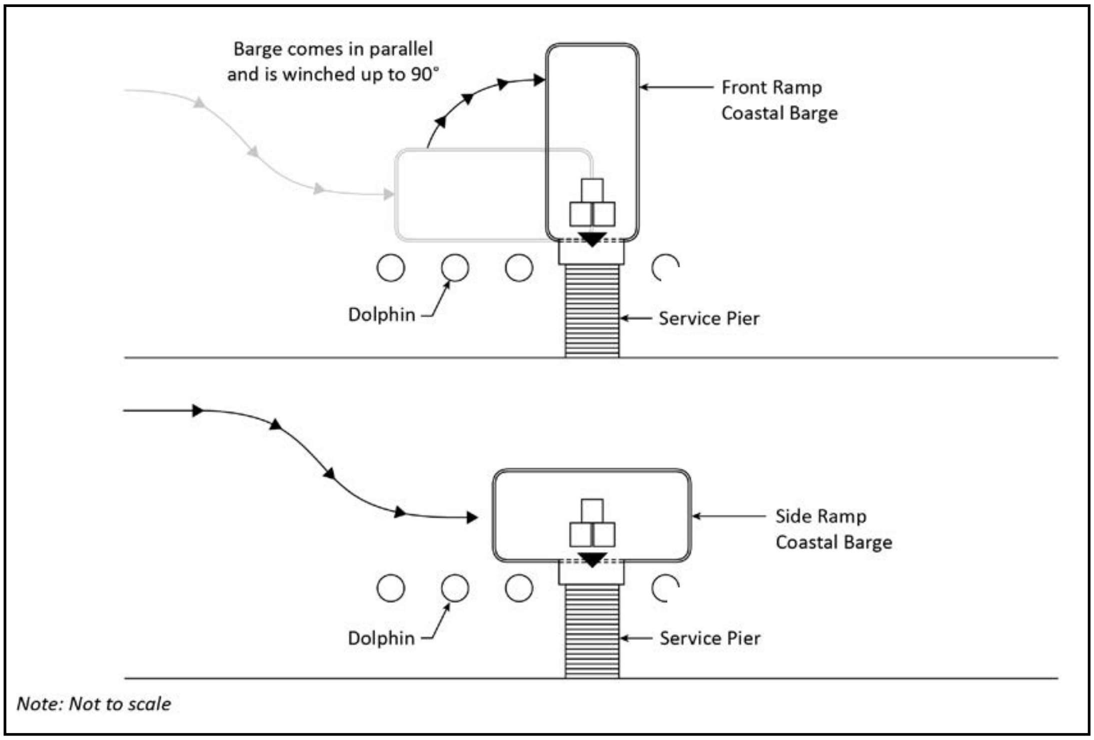

Figure 2.4-8: Coastal Barge Offloading

Sealift Facilities

Sealift barges are considerably larger than coastal barges and can carry heavier loads with relatively shallow draft. These loads would include larger processing and prefabricated facility modules, and even portions of the drill rig. To unload sealift barges, a sealift facility would be constructed adjacent to the service pier at the Central Pad. This would include an offloading bulkhead and offshore mooring dolphins to secure the barges as they form a barge bridge and are offloaded at the site.

The bulkhead would be constructed with sheet pile above the mean high water (MHW) line on the beach and be backfilled with gravel to transition to the grade of the Central Pad. As part of the bulkhead construction, the seafloor would require dredging and screeding to safely ground the large oceangoing barges sufficiently close to the bulkhead. Dredging and subsequent screeding would begin approximately 40 to 60 feet from the bulkhead and proceed north approximately 500 feet. Removed seafloor material would be placed along designated shoreline locations west of the Central Pad (Appendix D, RFI 106). Approximately 1,500 cubic yards would be dredged during each year of construction to support use of both the service pier and sealift facility (ExxonMobil 2011b). All pile driving, sheet driving, and dredging would occur in the winter, though screeding would occur in summer prior to the arrival of the first barges.

Each of the four offshore mooring dolphins would be a single pile driven into the seafloor during winter and topped with a rubber bumper and light. The mooring dolphins are needed to ensure an accurate alignment of the barges for offloading operations and would be left in place for future use (ExxonMobil 2011b).

The sealift facility would enable use of a temporary barge bridge for offloading large modules at the Central Pad. The sealift facility would allow up to three barges to abut each other end-to-end to enable movement of the modules across the barges and onto the Central Pad. The first barge to be offloaded would have a capacity of 1,500 tons because the barge draft must accommodate the average 5-foot water depth near the shoreline where the barge would be ballasted and grounded on the seabed. The barge would be secured to a mooring dolphin to resist any local movement during off-loading operations, and a 70-foot ramp would span the distance between the barge and the bulkhead. After the first barge was unloaded, the second barge would be navigated into position directly behind the first barge and also would be ballasted and grounded on the seabed. The second barge would be positioned so that modules could travel across the first barge onto the bulkhead and Central Pad. Similarly, the third barge would be placed directly behind the second barge and ballasted and grounded on the seabed. The third barge would be positioned so that modules could travel across the second and first barges, then onto the bulkhead and Central Pad. The second and third barges would have much larger capacities (3,000 and 4,000 tons, respectively) owing to the deeper waters away from shore.

The first and second barges would remain in place for the duration of the offloading operation, which would take less than 3 weeks during the summer seasons of construction (HDR 2011d). Other barges would rotate through the third position as cargo is offloaded. Self propelled modular transporters (SPMTs) would carry the modules from the barges to the Central Pad location. On completion of the offload, the barges would be refloated and depart the area. Up to ten sealift barges would access the Central Pad area during the module transportation activity. See Figure 2.4-9 and Figure 2.4-10 for an illustration of the sealift barge offloading process.

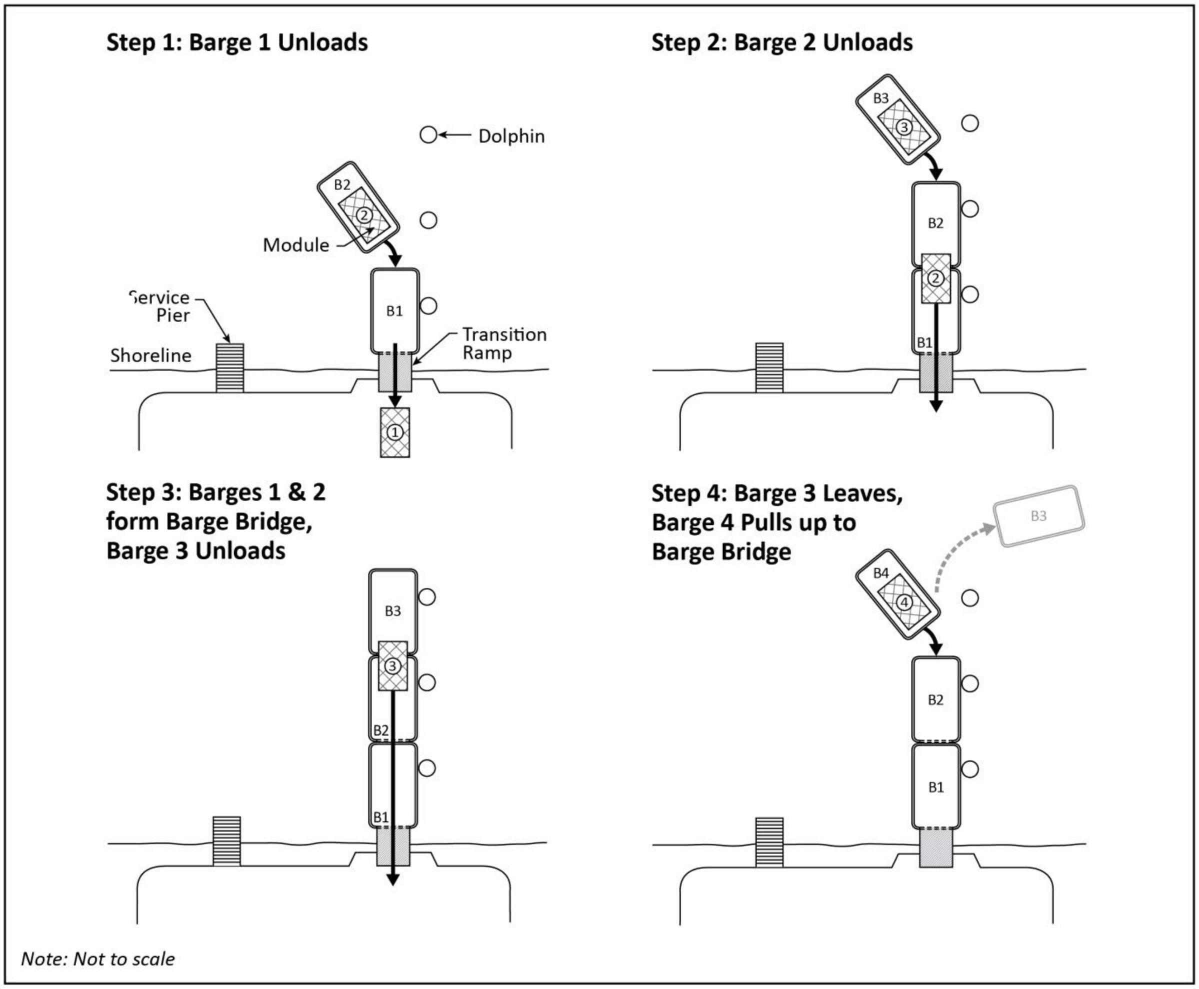

Figure 2.4-9: Barge Bridge

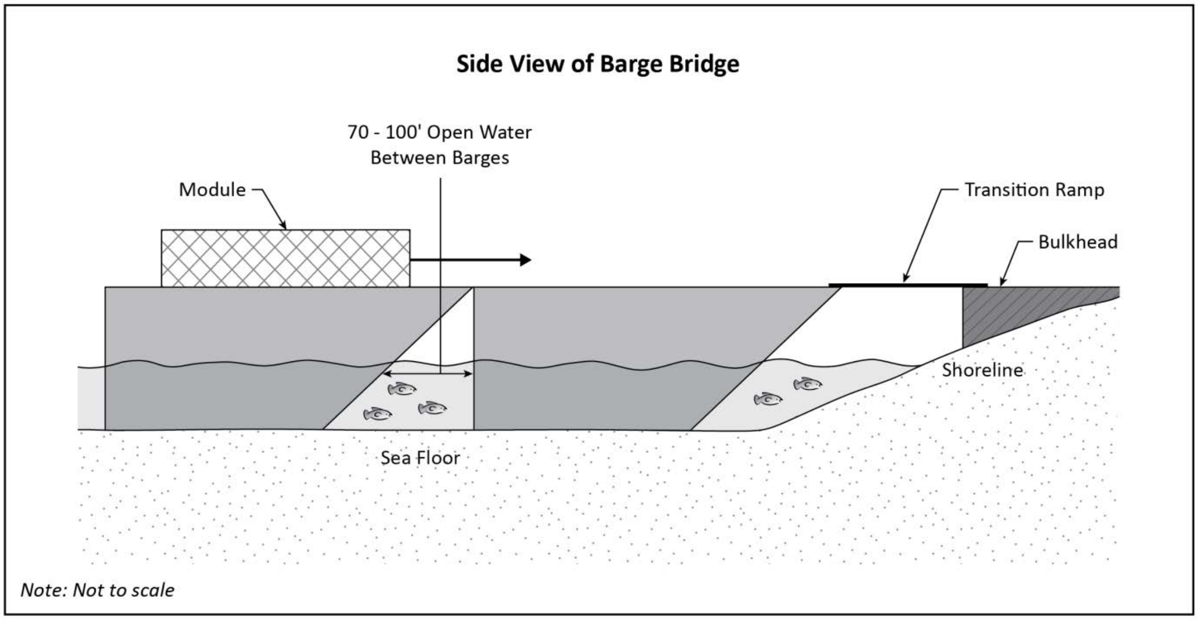

Figure 2.4-10: Side View of Barge Bridge

During operations, it is possible that periodic screeding and dredging would be required for the area in front of the service pier (ExxonMobil 2011b). This maintenance screeding would move up to 800 cubic yards of seafloor material during regular operations. Additionally, future operations may require the occasional use of sealift barges, and dredging or screeding might be required in the area of the sealift bulkhead (HDR 2011d).

Airstrip

Alternative B would include a 5,600-foot by 200-foot gravel airstrip and attached helipad that would be constructed south of the Central Pad, approximately 3 miles inland from the coast.

After completion, the gravel airstrip would provide the only year-round fixed-wing aircraft access to the Point Thomson area. The airstrip and associated features would amount to approximately 43 acres of gravel fill, and would include other associated features as described in Section 2.4.2.3. Electrical service would be supplied via a buried cable in the tundra from the Central Pad power-generating facilities (ExxonMobil 2011b), along with fiber optic cables for control and communication links to the Central Pad. Power to the runway lighting would be buried in the airstrip.

Construction would begin in Year 1, and by April of that year the airstrip would accommodate high-ceiling, "nonprecision" instrumented aircraft approaches that would enable fixed-wing traffic during good weather. In March of the following year, after the installation of the Navaid pads, the airstrip would be cleared for "precision" instrumented approaches, enabling plane transport in more inclement weather. The runway would be designed to provide landing and take-off capabilities for a Lockheed C-130 Hercules cargo plane (no passengers), which may be needed for maintenance and servicing of large equipment or for emergency response. The airstrip would also accommodate smaller personnel and light freight transportation aircraft (see Section 2.4.2.3, Airstrips, for aircraft details).

Infield Gravel Roads

Approximately 12 miles of infield gravel roads would be constructed to connect the Central, East, and West Pads, airstrip, gravel mine and stockpile, and freshwater supply sources (see Section 2.4.2.3, Gravel Roads, for a description of road widths and construction methods). The infield gravel roads would cross creeks and small tundra streams with culverts or bridges. Bridges would cross the larger drainages along the infield access road system. They would consist of pipe piling supports with sheet piling abutments and precast concrete decks, and would be constructed during the first construction season.

Infield gravel roads would, wherever possible, be located a minimum of 500 feet from elevated pipelines, in accordance with the USFWS, ADF&G, NSB, and Alaska Oil and Gas Association Steering Committee's 1994 caribou mitigation guidelines (Cronin et al. 1994).

2.4.3.4 Alternative B: Other Infrastructure

Water Distribution

Potable water would be obtained from the existing C-1 mine site reservoir and trucked daily to refill storage tanks for camp and production uses (Appendix D, RFI 109).

Power Distribution

During operations, power feeds to the East Pad, West Pad, airstrip, mine, and water reservoir would be provided using power cables fed from the 13.8 kV, or comparable, switchgear at the CPF module. Power cables going to the facilities not along the pipeline route (e.g., airstrip, mine/reservoir) would be buried in tundra along the infield gravel access roads 15 feet from the toe of the road. Junction boxes would be located approximately every 1,000 feet along the buried cable, and would consist of an 8-foot-tall, 8-inch support pipe serving as a conduit and two boxes: one for power and one for fiber optic cable connections. These junction boxes would be approximately 7.5 feet tall supported by the pipe conduit (see Figure 2.4-11; HDR 2011d; Appendix D, RFI 108).

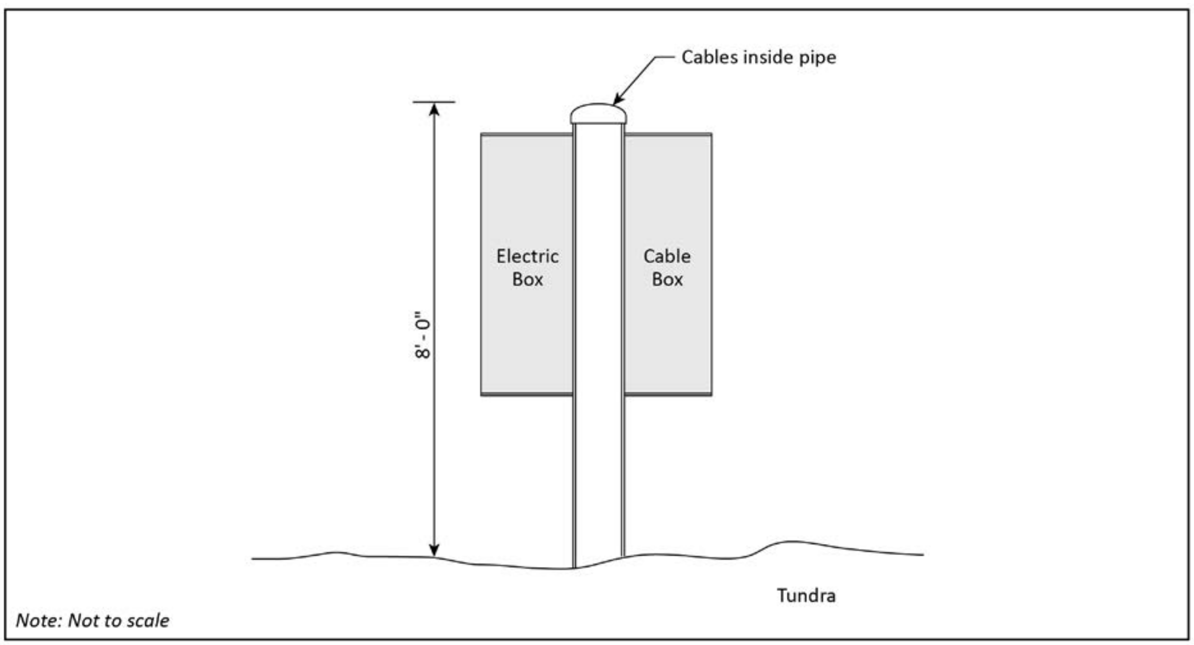

Figure 2.4-11: Power and Communications Cable Junction Box Illustration

Gravel Source

Most gravel for Alternative B would come from the new gravel mine site located approximately 2 miles south of the Central Pad and just north and east of the proposed airstrip. It is estimated that approximately 2.2 million cubic yards of gravel would be removed from the 58-acre mine site.

Gravel mining would begin in February of Year 2 and continue through that April. Based on boring data, this location has approximately 8 feet of overburden that would be removed to access usable gravel.

The Applicant proposes to completely install the gravel road from the mine to the airstrip and Central Pad in the first construction season, and to add gravel at the airstrip and Central Pad the following summer. In the second winter season, gravel would be placed for the East and West Pads and infield roads and added to the C-1 and Central Pads (ExxonMobil 2011b).

After completion of mining activity, the gravel mine site would be rehabilitated, including replacement of the overburden, contouring, and creating stable side walls. Over the course of 5 to 11 years, natural sheetflow would fill the mine site and create a reservoir that could be used as a permitted backup water supply in future years (ExxonMobil 2011b).

Additional Pads

Development of other gravel pads would include the existing C-1 storage pad, a water source access pad, and a gravel storage pad. These pads along with a construction camp ice pad were described earlier in Section 2.4.2.4, while approximate sizes and location of these pads for Alternative B are given in Table 2.4-4. Addition pads specific to Alternative B are:

- **Badami auxiliary pads:** Alternative B would require two small gravel pads at Badami. The first pad would be an approximately 100-foot by 120-foot gravel pad, connected to the existing Badami pad by a short gravel road. A second pad to facilitate ice road crossing of the export pipeline would be located south of the Badami Main Pad. These pads and connector road would constitute less than 1 acre and approximately 8,000 cubic yards of gravel.
- **Storage ice pad:** An ice pad would be used to hold organic and inorganic overburden at the gravel mine.

Table 2.4-4: Alternative B — Additional Pad Requirements

Pad	Estimated Size (acres)	Anticipated Location
C-1 Storage Pad	4	Current location
Water Source Access Pad	1	Next to C-1 mine site
Badami Auxiliary Pads	1	Badami
Gravel Storage Pad	14	Adjacent to the gravel mine
Overburden Storage Ice Pad (2 seasons [a])	38	Adjacent to the gravel mine
Construction Camp Ice Pad (1 season if needed)	14	South of the Central Pad

[a] All ice infrastructure would be built annually and melt in the summer.

Water Needs and Sources

Freshwater would be required for the construction of ice roads and pads, camp operations, and drilling. Water needs for the construction of Alternative B are identified in Table 2.4-5, but does not include water for dust suppression on gravel infrastructure each summer.

Table 2.4-5: Alternative B — Water Needs for Infrastructure Construction

Infrastructure Item	Estimated Size	Estimated Quantity of Water Needed Per Season (Gallons)
Tundra Ice Road[a] for VSM and Export Pipeline Construction (2 seasons)	30 miles	29,300,000
Tundra Ice Road for Transporting Materials and Supplies (3 seasons)	51 miles	36,000,000
Infield Ice Roads for Construction (3 seasons)	23 miles	15,800,000
Construction Camp Ice Pad (1 season if necessary)	14 acres	2,100,000
Overburden Storage Ice Pad (2 seasons)	6 acres	1,000,000

[a] All ice infrastructure would be built annually and melt in the summer.

Freshwater for ice infrastructure construction and drilling activities would be trucked from permitted water sources as listed in Section 2.4.2.4 Freshwater for camp use during construction, drilling, and operations would be transported from the C-1 mine site reservoir by truck, and the C-1 mine site reservoir would be the primary water source for all activities during operations. Table 2.4-6 identifies water needs by phase.

Table 2.4-6: Alternative B — Water Consumption by Phase

Phase	Estimated Use (Gallons)	Example Activities
Construction	232,500,000	All activities listed in Table 2.4-5, camp use, gravel watering, and dust suppression, and pipeline hydrostatic testing
Drilling	97,600,000	Camp use, drilling mud production
Operations	2,700,000[a]	Camp use, dust suppression

Source: ExxonMobil 2011a, Table 1B
[a] Operations water use is annual, rather than by phase.

Annual water use for the camps will vary depending on the activities occurring during each year. Workforce distribution for each phase is discussed in Section 2.4.3.5, Logistics and Sequencing.

2.4.3.5 Alternative B: Logistics and Sequencing

This section highlights the construction schedule for Alternative B. See Figure 2.4-12 for greater detail.

Materials, Modules, and Supplies to and from Point Thomson

Under this alternative, ice roads would be constructed between the Endicott Spur Road and Point Thomson to facilitate the construction of the export pipeline and movement of pioneer camp modules, equipment, and supplies until the sealift facility and service pier were operational. Once constructed, the gravel airstrip would provide year-round access to Point Thomson.

As part of project design and the Applicant's Proposed Alternative, the Applicant prepared a Modularization Study (cited in ExxonMobil 2009b) to determine a preferred approach for development at Point Thomson.

The approach relates to fabrication, transportation, logistics, and installation of housing, process, and utility modules and equipment. Of the options studied, landing sealift barges with large modules at Point Thomson was selected, with smaller modules being trucked to Prudhoe Bay and then transported to Point Thomson via a sea ice road (ExxonMobil 2009a). Approximately 8 months of optimization and front-end engineering contributed to the design of the facility modules, and the completeness of that design would enable procurement and fabrication to begin immediately upon receipt of the ROD.

Constructing the sealift facility would enable oceangoing barges to bridge near the coastline at the Central Pad to move the large facility modules. Modules would be delivered during the Year 3 summer barging season.

The pipeline and infrastructure construction would be executed over three winter construction seasons. The drilling program would take place over approximately 2.5 years.

Personnel to and from Point Thomson

During Year 1, the primary means of transporting personnel would be by helicopter from Deadhorse. Busing on the ice roads would be utilized as well during the construction seasons from late January to mid-April. After the gravel airstrip is completed in Year 2, personnel transfer would take place primarily by fixed-wing aircraft from Deadhorse to Point Thomson. Helicopters would also be used to transport personnel to Point Thomson (HDR 2011c).

During drilling and operations, personnel would fly to Point Thomson from Anchorage or Fairbanks through Deadhorse. In the event an ice road was available for materials or equipment supply, personnel would fly to Deadhorse and transit to Point Thomson by crew bus (HDR 2011c).

Drilling Sequence

The wells in Alternative B would be drilled in the following order:

• Year 4	Summer	Disposal well
	Fall/Winter	Complete PTU-15 and PTU-16
	Winter	Surface drill East Pad well
• Year 5	Spring	Drill and complete West Pad well Drill East Pad well to depth
	Winter	Drill fifth well at location to be determined
• Year 6	Spring	Complete fifth well
	Fall	Complete East Pad well
	Winter	Demobilize rig

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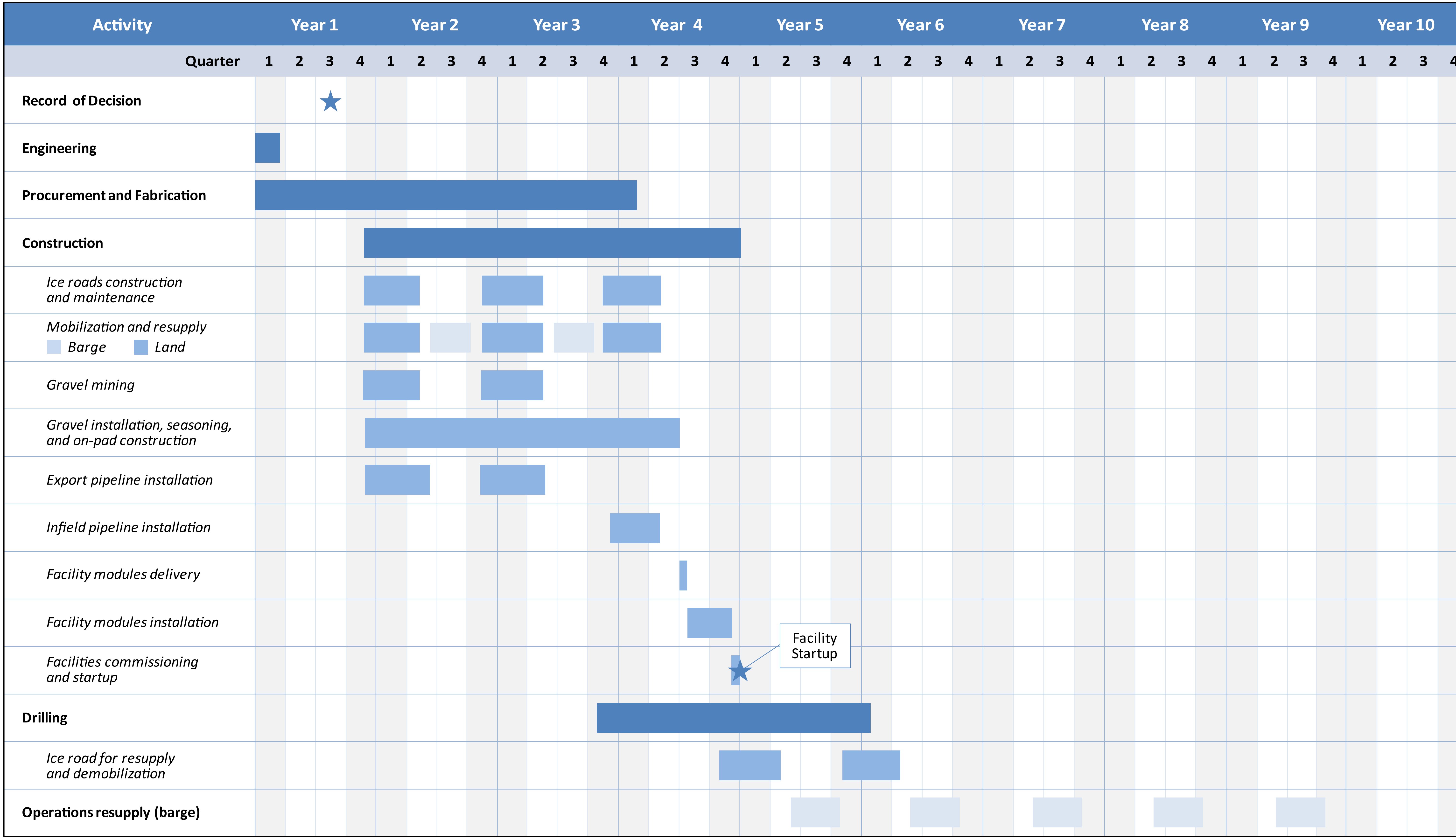

Figure 2.4-12

Alternative B Logistics and Sequencing

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Workforce Trends

Alternative B would have a total of six camps, five of which would demobilize with the crews for construction and drilling. The onsite workforce would peak during the summer of Year 2, when the pioneer camp and both construction camps would be onsite for infield work and barge resupply (see Figure 2.4-13).

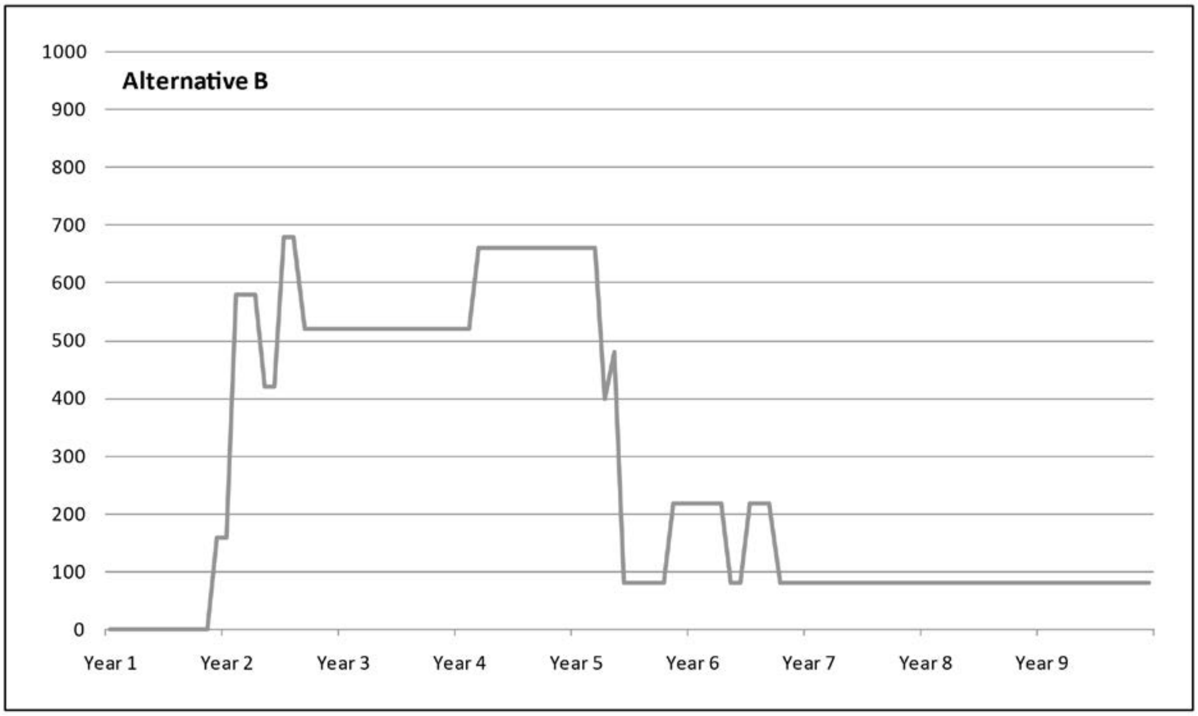


Figure 2.4-13: Alternative B — Onsite Workforce in Beds Occupied Over Time

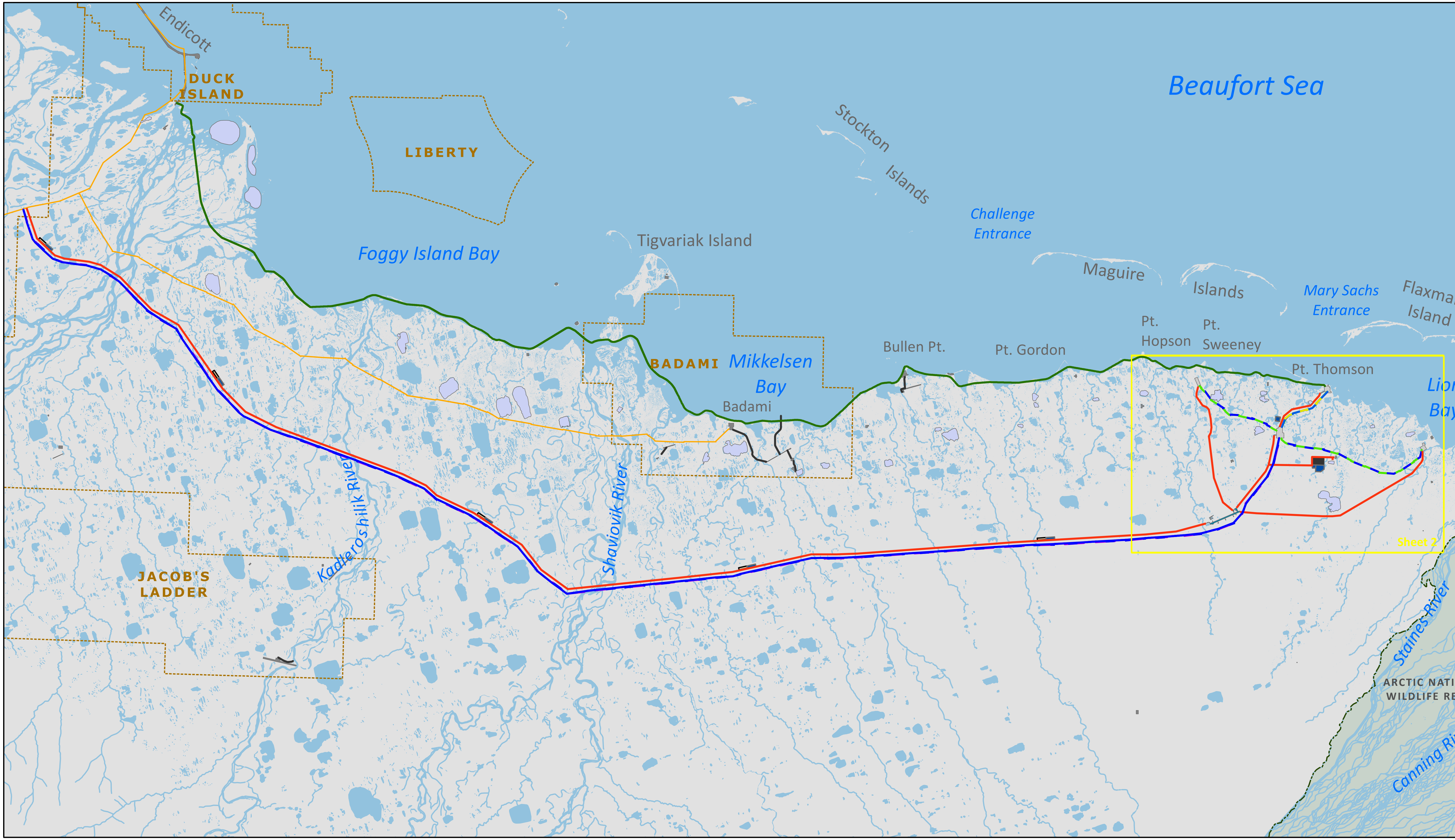
Note: The workforce totals in this figure are based on the assumption that each camp would be occupied to capacity, though there may be times in which the activities occurring would not require the camps to operate at capacity.

2.4.4 Alternative C: Inland Pads with Gravel Access Road

The intent of Alternative C is to minimize impacts to coastal resources such as marine mammals, marine fish, subsistence activities, coastal processes, and to avoid potential impacts to the proposed project from coastal erosion. To minimize impacts, this alternative would move project components inland and as far away from the coast as practicable and feasible (see Figure 2.4-14 and Figure 2.4-15). To provide year-round access to Point Thomson, this alternative would also include the construction of a 44-mile gravel road from Point Thomson to the Endicott Spur Road. Alternative C would not include barging or associated facilities for sea access to Point Thomson.

This alternative also attempts to minimize impacts to hydrologic connectivity by moving linear facilities, such as infield roads, further inland and orienting them in a north/south direction in alignment with the areas predominant hydraulic gradient. See Table 2.4-7 for other key features of Alternative C.

Table 2.4-7: Alternative C — Summary	
Theme	Minimize coastal impacts
Pads	• Central Well Pad (27 acres), located on coast • Central Processing Pad (52 acres), located ~ 2 miles inland • East Pad (19 acres), located ~ one-half mile inland • West Pad (19 acres), located ~ one-half mile inland • Endicott auxiliary pad (1 acre) • Deadhorse module staging pad (acreage to be determined by detailed engineering)
Transportation to/from Field	Construction • Air – helicopter, fixed-wing beginning in Year 5 • Seasonal tundra ice road (49 mi) for transporting modules, materials and supplies (3 years) • Seasonal tundra ice road (44 mi) for VSM and export pipeline construction (2 years) • Seasonal tundra ice road (49 mi) for transporting materials and supplies (1 year, replacing the pipeline construction ice road and supplementing the module-capable ice road) • Seasonal sea ice road (47 mi) for supplemental materials and equipment transport (up to 3 years, optional each year) • Tundra-safe, low-ground-pressure vehicles when allowed Drilling • Same as construction, Operations • Air – helicopter and fixed-wing air transport to gravel airstrip • New all-season gravel road to Endicott Spur Road (45 mi)
Module Transport	• To Deadhorse by sealift barge • Heavy-duty tundra ice road (49 mi) to transport fuel storage, camp, drill rig, and facilities modules (3 years; this ice road would also be used for materials and supplies, above) • Heavy-duty tundra ice road (49 mi) to demobilize drill rig (1 year)
Infield Transport	• Infield ice roads for construction (15 mi, *3 years*) • Gravel roads (20 mi)
Infield Pipelines	• 8-inch gathering pipelines between the Central Processing, East, and West Pads (9 mi) • 10-inch production line between the two Central Pads (3 mi) • 12-inch high pressure gas injection pipeline between the two Central Pads (3 mi)
Export Pipeline	12-inch export pipeline on VSMs with 7-foot clearance; tie-in at Endicott (51 mi)
Primary Water Source	C-1 mine reservoir
Other Infrastructure	• New gravel airstrip (5,600 feet x 200 feet) and associated facilities, located at the site of the former West Staines State gravel airstrip (43 acres) • Infield gravel mine; up to 5 additional gravel mines along the all-season gravel road • Additional pads for stockpiling, storage, and water access • Ice pads for temporary storage and camps during construction • Enlarged fuel storage area in Deadhorse during construction
Compressor Type	Reciprocal



POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Oil and Gas Development Unit
- Existing Facilities
- Existing Pipeline
- Existing Road
- Water Body

Proposed Project Layout

- Road Centerline
- Sea Ice Road
- Gathering Pipeline
- Export Pipeline
- Gathering/Injection Pipeline
- Tundra Ice Roads
- Potential Water Source
- Gravel Mine
- Gravel Pads
- Airstrip
- Gravel Mine - All Season Road
- Ice Pads

The data displayed is concept level and has not been engineered.

0 2.5 5 Miles

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Figure 2.4-14
Alternative C - Inland Pads with Gravel Access Road
Sheet 1 of 2

Date: 21 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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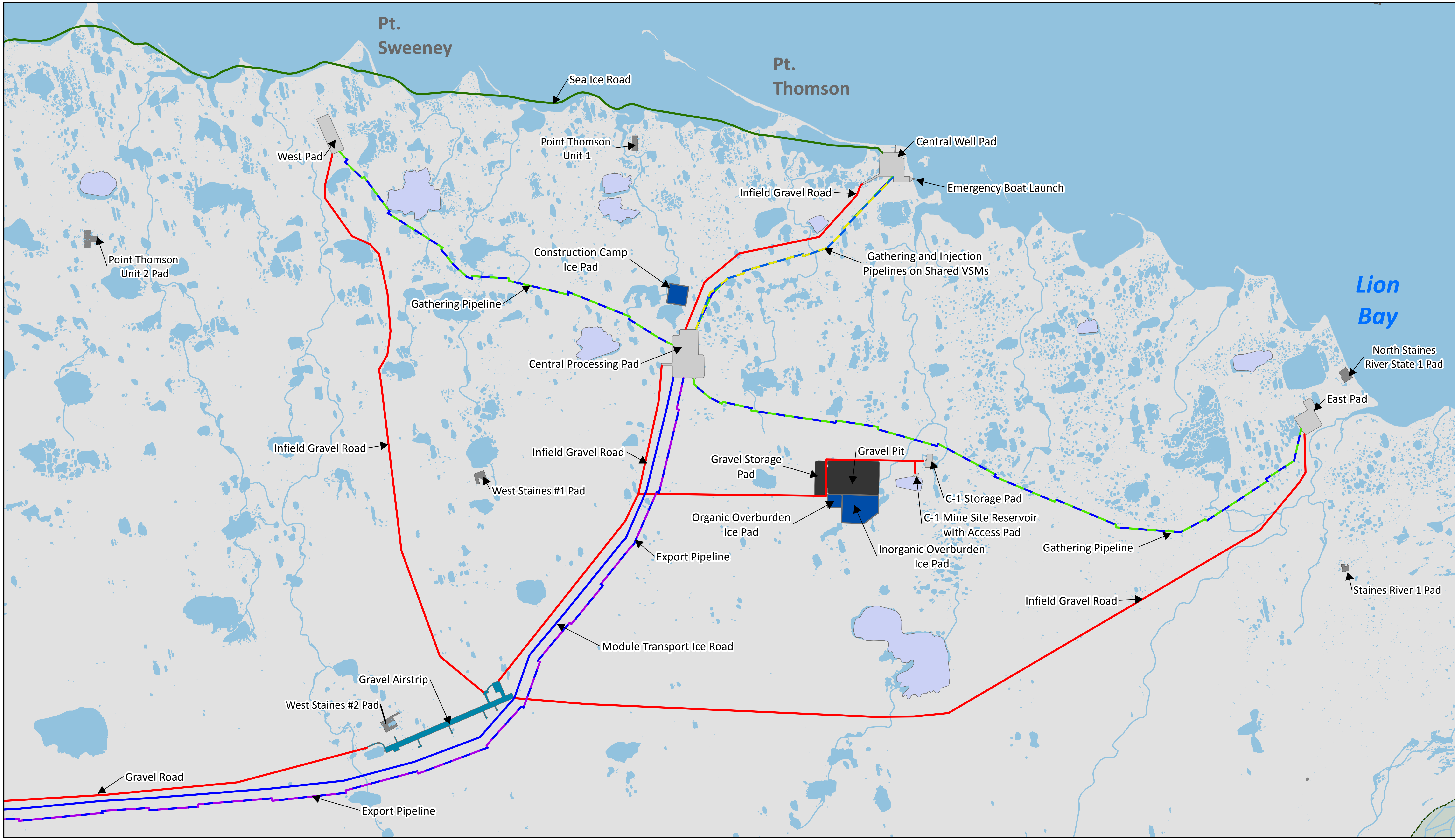

POINT THOMSON PROJECT EIS

Legend
- Arctic National Wildlife Refuge
- Existing Facilities
- Water Body

Proposed Project Layout
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- Sea Ice Road
- Gathering Pipeline
- Export Pipeline
- Gathering/Injection Pipeline
- Road Centerline
- Potential Water Source
- Gravel Mine
- Gravel Pads
- Airstrip
- Ice Pads

The data displayed is concept level and has not been engineered.

0 1 2 Miles

N

Figure 2.4-15
Alternative C - Inland Pads with Gravel Access Road
Sheet 2 of 2

Date: 21 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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2.4.4.1 Alternative C: Production Pads

Alternative C would locate the drilling and production facilities on four onshore gravel pads that would consist of a Central Well Pad, a Central Processing Pad, and two outlying pads (the East and West Pads). The East and West Pads would be located approximately 4 miles away from the Central Processing Pad. These onshore gravel pads would be connected by a 20-mile infield gravel road network and 15 miles of infield gathering pipelines and injection flowlines. Pig launchers and receiver modules would be located as required at each well and processing pad. Additional infield nondrilling or production pads would include a small water-source pad and a gravel mine stockpile pad.

This alternative would include five wells, distributed on the well pads as described in Section 2.4.2.1.

Central Processing Pad

The Central Processing Pad would be located inland, approximately 2 miles southwest from the Central Well Pad. The Central Processing Pad would be the largest of the four gravel pads (52 acres) and would be the primary storage area for construction, drilling, and operations once it was constructed. The processing, production, and maintenance facilities as well as the main camps and storage would be located there.

- **Main Processing Facility and Utility Modules:** The CPF on the Central Processing Pad would be made up of facility modules that would be transported to Prudhoe Bay by sealift barge, staged, and moved to Point Thomson in the winter using SPMTs along the ice access road.

  The two-tip flare stack described in Section 2.4.2.1 would be located just west of the main portion of the Central Processing Pad.

- **Support Facilities:** Support facilities for Alternative C would mostly be located on the Central Processing Pad. Unique considerations for this alternative include:
  - **Construction camps:** Alternative C construction camps would have capacity for up to 600 personnel. Construction camps would demobilize in Year 6.
  - **Warehouse storage:** Separating the Central Well Pad from the Central Processing Pad would preclude using the same storage space for drilling and construction, thereby increasing storage requirements.
  - **Disposal well and storage** The Class I disposal well would be located on the Central Processing Pad and would be used as the injection well for cuttings and waste fluid disposal. Cuttings from the drilling process at the well pads would be trucked to the Central Processing Pad. Well pads would contain enough space for the storage of cuttings until they could be transported to the disposal well.
  - **Fuel storage and supply:** In addition to the initial fuel storage needs of 1.5 million gallons of diesel described in Section 2.4.2.1 for all alternatives, Alternative C would require an additional 6 million gallons of diesel fuel to support construction activities between the end of the ice road season in early Year 4 and the beginning of the ice road season in late Year 4, and a like amount for Year 5. This fuel would be trucked to Deadhorse, requiring an expansion of the existing fuel depot to stockpile fuel during the summer for winter transport to Point Thomson. It would then be trucked to the project site and placed in permanent fuel storage tanks on the Central Pad. The permanent fuel tanks would be fabricated outside of Alaska and sealifted to West Dock in Prudhoe Bay, where they would be staged for transport to Point Thomson by ice road.

Central Well Pad

Drilling facilities and wells would be located at the Central Well Pad, which would be located near the shore by expanding the existing PTU-3 gravel pad to 27 acres. A drill rig camp would be located on the Central Well Pad during drilling. Due to its proximity to the coastline, slope protection in the form of gravel-filled geotextile bags, armor rock, or jute mating would likely be needed on three sides of the Central Well Pad.

- **Drilling/well infrastructure:** The production (PTU-15) and injection (PTU-16) wells completed in 2011 are located on what would become the Central Well Pad.

East and West Pads

The 19-acre East Pad would be located about 4.5 miles east of the Central Processing Pad, and about one-half mile inland from the coastline and the existing North Staines River State No. 1 Pad. The 19-acre West Pad would be located a little more than 3 miles west of the Central Processing Pad, and about one-half mile inland. The East and West Pads would be located on undeveloped sites and sized to incorporate the storage of material/liquid that would be injected into the Class I disposal well, which would be located on the Central Processing Pad.

2.4.4.2 Alternative C: Pipelines

Export Pipeline

A 51-mile elevated export pipeline would be constructed from the Central Processing Pad to the existing Endicott common carrier pipeline, which connects to TAPS Pump Station No. 1. The pipeline alignment would parallel the gravel access road and would be placed approximately 500 feet south of the road. This 500-foot separation follows the 1994 caribou mitigation guidelines recommendation for elevated pipelines (Cronin et al. 1994).

The pipeline would cross the proposed infield road between the East Pad and the airstrip. The road crossing would be accomplished via casings through the roadbed. Piping facilities associated with the export pipeline would include pig launchers/receivers, isolation valves, metering equipment, leak detection equipment, data acquisition equipment, and control/safety systems. A pig launcher and custody transfer meter module would be located at the CPF on the Central Processing Pad. A pig receiver and surveillance meter module, a control module, and a 120-kW generator would be located at the Endicott junction. The Applicant would attempt to purchase power for the Endicott modules from the field operator, but would require a generator in the event Endicott ceased operations during Point Thomson operational field life.

Infield Pipelines

Alternative C would include approximately 9 miles of gathering pipelines connecting the East and West Pads to the CPF and 6 miles of production pipeline between the Central Well Pad and the CPF. The 8-inch gathering line between West Pad and the CPF would be on the T-shaped support structures described for Alternative B, as would the 8-inch gathering and 12-inch export pipelines between the CPF and East Pad. The 10-inch production pipeline and 12-inch injection flowline (see below) would share an H-shaped support system, with two parallel VSMs and an HSM spanning the distance between them (see Figure 2.4-16). Both the T-shaped and H-shaped support structures would have a minimum 7-foot clearance to allow caribou passage. The support members for Alternative C would be designed to accommodate condensate production, and any future development for natural gas production would require additional pipelines with independent support structures (ExxonMobil 2011b).

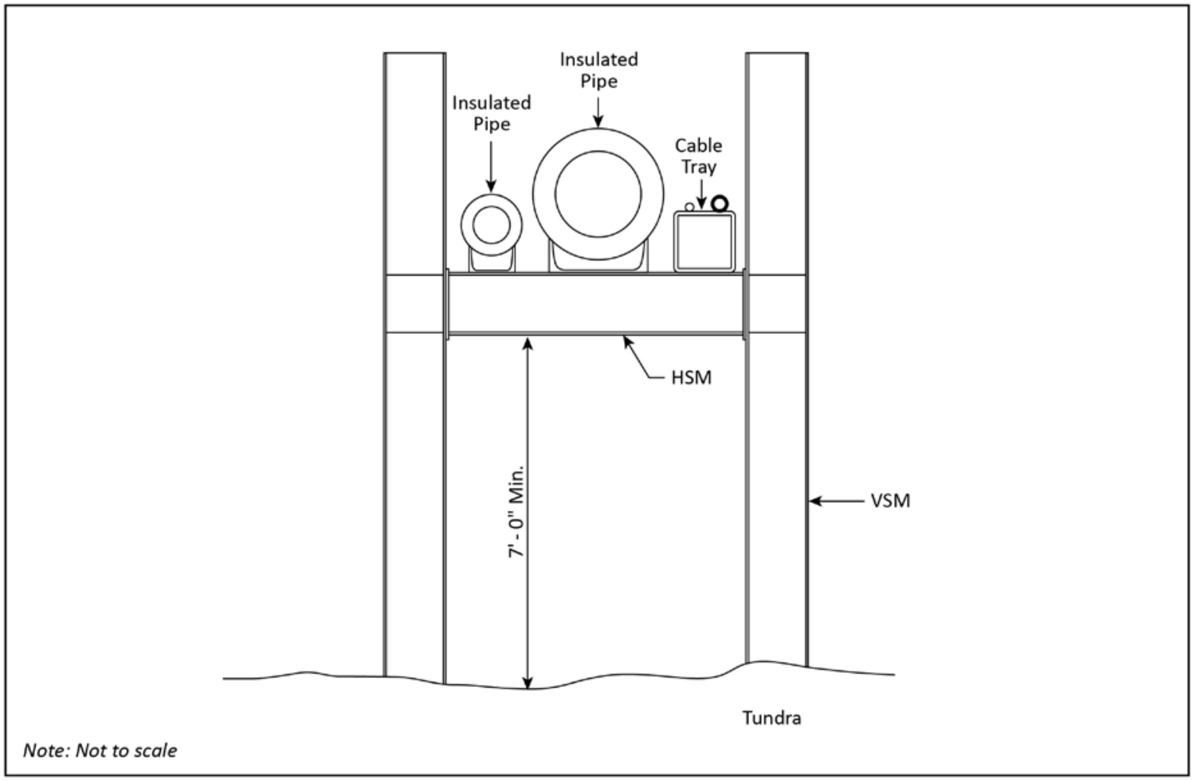

Figure 2.4-16: H-shaped Pipeline Support Structure

Infield Gas Injection Flowline

Because the CPF and the Central Well Pad are separated, approximately 2 miles of approximately 12-inch heat-traced, high pressure flowline plus insulation, would need to be constructed between the two facilities for the conveyance of dry gas to the reinjection well. This pipeline would operate at 200 mmscfd, with a design pressure of 12,000 psig, and would share VSMs with the production line between the CPF and the Central Well Pad. Pigging modules would be located at each end of the pipeline.

Pipeline Construction and Maintenance

Construction of the export pipeline would occur over two winter seasons. VSMs and HSMs would be installed first, beginning from the Endicott end, between December and April. The pipe of the export pipeline would be installed the following winter season between January and April. The two-winter construction scheme allows for a reduced ice road width because the road would not have to be shared simultaneously for the installation of both the VSMs and the export pipeline, while also accommodating traffic bypassing modules in Year 2. Crews constructing the pipeline would be housed either at a temporary construction camp on an ice pad along the route, or at Point Thomson.

Infield pipelines would be constructed during the third construction winter season.

2.4.4.3 Alternative C: Access and Transportation

Alternative C relies on ice roads, gravel roads, and aircraft for transportations as summarized in Table 2.4-8, and does not include any barging. The existing coastal barging access would cease and no barge facilities would be constructed at Point Thomson. Within Point Thomson, the infield gravel road network would be the primary way for personnel, materials, and equipment to travel. All sealift and some truckable modules may be staged in Deadhorse awaiting ice road opening.

Table 2.4-8: Alternative C — Transportation Modes for Materials, Equipment, and Personnel by Phase

	Ice Road	Gravel Road	Airplane	Helicopter
Construction				
Personnel	To/From (TF), Infield (IF)	IF	TF[a]	TF, IF
Materials and Equipment[b]	TF,IF	IF	TF	TF, IF
Drilling				
Personnel	TF, IF	TF, IF	TF	TF
Materials and Equipment[b]	TF	TF,IF	TF	TF
Operations				
Personnel	IF	TF, IF	TF	TF, IF
Materials and Equipment	IF	TF, IF	TF	TF, IF

[a] The airstrip could be used for personnel and equipment transportation late in the second year of construction.

[b] While a wide variety of transportation modes would be used, the mode used would ultimately be determined by the size of the equipment needed and the time at which it was needed, e.g., the size of the permanent camp in this alternative requires barge transport to Point Thomson.

The total number of trips to Point Thomson by mode and phase of the project is detailed in Table 2.4-9. Construction and drilling phase trip numbers are cumulative based on the activities required for that phase. Land transport numbers in construction and drilling include the overland transportation of large tanks, modules, and the drill rig along the access ice road, as well as standard resupply trucks. The annual operations numbers would likely increase or decrease depending on the activities being performed in a given year. Because infield traffic levels would be directly related to daily activities in each phase of the project, no estimates for infield traffic levels were developed for this analysis. Additional discussion of the logistics of Alternative C can be found in Section 2.4.4.5.

Table 2.4-9: Alternative C — Round Trips to Point Thomson by Mode and Phase

	Construction (total for phase)	Drilling (total for phase)	Operations (annual)
Land Transport (ice and gravel access roads)	10,370	6,850—8,200	370
Fixed-wing Aircraft	1,040	540	45
Helicopter	6,210	1,000—1,200	5

Source: ExxonMobil 2011a, Tables 1A and 1B

Gravel Access Road

A new 44-mile gravel road would be constructed to provide access to and from Point Thomson during operations. It is assumed the gravel road would provide support for late-term drilling and long-term operations but not for the installation of the Point Thomson project facilities and infrastructure. This road would be located between 3 and 8 miles south of the coastline, depending on location, and would generally follow the Bullen Point Road Corridor[1], beginning at the Endicott Spur Road, south of the Badami common carrier pipeline (and east of the Kadleroshilik River), and continue eastward to Point Thomson. The road would generally be located approximately 500 feet to the north of the export pipeline.

The gravel access road footprint would be approximately 58 wide feet with an average gravel depth of 7 feet, depending on the topography and slope requirements. The road would consist of two travel lanes, two shoulders, and a 2:1 side slope. Approximately 2.5 million cubic yards of gravel material would be needed for the new road. In addition to the new infield gravel mine, gravel mine sites, tie-back roads, and associated gravel storage pads would be needed approximately every 10 miles along the all-season gravel road during its construction. Each gravel mine would supply gravel for the 5 miles on either side of it (HDR 2011g).

Design, environmental clearance, and ROW resolution would require several years prior to construction. A number of special field studies, including hydrology, would need to occur over several seasons. The earliest construction start date of the gravel access road would be December of Year 3 after publication of the Corps ROD.

The gravel access road would require multiple river crossings with bridges and numerous culverts of varying size. Bridges would be needed for major stream crossings (see Section 5.6, Hydrology). These would be of structural steel I-beams or steel box beams supporting a precast concrete deck. Other streams would be crossed by either bridges or culvert batteries. Approximately 400 to 600 culverts would be installed to manage sheetflow for the all-season gravel road (Appendix D, CS 3A).

On environmental clearance of gravel access road, a tundra ice road would be built to support the construction of the gravel road. Construction would start at the Endicott Spur Road and continue toward Point Thomson. This ice road would not be available to support construction at Point Thomson because it would not be completed when necessary for that task; rather, it would be dedicated to gravel road construction.

A temporary camp for gravel access road construction workers would need to be established to house the approximate 250 construction crew members (HDR 2011g). The camp would likely be located at Deadhorse.

Ice Roads

In addition to the ice road needed for construction of the gravel access road, two main ice roads would need to be constructed during the construction phase, between the Endicott Spur Road and Point Thomson. A 49-mile tundra ice access road would be constructed and used for transporting materials, supplies, and modules to and from Point Thomson. Another 44-mile seasonal tundra ice road would be constructed for VSM and export pipeline construction.

The access road would be approximately 40 feet wide for two-way traffic of standard vehicles and one-way transport of modules (outgoing fuel tanks in Year 1, the drill rig and camps in Year 2, and facility modules in Year 3, returning SPMTs each year). Because these up-to-1,300-ton modules are very slow moving, and travel between 1.5 and 3 miles per hour, the access road would have 35-foot-wide bypass ties to the pipeline construction road, which would be 400 feet north of the access road. The bypass ties would be spaced every

[1] The Bullen Point Road Corridor was a proposed conceptual road corridor the Alaska Department of Transportation and Public Facilities (DOT&PF) considered as part of their Roads to Resources initiative in the early 2000s. The intended purpose of this road corridor was to provide an all-season mainline gravel road, in lieu of seasonal ice roads, to improve operations and encourage further field developments on the North Slope. The *Bullen Point Roadway Reconnaissance Engineering Report* (2005) details the proposed road corridor, conceptual cross sections, and preliminary bridge locations.

mile along the two roads. The pipeline construction road, normally 35 feet wide, would be enlarged to 50 feet to provide pipeline crews and equipment with safe workspace while also allowing pilot cars to lead one-way traffic around slow module convoys (see Figure 2.4-17 and Figure 2.4-18; HDR 2011g).

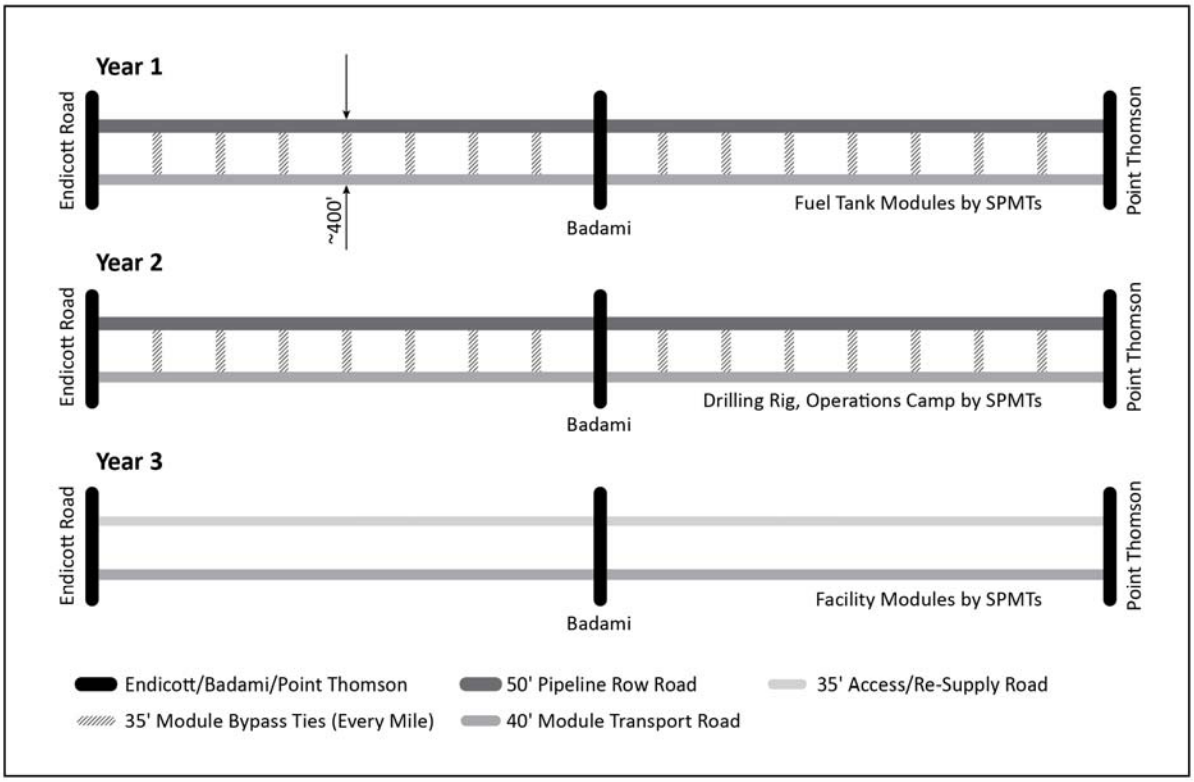

Figure 2.4-17: Alternative C Ice Access Road Diagram

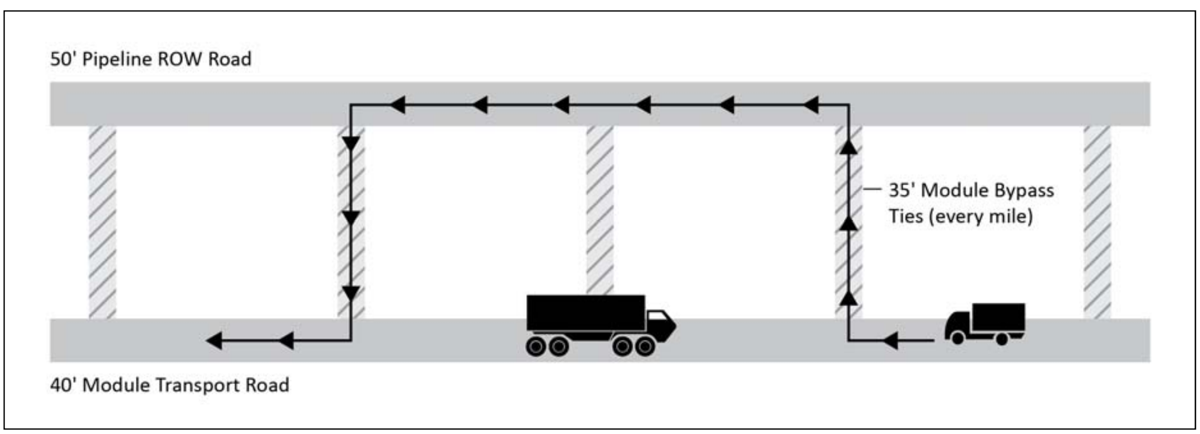

Figure 2.4-18: Bypass Tie-in Functional Diagram

Other minor ice roads would be constructed during the construction season as well as on an as-needed basis during operations according to existing ice road permitting requirements. Additionally, the Applicant may construct an additional 48-mile sea ice road, in addition to the tundra ice road, to maximize the ice road season during any or all years of construction.

At the end of the drilling program, an ice road would be constructed between Point Thomson and the Spur Road to demobilize the drill rig. After demobilization of the rig, there would be no ice roads planned between Endicott and Point Thomson, or within the field.

Airstrip

A 5,600-foot by 200-foot gravel airstrip, with an average thickness of 8 feet, would be constructed for use at Point Thomson, providing the only year-round fixed-wing aircraft access to the area once it is constructed. The airstrip would be constructed in the location of the former West Staines gravel airstrip, which would also be incorporated into the new all-season gravel road alignment. The West Staines gravel airstrip has been abandoned for some time and due to the effects of high winds and sheetflow on the North Slope, very little gravel remains in the airstrip footprint. The current disturbed airstrip footprint is approximately 2,500 feet by 75 feet. The new footprint for the airstrip and associated facilities would be approximately 43 acres.

The runway would be designed to accommodate a Lockheed C-130 Hercules cargo plane for maintenance and servicing of large equipment or potentially for emergency response, though most aircraft to Point Thomson would be similar to those described in Section 2.4.2.3, Airstrips.

Air service to support initial construction and drilling activities would be provided by helicopter from Deadhorse. The airstrip would be ready for precision instrumented approaches early in Year 6 (ExxonMobil 2011a), at which time fixed-wing aircraft would become the primary aircraft using the Point Thomson airstrip for the remainder of construction.

Infield Gravel Roads

A 20-mile infield gravel road network would be constructed to connect the well and processing pads, airstrip, gravel mine and stockpile, and freshwater supply sources. Approximately 200 to 300 culverts would be installed (Appendix D, CS 3A).The location and placement of the infield gravel roads would be generally aligned in a north-south direction, parallel to the existing hydrologic drainage patterns. Roads and bridges would be constructed during the Year 3.

2.4.4.4 Alternative C: Other Infrastructure

Water Distribution

An infield water pipeline to convey freshwater for operational use would be constructed aboveground, along an alignment generally following the access road system from the water source to the Central Processing Pad. It would not go to the well pads. The 3- or 4-inch water line would be insulated, resulting in an overall external diameter of approximately 12 inches. The pipeline would be installed on timber supports approximately 12 inches off the ground for a total 24 inches from the ground to the top of the pipeline (ExxonMobil 2011b).

Power Distribution

Power would be generated at the Central Processing Pad and distributed to the well pads on the infield pipeline supports. Airstrip and water source power would be distributed from cables buried within the infield gravel road to the airstrip and water source (HDR 2011f).

Gravel Source

The primary gravel source for infield construction would be from a new 66-acre gravel mine site located near the proposed Central Processing Pad. Approximately 2.9 million cubic yards of gravel would be removed from the mine.

Before breakup in Year 3, the mine would be rehabilitated, including replacement of the overburden, contouring, and creating stable side walls. During operations, the new mine site reservoir could serve as a secondary water source for the project.

Construction of the gravel access road would also require up to five additional gravel mines, sited approximately every 10 miles along the road corridor, with the exact locations determined by boring data of the area. These additional mines would be approximately 13 acres in size with an accompanying 13-acre ice pad, and would produce approximately 240,000 cubic yards of gravel each (Appendix D, RFI 97).

Additional Pads

Alternative C would include a 14-acre gravel storage pad, gravel storage pads at each mine along the gravel access road, and a new gravel pad at Deadhorse for module staging.

- **Access road gravel storage pads:** Gravel would need to be stored at each of the five gravel mines along the access road for maintenance needs over the life of the road.
- **Module staging pad:** Alternative C would require many modules of up to 1,300 tons to complete the CPF. These modules, and any permanent fuel storage tanks, would be sealifted to Prudhoe Bay during the summer open water season but would have to be stored at Deadhorse until the ice road to Point Thomson was installed. The staging area would need to include generators and heaters to prevent the internal instrumentation in the modules from freezing while the modules are staged. Deadhorse does not currently have the storage capacity for that volume of large modules, and a pad would need to be constructed prior to module deliver. The number of modules and subsequent size of the storage pad would be determined during detailed engineering.

In addition to gravel pads, ice pads would be used to support construction, including approximately 43 acres of ice pad adjacent to the infield gravel mine for overburden storage. Similar ice pads would also be needed in association with the gravel mines located along the all-season gravel road. Mobile construction camps would be located on ice pads until gravel pads became usable. Table 2.4-10 gives approximate sizes of these additional pads.

Table 2.4-10: Alternative C — Additional Pad Requirements		
Pad	Estimated Size (acres)	Anticipated Location
Infield Gravel Storage Pad	14	Adjacent to the gravel mine
Infield Construction Camp Ice Pad[a] (1 season, if needed)	14	South of the Central Pad
Infield Overburden Ice Pad (2 seasons)	43	Adjacent to the gravel mine
Access Road Overburden Ice Pads (3 seasons)	119	Adjacent to the gravel access road mines

[a] All ice infrastructure would be built annually and melt in the summer.

Water Sources

Freshwater would be required for the construction of ice roads, ice pads, camp operations, and drilling. Water needs for the construction infrastructure associated with Alternative C are identified in Table 2.4-11.

Table 2.4-11: Alternative C — Water Needs for Infrastructure Construction		
Infrastructure Item	Estimated Size	Estimated Quantity of Water Needed (Gallons)
Tundra Ice Road for Module Transport (3 seasons)	49 miles	47,100,000
Tundra Ice Road for VSM and Export Pipeline Construction (2 seasons)	44 miles	43,500,000
Tundra Ice Access Road (1 season)	49 miles	47,100,000
Bypass Ties Between Pipeline Construction and Module Transport Ice Roads (42 ties, 400 feet each)	4 miles	4,000,000
Infield Ice Roads for Construction (3 seasons)	15 miles	10,200,000
Infield Construction Camp Ice Pad (1 season if needed)	14 acres	2,1000,000
Infield Overburden Ice Pad (2 seasons)	43 acres	6,500,000

[a] All ice infrastructure would be built annually and melt in the summer.

Freshwater for construction would be transported by truck from the C-1 mine reservoir (HDR 2011g). Freshwater demand during drilling and operations would also use the C-1 mine reservoir. Water would be delivered to the Central Processing Pad via an elevated water line, as described in Section 2.4.4.1. Water for drilling activities on the well pads would be transported by truck from the reservoir and stored in onsite tanks. Table 2.4-12 lists estimated water use amounts by project phase.

Table 2.4-12: Alternative C — Water Consumption by Phase		
Phase	Estimated Use (Gallons)	Example Activities
Construction	499,400,000	All activities listed in Table 2.4-11, camp use, gravel watering, and dust suppression, and pipeline hydrostatic testing
Drilling	13,500,000	Camp use, drilling mud production
Operations	2,900,000[a]	Camp use, dust suppression

Source: ExxonMobil 2011a, Table 1B
[a] Operations water use is annual, rather than by phase.

2.4.4.5 Alternative C: Logistics and Sequencing

Alternative C would require engineering (beyond what the Applicant will have completed by the time of the ROD) to design modules capable of transport overland to Point Thomson via an ice road. Additional detailed engineering would be required before procurement and module fabrication. Alternative C would require additional civil engineering for the pads, and onsite construction would not likely begin prior to the winter of Year 3. Construction would take place over three construction seasons. Fabrication and procurement would likely result in module delivery to Deadhorse during the summer of Year 5 and shipment to Point Thomson that winter. The drilling program would take place over four seasons and be completed by March of Year 8. See Figure 2.4-19 for greater detail.

Materials, Modules, and Supplies to and from Point Thomson

Under Alternative C, facility and permanent fuel storage modules would be barged to the West Dock in Deadhorse then transported overland to Point Thomson via ice road. The design and fabrication of the modules, which would weigh up to 1,300 tons each, would require nearly 4 years after issuance of the ROD. All sealift modules and some truckable modules would have to be delivered to Deadhorse during open water season, staged for 6 to 9 months, and then transported during the following ice road season in Year 6.

Prudhoe Bay infrastructure (dock, access roads, culverts, laydown areas, and fuel storage) would need to be evaluated and may require upgrades to accommodate the proposed modules and fuel needs. West Dock may require upgrades to facilitate landing of sealift barges that would accommodate anticipated modules. Studies would have to be completed to determine the maximum size modules that the roads and bridges in the Deadhorse area could withstand. Either the modules would have to be designed to meet the road/bridge specifications or the roads and bridges would need to be upgraded, depending on the results of the studies. Pipe crossings of the road, in which the pipelines slope down to a point near the road to pass under it, would most likely need to be modified to accommodate wide modules.

Once the gravel access road was complete late in Year 6, it would become the primary access route to Point Thomson. Supplies for the last season of drilling would be transported along this route, and materials and equipment resupply would occur on an ongoing, rather than annual, basis. To accommodate the 2 percent grade requirements of the drill rig, and the fact that access road bridges would not be designed to accommodate the drill rig, the rig would be demobilized by ice road in Year 8.

Personnel to and from Point Thomson

During the first construction season (Year 3/Year 4), the primary means of transporting personnel would be by helicopter from Deadhorse, supplemented by crew busses on the ice access road from late January to mid-April. After the gravel airstrip was completed in September of Year 4, personnel transfer would take place primarily by fixed-wing aircraft from Anchorage or Fairbanks for the remainder of construction.

Because a crew bus can accommodate up to 40 crew members, while the standard charter airplane can transport only 30 crew members, personnel would fly from Anchorage or Fairbanks to Deadhorse and would be bussed from Deadhorse to Point Thomson (HDR 2011c) beginning late in Year 6.

Drilling Sequence

The wells in Alternative C would be drilled in the following order:

• Year 5	Spring	Disposal well
	Winter	Complete PTU-15 and PTU-16 (through spring Year 6)
• Year 6	Summer	Surface drill East Pad well Surface drill West Pad well
	Fall/winter	Drill West Pad well to depth
• Year 7	Spring	Drill East Pad well to depth and complete Complete West Pad well and complete Surface drill fifth well
	Winter	Drill fifth well to depth and complete
• Year 8	Spring	Demobilize drill rig

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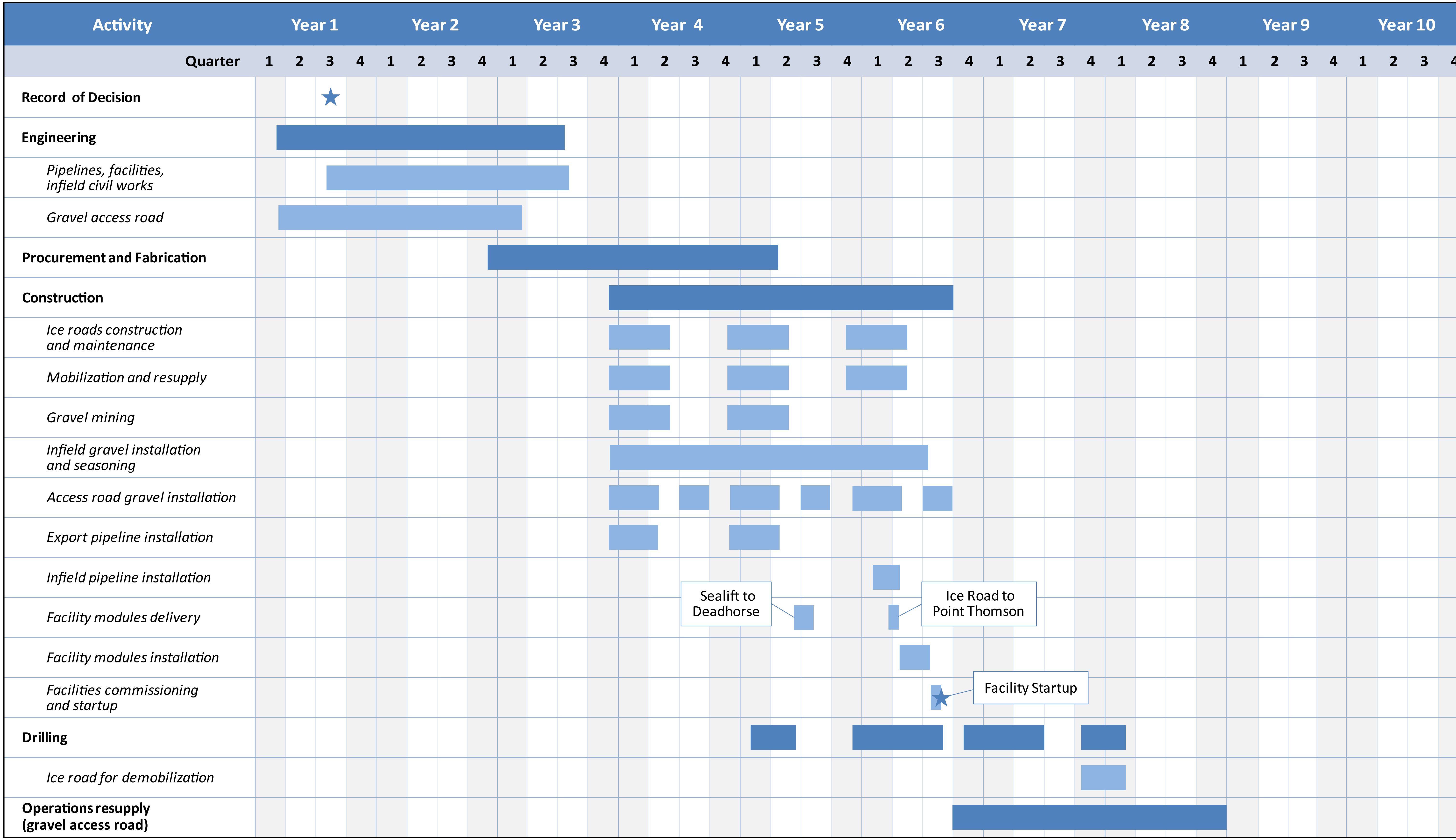

POINT THOMSON PROJECT EIS

Figure 2.4-19

Alternative C Logistics and Sequencing

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Workforce Trends

Alternative C would have a total of six camps, five of which would demobilize with the construction and drilling crews. The project workforce onsite would peak at 990 personnel in the winters of Years 5 and 6, including 740 personnel at infield camps and 250 staff members at the access road construction camp (see Figure 2.4-20).

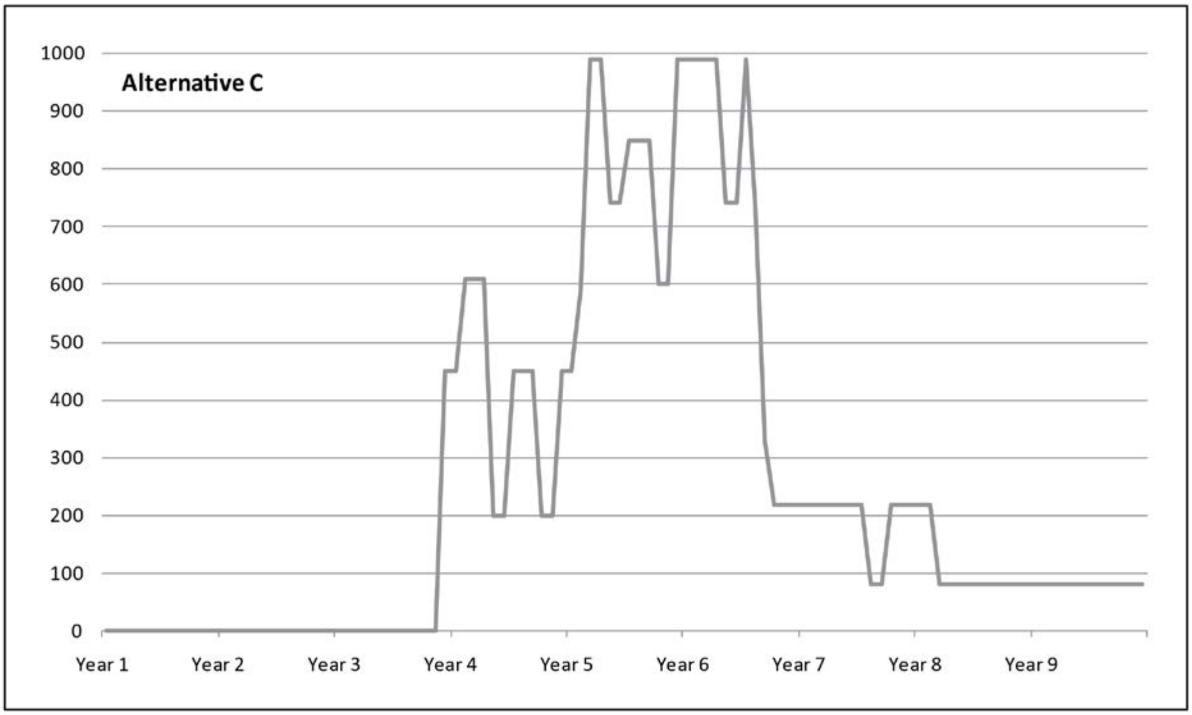

Figure 2.4-20: Alternative C — Onsite Workforce in Beds Occupied Over Time

Note: The workforce totals in this figure are based on the assumption that each camp would be occupied to capacity, though there may be times in which the activities occurring would not require the camps to operate at capacity.

2.4.5 Alternative D: Inland Pads with Seasonal Ice Access Road

The intent of Alternative D is to minimize impacts to coastal resources such as marine mammals, marine fish, subsistence activities, coastal processes, and to reduce potential impacts to the proposed project from coastal erosion. To minimize impacts, this alternative would move the project components inland and as far away from the coast as practicable and feasible (see Figure 2.4-21 and Figure 2.4-22). This alternative is also characterized by access to and from Point Thomson occurring primarily via an inland 48-mile seasonal ice road, running east from the Endicott Spur Road to the northern end of the Point Thomson project area. See Table 2.4-13 for other key features of Alternative D.

Table 2.4-13: Alternative D — Summary	
Theme	Minimize coastal impacts
Pads	• Central Well Pad (27 acres), located on coast • Central Processing Pad (52 acres), located ~ 2 miles inland • East Pad (19 acres), located ~ one-half mile inland • West Pad (19 acres), located ~ one-half mile inland • Deadhorse module staging pad (to be determined based on detailed engineering) • Badami auxiliary pads (1 acre)
Transportation to/ from Field	Construction • Air – helicopter and tundra ice airstrip (5,600 feet x 200 feet) through Year 5 when gravel airstrip becomes available • Seasonal tundra ice road (48 mi) between Endicott Spur Road and Point Thomson for transporting materials and supplies (3 years) • Seasonal tundra ice road (22 mi) for VSM and export pipeline construction (2 years) • Seasonal tundra ice road (48 mi) for transporting materials and supplies (1 year, replacing the pipeline construction ice road and supplementing the module-capable ice road) • Seasonal sea ice road (48 mi) for supplemental materials and equipment transport (up to 3 years, optional each year) • Tundra-safe, low ground pressure vehicles when allowed Drilling and Operations • Air – helicopter and gravel airstrip • Seasonal tundra ice access road (48 mi; annual)
Module Transport	• To Deadhorse by sealift barge • Heavy-duty tundra ice road (47 mi) for fuel tank, camp, drill rig, and facility module transport (3 years; same road as mentioned above for supply transport in Years 1 and 2) • Heavy-duty tundra ice road (48 mi) for drill rig demobilization (1 year)
Infield Transport	• Infield ice roads for construction (14 mi, 3 years) • Gravel roads (18 mi)
Infield Pipelines	• 8-inch gathering pipelines between the Central Processing, East, and West Pads (8 mi) • 10-inch production line between the two Central Pads (2 mi) • 12-inch high-pressure gas injection pipeline between the two Central Pads (2 mi)
Export Pipeline	• 12-inch export pipeline on VSMs with 7-foot clearance, tie-in at Badami (23 mi)
Primary Water Source	• C-1 mine site reservoir (construction) • New mine site reservoir (drilling and operations)
Other Infrastructure	• New gravel airstrip (5,600 feet x 200 feet) and associated facilities, located approximately 1 mile northeast of the former West Staines No. 2 airstrip (43 acres) • Infield gravel mine • Additional pads for stockpiling, storage, and water access • Ice pads for temporary storage and camps during construction • Expanded fuel storage at Deadhorse
Compressor Type	Reciprocal

2.4.5.1 Alternative D: Production Pads

Alternative D would locate the drilling and production facilities onto a four-pad configuration. Similar to Alternative C, the four onshore gravel pads would consist of a Central Well Pad, a larger Central Processing Pad, and two outlying pads (the East and West Pads). The East and West Pads would be located about 4 miles away from the Central Processing Pad. These onshore gravel pads would be connected by an 18-mile infield gravel road network and 12 miles of infield pipelines. Pig launchers and receiver modules would be located as required at each pad. Additional nondrilling or production pads, including a small water source pad, a gravel mine stockpile pad, the C-1 storage pad, and Badami auxiliary pads, are described in Section 2.4.5.4 under "Additional Pads."

Central Pads

This alternative separates the Central Well and Central Processing Pads by 2 miles. The Central Well Pad would be located near the shore and use the existing PTU-3 gravel pad site. The PTU-3 pad would not be expanded. A drill rig camp would be located on the Central Well Pad near the drill rigs during drilling. Due to its proximity to the coastline, slope protection would likely be needed on three sides of the Central Well Pad.

The Central Processing Pad would be located inland approximately 2 miles south, in the vicinity of the existing C-1 pad and the new gravel mine location proposed under Alternative B. The 52-acre Central Processing Pad would be the largest of the four gravel pads and would be the primary storage for construction, drilling, and operations once it is constructed. The processing, production, and maintenance facilities as well as the main camps and storage would be located here. The seasonal nature of ice-road-only access to Point Thomson would require additional area for storage.

As with Alternative C, the Central Processing and Well Pads combined would include the key infrastructure to support remote operations and drilling (see Section 2.4.2.1). The components of the infrastructure are the same for both alternatives except that:

- The export pipeline would run to Badami in this alternative rather than Endicott.
- Power to the airstrip would be delivered via power lines on the export pipeline to the point along the route closest to the airstrip. From that point, the power lines would be routed down the vertical supports and trenched in the tundra approximately 180 feet to the airstrip.
- Water during operations would be distributed by a 3- or 4-inch insulated water line that would be buried within the gravel of the road between the new mine site reservoir and the Central Processing Pad.

Alternative D would also share the high fuel storage needs as described for Alternative C. In addition to the initial fuel storage needs of 1.5 million gallons of diesel described in Section 2.4.2.1 for all alternatives, Alternative D would require an additional 6 million gallons of diesel fuel to support construction activities between the end of the ice road season in early Year 4 and the beginning of the ice road season in late Year 4, and a like amount for Year 5.

East and West Pads

The 19-acre East Pad would be located a little over 3 miles east of the Central Processing Pad, and about one-half mile inland from the coastline and the existing 4-acre North Staines River State No. 1 Pad. The 19-acre West Pad would be located almost 5 miles west of the Central Processing Pad, and about one-half mile inland. The East and West Pads would be located on undeveloped sites and would have the same components as described for Alternative C.

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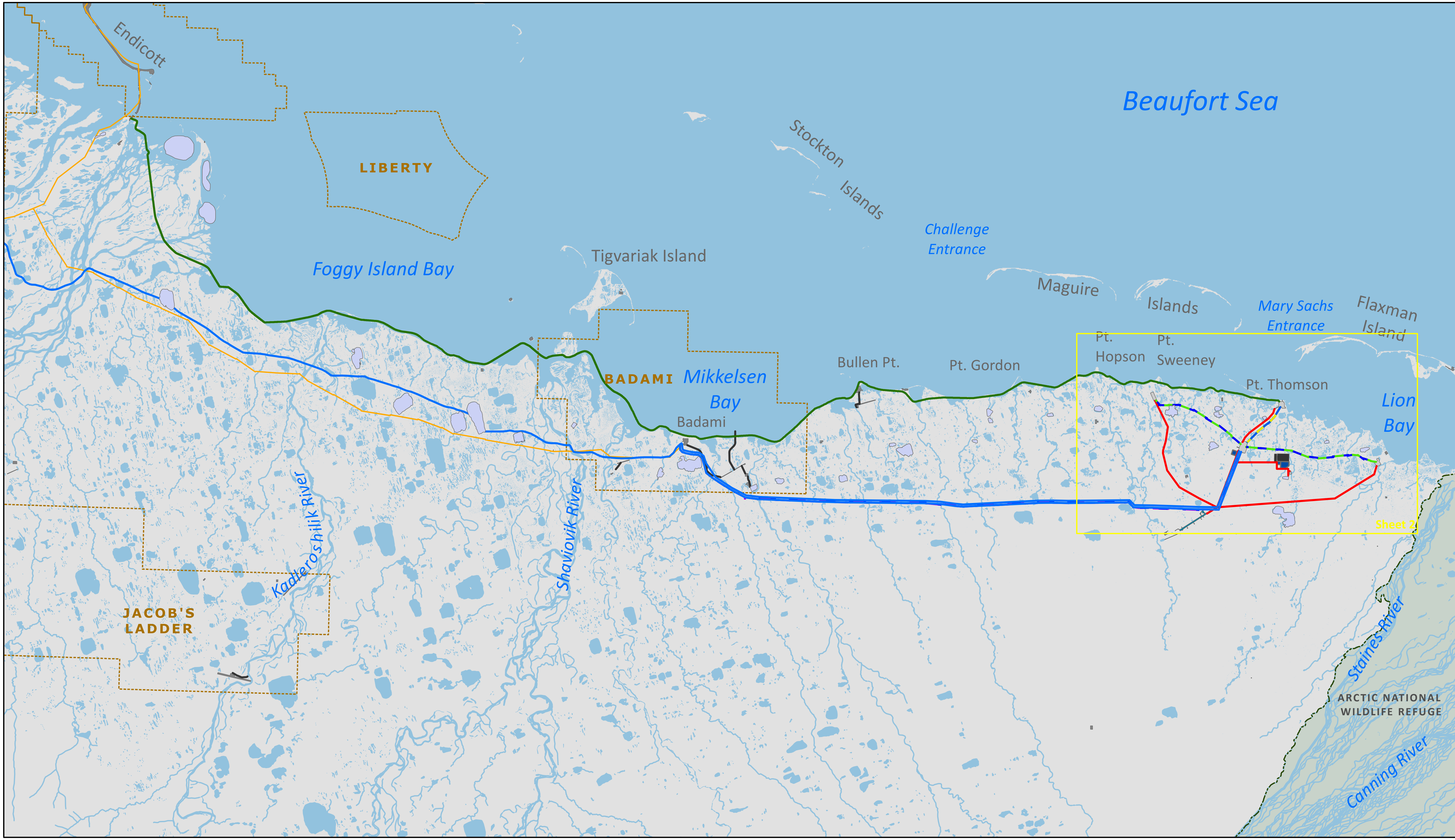

POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Oil and Gas Development Unit
- Existing Facilities
- Existing Pipeline
- Existing Road
- Water Body

Proposed Project Layout

- Tundra Ice Roads
- Export Pipeline
- Gathering/Injection Pipeline
- Gathering Pipeline
- Road Centerlines
- Sea Ice Road
- Potential Water Source
- Airstrip
- Site Pads
- Ice Pads
- Mine

The data displayed is concept level and has not been engineered.

0 2.5 5 Miles

N

Figure 2.4-21
Alternative D - Inland Pads with Seasonal Ice Access Road
Sheet 1 of 2

Date: 21 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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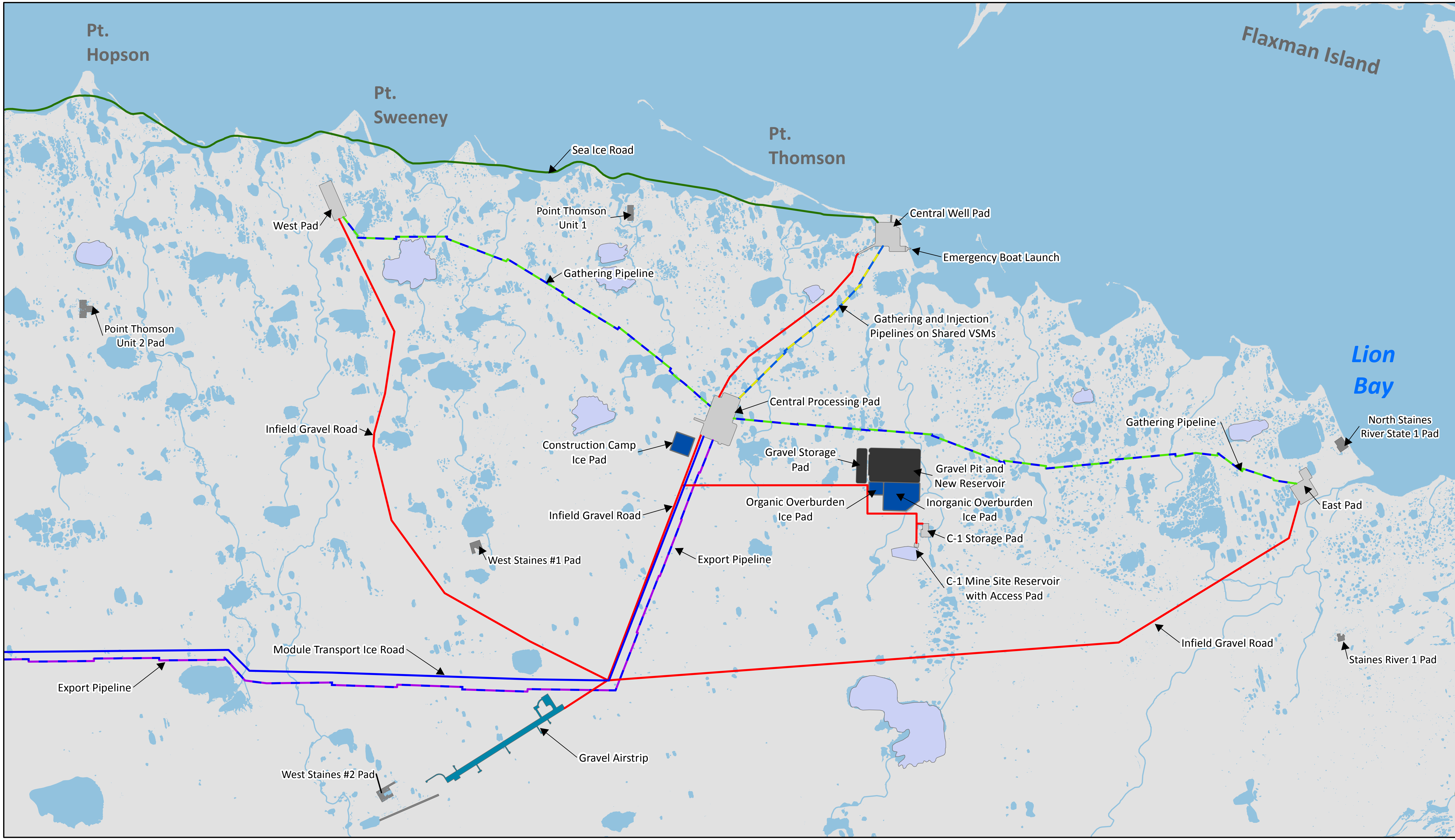

POINT THOMSON PROJECT EIS

Legend
- Arctic National Wildlife Refuge
- Existing Facilities
- Water Body

Proposed Project Layout
- Tundra Ice Roads
- Road Centerline
- Export Pipeline
- Gathering/Injection Pipeline
- Gathering Pipeline
- Sea Ice Road
- Potential Water Source
- Airstrip
- Gravel Pads
- Ice Pads
- Mine

The data displayed is concept level and has not been engineered.

0 1 2 Miles

N

Figure 2.4-22
Alternative D - Inland Pads with Seasonal Ice Access Road - Sheet 2 of 2

Date: 21 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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2.4.5.2 Alternative D: Pipelines

The infield gathering pipelines, production lines, injection flowlines, and their supports would be the same as those described in Alternative C. The export pipeline would differ in that it would tie into the existing common carrier pipeline at Badami. The pipeline would be 23 miles long and follow a route generally located more than 4 miles inland. This route would not cross any rivers that might require bridges, and VSM spacing would accommodate the route's stream crossings. The proposed route would cross three proposed gravel roads: the infield road between the East Pad and the airstrip; the infield road between the gravel mine and the C-1 storage pad; and the infield gravel road to the airstrip. At the road crossings, the pipeline would be installed in casings through the roadbed using standard design practices for the North Slope.

2.4.5.3 Alternative D: Access and Transportation

Under this alternative, the ice road from the Endicott Spur Road and/or aircraft would be the two primary ways to transport materials, equipment, and personnel to and from Point Thomson as summarized in Table 2.4-14. All modules would be transported by ice road. Within Point Thomson, the infield gravel road network would be the primary way for personnel, materials, and equipment to travel.

Table 2.4-14: Alternative D — Transportation Modes for Materials, Equipment, and Personnel by Phase

	Ice Road	Gravel Road	Airplane	Helicopter
Construction				
Personnel	To/From (TF), Infield (IF)	IF	TF[a]	TF, IF
Materials and Equipment[b]	TF,IF	IF	TF	TF, IF
Drilling				
Personnel	TF, IF	IF	TF	TF
Materials and Equipment[b]	TF	IF	TF	TF
Operations				
Personnel	TF	IF	TF	TF, IF
Materials and Equipment	TF	IF	TF	TF, IF

[a] The airstrip could be used for personnel and equipment transportation late in the second year of construction.

[b] While a wide variety of transportation modes would be used, the mode used would ultimately be determined by the size of the equipment needed and the time at which it was needed

The total number of trips to Point Thomson by mode and phase of the project is detailed in Table 2.4-15. Land transport numbers in construction and drilling include the overland transportation of large tanks, modules, and the drill rig along the access ice road, as well as standard trucks for materials resupply. Because infield traffic levels would be directly related to daily activities in each phase of the project, no estimates for infield traffic levels were developed for this analysis. While Alternative D would not include barge transportation to Point Thomson, the modules containing facilities for the CPF would be transported from their fabrication site to West Dock at Prudhoe Bay via sealift barge. Additional discussion of the logistics of Alternative D can be found in Section 2.4.5.5.

Table 2.4-15: Alternative D — Round Trips to Point Thomson by Mode and Phase			
	Construction (total for phase)	Drilling (total for phase)	Operations (annual)
Land Transport (ice roads)	7,345	8,525—10,150	250
Fixed-wing Aircraft	1,040	840	465
Helicopter	5,070	2,000—2,400	5

Source: ExxonMobil 2011a, Tables 1A and 1B

Ice Roads

Tundra ice roads would be the primary access to Point Thomson during construction, drilling, and operations. During construction, at least three seasonal tundra ice roads to Point Thomson would be constructed. The first 40-foot-wide tundra ice road would extend 48 miles between the Endicott Spur and Point Thomson for transporting modules, such as those housing temporary and permanent fuel tanks, camps, drill rig components, and modules. A second 48-mile, 35-foot-wide ice road would connect the Endicott Spur Road and Badami to facilitate the transport of materials and equipment, unimpeded by slow-moving modules. These two roads would not have connector ties between the Endicott Spur Road and Badami.

A third ice road would be constructed to span the 22 miles between Badami and Point Thomson. In the first two years of construction, that ice road would be used for construction of the export pipeline. As in Alternative C, the pipeline construction ice road would be 50 feet wide to accommodate both module bypass traffic and pipeline construction, and would be tied by 400-foot-long, 35-foot-wide bypass roads at each mile of the parallel roads (see Figure 2.4-23). In Year 5, after completion of the export pipeline, the pipeline construction road would not be constructed. Instead, a 35-foot-wide access road would be constructed to allow unimpeded resupply traffic to Point Thomson while the module transport road was being used to transport the facility modules; there would be no connection ties between the two roads.

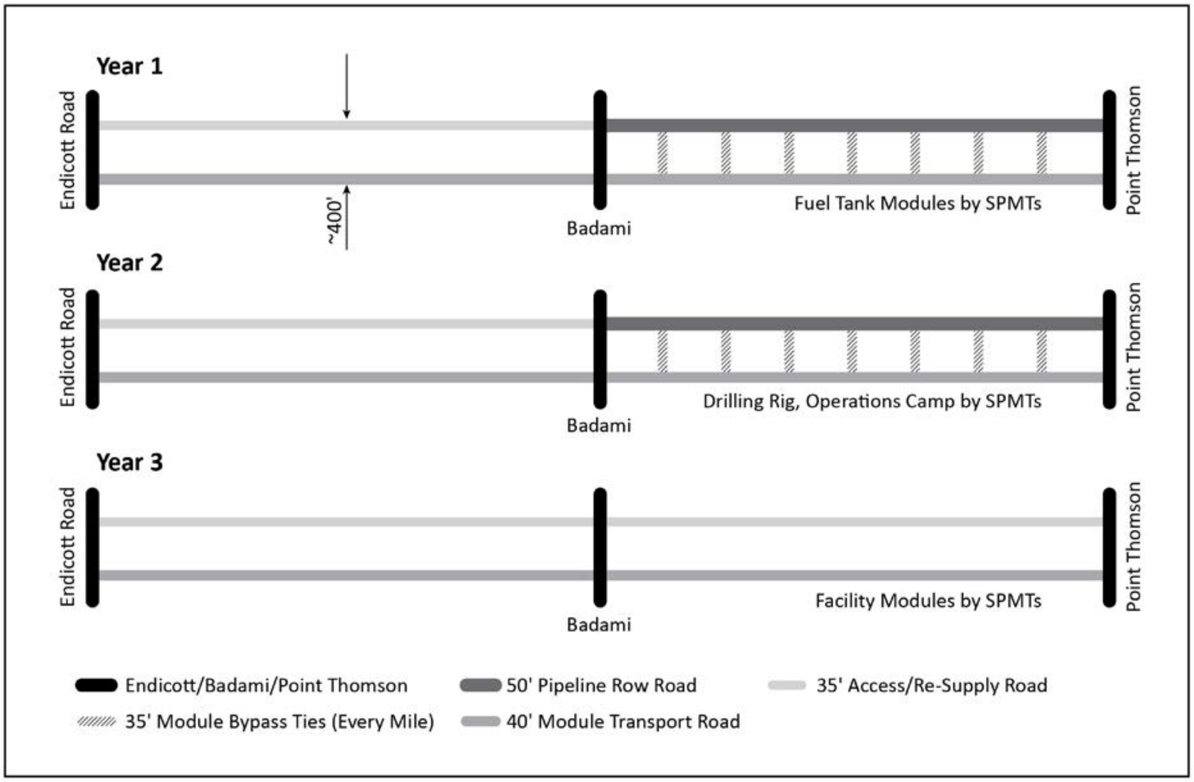


Figure 2.4-23: Alternative D — Ice Access Road Diagram

Additionally, the Applicant may construct an additional 47-mile sea ice road in addition to the tundra ice road, to maximize the ice road season during any or all years of construction.

After completion of construction, a single, 35-foot-wide ice access road would be built annually between the Endicott Spur Road and Point Thomson for annual resupply of fuel and consumables, as well as personnel transport. Early in Year 10, a 40-foot-wide, generally 1-foot-thick ice road would be constructed between Endicott and Point Thomson to demobilize the rig.

Airstrips

Air service to support drilling and initial construction activities would be provided by helicopter and a 5,600-foot by 200-foot seasonal tundra ice airstrip during the winter until the gravel airstrip is useable in Year 5.

A new 5,600-foot by 200-foot gravel airstrip, with an average depth of 8 feet, would be constructed for use at Point Thomson, providing the only year-round, fixed-wing aircraft access to the area. The airstrip would be located northeast of the former West Staines gravel airstrip. This airstrip would connect to the infield development via the infield gravel road network. The airstrip and associated features would be approximately 43 acres.

The runway would be designed to provide landing and take-off capabilities for a Lockheed C-130 Hercules cargo plane (no passengers), though the most frequent aircraft would be the passenger aircraft described in Section 2.4.2.3, Airstrips.

Infield Gravel Roads

A 18-mile infield gravel road network would be constructed to connect the pads, airstrip, gravel mine, gravel stockpile, and freshwater supply sources. The location and placement of the infield gravel roads would be aligned in a general north-south orientation to minimize water flow obstruction for most streams, as well as sheetflow during spring, which generally flow from the south to the north.

The infield gravel roads would cross creeks and small tundra streams, with culverts or bridges installed at these crossings as appropriate. Approximately 200 to 300 culverts would be installed to manage sheetflow during spring (Appendix D, CS 3B). Bridges would be constructed during Year 4 and would be used to cross the larger drainages along the infield access roads.

2.4.5.4 Alternative D: Other Infrastructure

Gravel Source

The primary gravel source for the project would be from a new 66-acre gravel mine site located less than 2 miles south of the Central Well Pad and near the proposed Central Processing Pad. Approximately 2.8 million cubic yards of gravel would be removed from the mine. Gravel mining would begin in Year 2.

Before breakup in Year 3, the mine would be closed, including replacement of the overburden, contouring and creating stable side walls. Water during spring runoff would fill the new freshwater reservoir. An inlet structure would be constructed to divert water from an adjacent stream during peak discharges that occur during spring breakup (HDR 2011f). The C-1 reservoir could serve as a secondary water source during operations and throughout field life.

Additional Pads

Development of other gravel pads would include a gravel storage area at the existing C-1 storage pad, a water source access pad (as described in Section 2.4.2.4), as well as auxiliary pads at Badami and a module staging pad at Deadhorse. Table 2.4-16 lists approximate size and location of these pads for Alternative D.

- **Badami auxiliary pads:** Similar to Alternative B, Alternative D would require two small gravel pads at Badami: one for a generator and metering/pigging module at the tie-in to the export pipeline, and a second to facilitate ice road crossing of the export pipeline. These pads, and road connecting the metering pad to the main Badami pad, would require a combined 1 acre of fill and approximately 8,000 cubic yards of gravel.
- **Module staging pad:** Alternative D would require many modules of up to 1,300 tons to complete the CPF. As described in Alternative C, these modules and any permanent fuel storage tanks would be sealifted to Prudhoe Bay during the summer open water season but would have to be stored at Deadhorse until the ice road to Point Thomson is installed. Deadhorse does not currently have the storage capacity for that volume of large modules, and a pad would need to be constructed prior to module delivery. The size of that pad would be determined by the number and size of the modules resulting from final engineering of this alternative.

Ice pads would be required as described in the Common to All Action Alternatives, Section 2.4.2.4. Construction crews for the export pipeline would be housed primarily in a remote camp on an ice pad in the vicinity of the Badami unit, and the gravel mine overburden ice pad would be approximately 44 acres.

Table 2.4-16: Alternative D — Additional Pad Requirements		
Pad	Estimated Size (acres)	Anticipated Location
C-1 Storage Pad	4	Current location
Water Source Access Pad	1	Next to C-1 mine site reservoir
Gravel Storage Pad	17	Adjacent to the gravel mine
Badami Auxiliary Pads	1	Badami
Overburden Storage Ice Pad[a] (2 seasons)	44	Adjacent to the gravel mine
Construction Camp Ice Pad (1 season if necessary)	14	South of the Central Pad

[a] All ice infrastructure would be built annually and melt in the summer.

Water Needs and Sources

Freshwater would be required for the construction of ice roads and pads, camp operations, and drilling. Water needs for the construction of infrastructure associated with Alternative D are identified in Table 2.4-17.

Table 2.4-17: Alternative D — Water Needs for Infrastructure Construction		
Infrastructure Item	Estimated Size	Estimated Quantity of Water Needed (Gallons)
Tundra Ice Airstrip[a] (5,600 feet x 200 feet; 2 seasons)	39 acres	5,900,000
Tundra Ice Road for VSM and Export Pipeline Construction (2 seasons) and Materials Transport (1 season)	22 miles	21,100,000
Tundra Ice Road for Materials Transport (annual)	48 miles	46,200,000
Ice Bypass Ties Between Pipeline Construction and Module Transport Ice Roads (22 total; 2 seasons)	2 miles	2,000,000
Tundra Ice Road for Module Transport(3 seasons)	48 miles	46,200,000
Infield Ice Roads for Construction (3 seasons)	14 miles	9,800,000
Construction Camp Ice Pad (1 season if needed)	14 acres	2,1000,000
Gravel Overburden Ice Pad (2 seasons)	44 acres	6,500,000

[a] All ice infrastructure would be built annually and melt in the summer.

Freshwater for construction and drilling would typically be transported by truck. Water for ice roads between Badami and Point Thomson would be supplied from permitted water sources along the ice road, as described in Section 2.4.2.3. Water for infield ice roads and other construction uses would be supplied from the C-1 mine site reservoir.

Freshwater for operational use would typically be transported by a 3- or 4-inch insulated water line that would be buried within the gravel of the road between the new mine site reservoir and the Central Processing Pad. Water tanks for drilling activities on the well pads would be refilled by truck from either permitted surface water or the new mine reservoir. Table 2.4-18 lists water usage amounts by project phase.

The new mine site reservoir would serve as the primary water source for Alternative D throughout the field's operational life, while the C-1 mine site reservoir could serve as a secondary water source.

Table 2.4-18: Alternative D— Water Consumption by Phase

Phase	Estimated Use (Gallons)	Example Activities
Construction	391,100,00	All activities listed in Table 2.4-17, camp use, gravel watering, and dust suppression, and pipeline hydrostatic testing
Drilling	209,100,000	Camp use, drilling mud production
Operations	21,100,000[a]	Camp use, dust suppression, annual ice road to Endicott Spur Road

Source: ExxonMobil 2011a, Table 1B
[a] Operations water use is annual, rather than by phase.

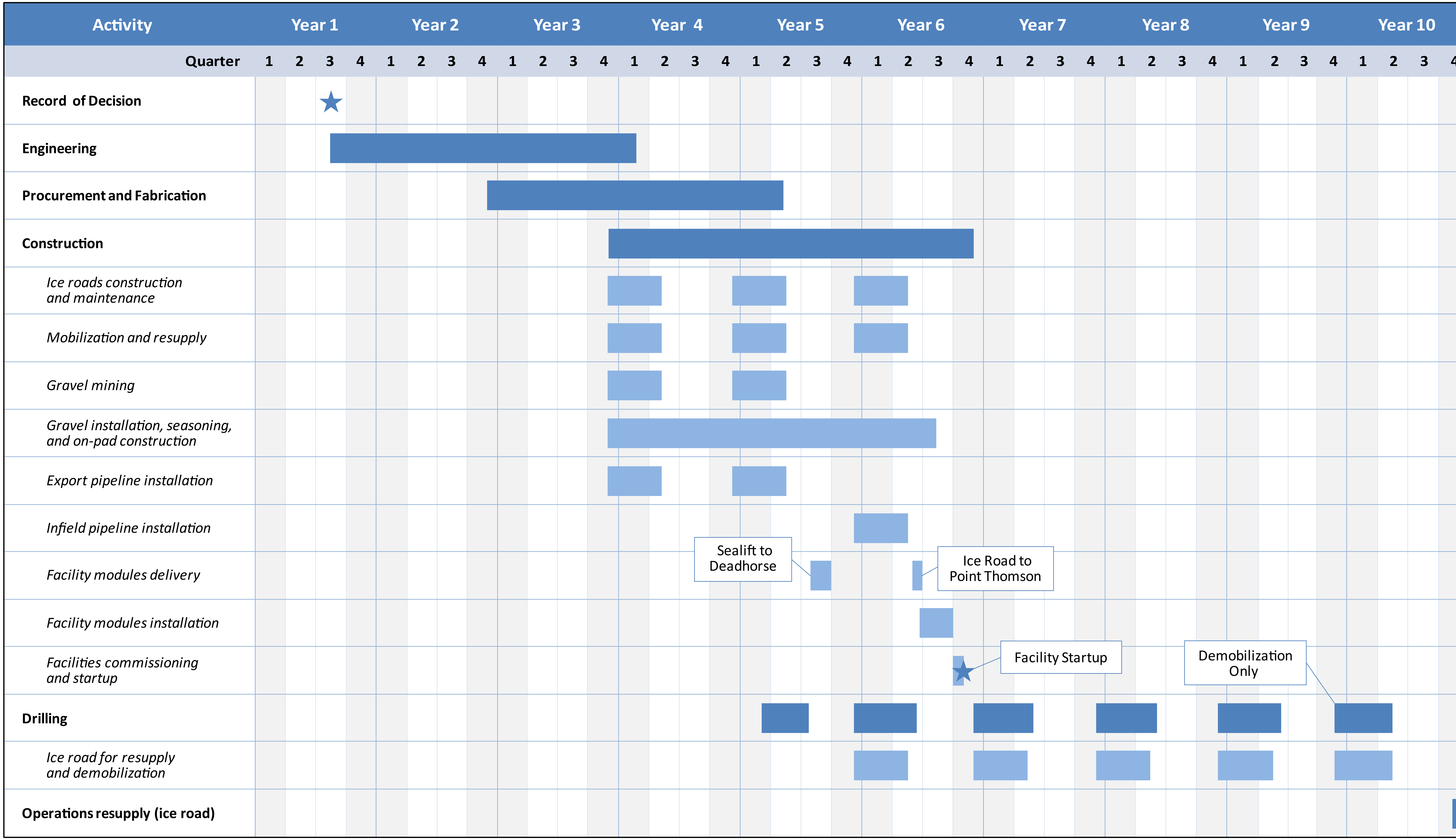
2.4.5.5 Alternative D: Logistics and Sequencing

The logistics and sequencing for Alternative D would be similar to those described in Alternative C, though Alternative D would use an annual ice access road to resupply its drilling and operations activities each year. This transportation constraint would result in a 5-year drilling program ending in Year 9 before the rig was demobilized along the ice road early in Year 10. See Figure 2.4-24 for greater detail.

Drilling Sequence

The wells in Alternative D would be drilled in the following order:

- Year 5 Spring Drill disposal well
- Year 6 Spring Complete PTU-15 and PTU-16
- Year 7 Spring Drill West Pad well and complete
- Year 8 Spring Drill East Pad well and complete
- Year 9 Spring Drill fifth well and complete
- Year 10 Spring Demobilize drill rig



POINT THOMSON PROJECT EIS

Figure 2.4-24

Alternative D Logistics and Sequencing

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Workforce Trends

Alternative D would have a total of five camps, four of which would demobilize with the construction and drilling crews. The onsite project workforce would peak in Years 5 and 6, when 740 personnel would be housed at the construction and drilling camps (see Figure 2.4-25). While 80 personnel would be required for year-round operations, an additional 60 crew members would be required beginning in winter of Year 6 to construct and maintain the annual ice resupply road.

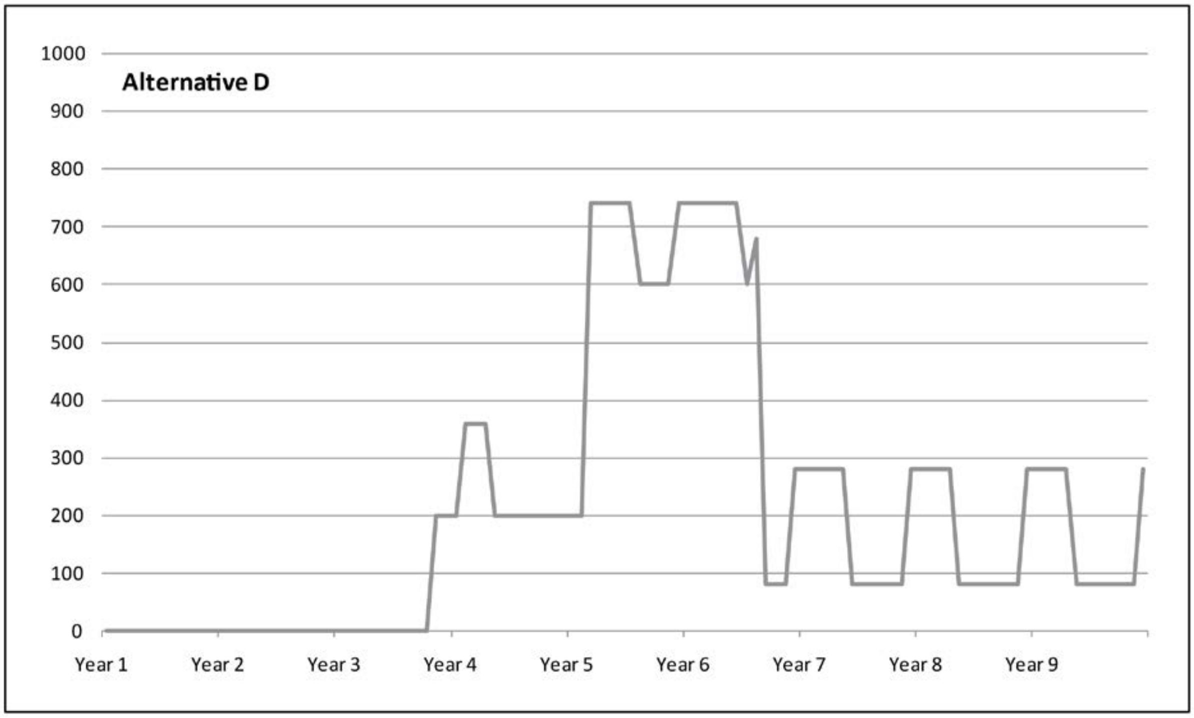


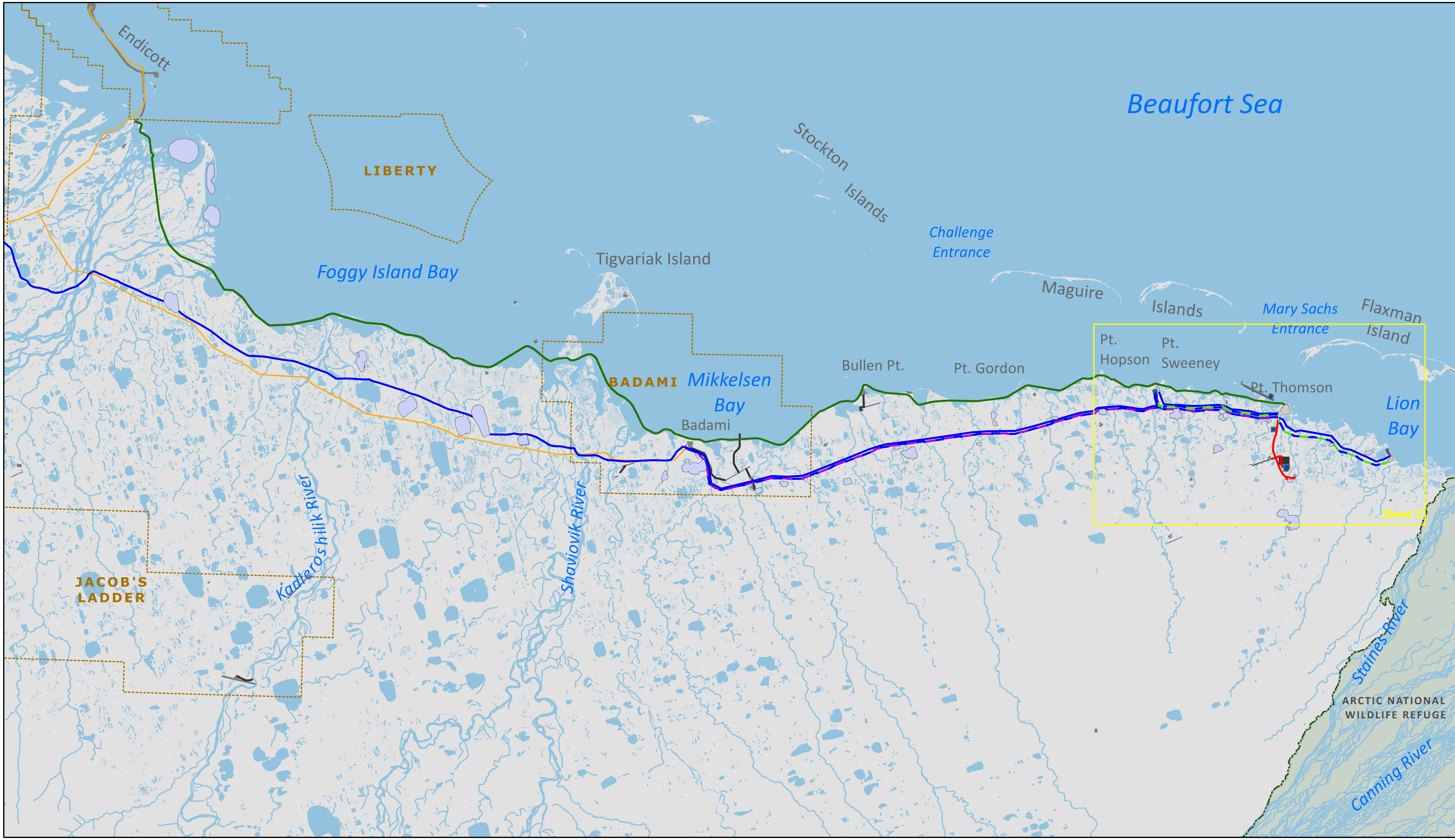
Figure 2.4-25: Alternative D — Onsite Workforce in Beds Occupied Over Time

Note: The workforce totals in this figure are based on the assumption that each camp would be occupied to capacity, though there may be times in which the activities occurring would not require the camps to operate at capacity.

2.4.6 Alternative E: Coastal Pads with Seasonal Ice Roads

The intent of Alternative E is to minimize the development footprint to reduce impacts to wetlands and surrounding water resources. To minimize the development footprint, this alternative would reduce the amount of gravel fill needed for some of the project components. In particular, the footprints of the East and West Pads would be a combination of gravel and multiyear, multiseason ice pad extensions (see Figure 2.4-26 and Figure 2.4-27). During drilling, the gravel pad footprint would be expanded by ice to support other associated facilities. Over the long term during operations, the ice pad footprint would be removed and only the gravel fill would remain to support the wellheads and associated required infrastructure. An expanded Central Pad incorporating both the central well and processing infrastructure would compensate for the two smaller ice/gravel combination pads. The gravel footprint would also be reduced by the use of ice roads for much of the infield road system. See Table 2.4-19 for other key features of Alternative E.

Table 2.4-19: Alternative E — Summary	
Theme	Reduce development footprint
Pads	• Central Well/Processing Pad near coastline (77 acres) • East Pad (17 acres of gravel and 11 acres of ice expansion; total 28 acres) • West Pad (13 acres of gravel and 11 acres of ice expansion; total 24 acres) • Badami auxiliary pad (1 acre)
Transportation to from Field	Construction • Air – helicopter and sea ice airstrip (5,600 feet x 200 feet) • Seasonal tundra ice road (44 mi) between the Endicott Spur Road and Point Thomson for transporting materials and supplies • Seasonal tundra ice road (22 mi) for VSM and export pipeline construction (2 years) • Seasonal sea ice road (47 mi) for supplemental materials and equipment transport (up to 3 years, optional each year) • Tundra-safe, low-ground-pressure vehicles when allowed • Coastal barge access via service pier and mooring dolphins • Sealift facility with onshore bulkhead and offshore mooring dolphins Drilling • Ice road and barge access as described for construction • Air access to gravel airstrip (3,700 feet x 200 feet) • Tundra-safe, low ground pressure vehicles when permitted Operations • Barge, air, and tundra-safe overland modes as described for drilling • Seasonal tundra ice road from the Endicott Spur Road as needed to support operations
Module Transport	To Point Thomson by sealift barge
Infield Transport	• Helicopters • Gravel road only between airstrip and Central Pad (4 mi) • Ice roads connecting to East and West Pads (9 mi, annually through operations) • Tundra-safe, low ground pressure vehicles when permitted
Infield Pipelines	8-inch gathering pipelines on VSMs (10 mi)
Export Pipeline	12-inch export pipeline on VSMs, tie-in at Badami (22 mi)
Primary Water Source	Existing C-1 reservoir
Other Infrastructure	• New gravel airstrip (3,700 feet x 200 feet, 29 acres) and associated facilities located approximately 2 miles south of the Central Pad • Short-term emergency camp facilities at East and West Pads • Helipads at East and West Pads • Helicopter facility (hangar, maintenance shop) at Central Pad • Infield gravel mine • Additional pads for stockpiling, storage, and water access • Ice pads for temporary storage and camps during construction
Compressor Type	Reciprocal



POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Oil and Gas Development Unit
- Existing Facilities
- Existing Pipelines
- Existing Road
- Water Body

Proposed Project Layout

- Road Centerline
- Tundra Ice Roads
- Sea Ice Road
- Export Pipeline
- Gathering Pipeline
- Potential Water Source
- Gravel Mine
- Gravel Pads
- Airstrip
- Sea Ice Airstrip/Ice Pads

The data displayed is concept level and has not been engineered.

0 2.5 5 Miles

N

Figure 2.4-26
Alternative E - Coastal Pads with Seasonal Ice Roads
Sheet 1 of 2

Date: 21 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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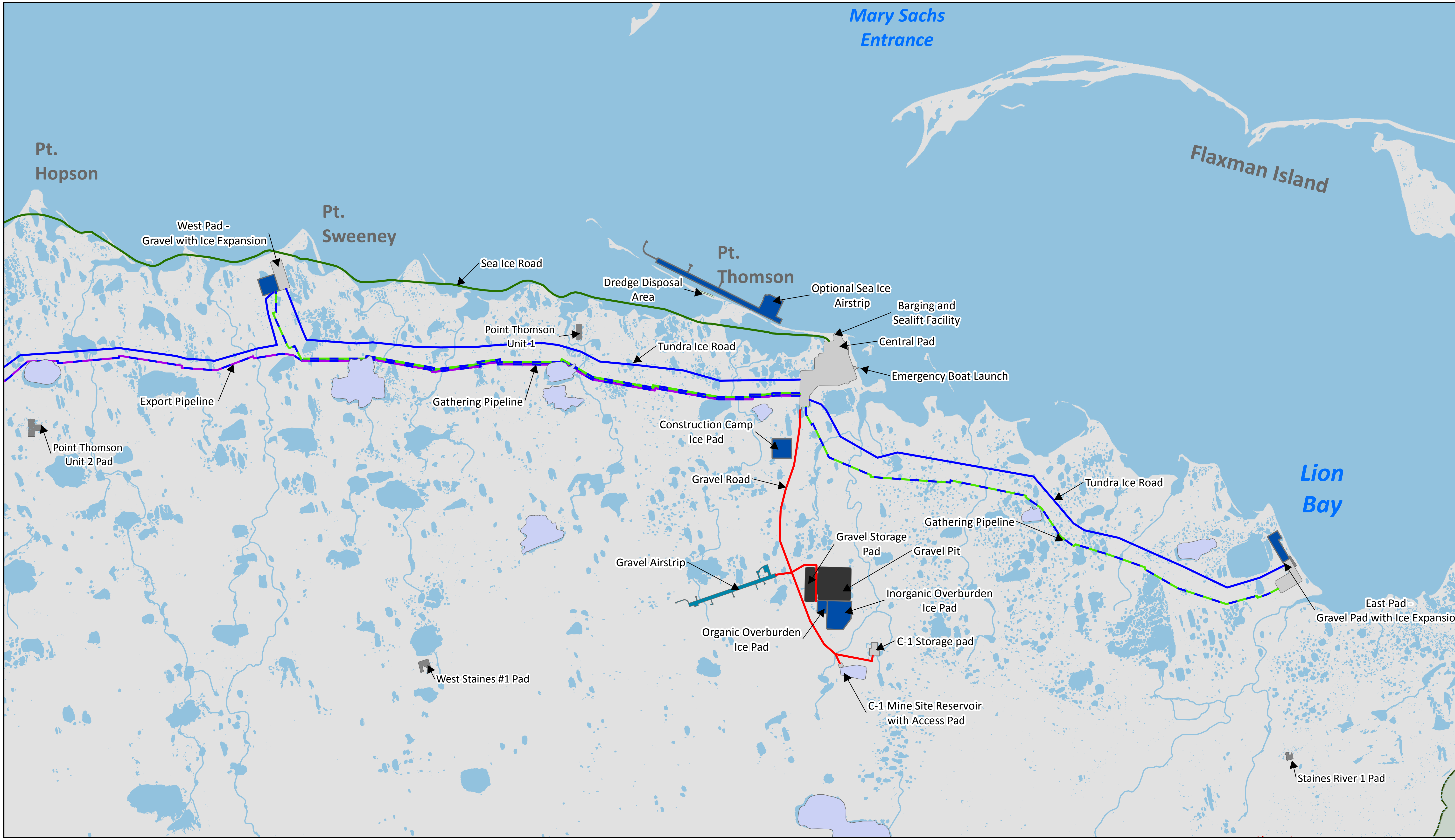

POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Existing Facilities
- Water Body

Proposed Project Layout

- Tundra Ice Roads
- Export Pipeline
- Gathering Pipeline
- Road Centerline
- Sea Ice Road
- Potential Water Source
- Gravel Mine
- Gravel Pads
- Airstrip
- Sea Ice Airstrip/Ice Pads

The data displayed is concept level and has not been engineered.

0 1 2 Miles

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Figure 2.4-27
Alternative E - Coastal Pads with Seasonal Ice Roads
Sheet 2 of 2

Date: 21 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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2.4.6.1 Alternative E: Production Pads

Alternative E would locate the drilling and production facilities onto a three-pad configuration that would consist of an enlarged Central Pad and two other ice-gravel combination pads (the East and West Pads). The gravel footprint of the East and West Pads would allow for adequate pad space for operations and would be supplemented with a multiseason ice pad extension during the drilling phase. The existing 12-acre PTU-3 gravel pad would be incorporated and expanded for the Central Pad. The East Pad would incorporate some of the existing fill at the North Staines River No. 1 pad for the drilling rig facility, but non-drilling facilities would be placed on an adjoining ice pad. The West Pad would consist of a gravel-ice combination in a previously undeveloped location. The Central Pad would connect to the airstrip and C-1 storage pad and reservoir via a 4-mile gravel road. Seasonal ice roads would be constructed to access the East and West Pads. Ten miles of infield gathering pipelines would be constructed and pig launchers and receiver modules would be located at each pad for the gathering pipelines. Additional nondrilling or production pads, which would include a small water source pad, a gravel mine stockpile pad, the C-1 storage pad, and auxiliary pads at Badami, are described in Section 2.4.6.4 under “Additional Pads.”

Central Pad

Alternative E would collocate the Central Well and Central Processing Pads into a single footprint called the Central Pad at the site of the PTU-3 gravel pad. The 77-acre Central Pad would be the largest of the three gravel pads and would be the primary storage for construction, drilling, and operations. The Central Pad is larger under this alternative to provide more storage and additional support space to compensate for the smaller gravel footprint of and limited access to the East and West Pads. To make drilling phase at the East and West Pads as efficient as possible, materials would be transported by barge to the Central Pad in the summer and stockpiled to be available as soon as the infield tundra ice roads are completed. The Central Pad would also include a helipad and associated aviation systems, given that access to the other well pads during the summer would be mostly by helicopter or occasionally by tundra-safe, low ground pressure vehicles.

The Central Pad would include the infrastructure to support remote operations and drilling as described in Section 2.4.2.1.

- **Drilling/well infrastructure.** Production, injection, and disposal wells would be distributed across the well pads as described in Section 2.4.2.1. A camp would also be located on the pad near the drill rig to accommodate the rig and support crews during active drilling. Due to its proximity to the coastline, slope protection would likely be needed on three sides of the Central Pad.

  Oil spill response equipment would be staged at the Central Pad.

- **Support facilities.** Support facilities on the Central Pad would include all those discussed in Section 2.4.2.1. Alternative E includes the following unique set of support components:

  - **Emergency boat launch ramp dimensions:** The emergency response boat launch ramp would be constructed as described in Alternative B.
  - **Fuel storage and resupply:** Diesel fuel would be resupplied throughout the year by tanker trucks via ice road (winter) and/or barge (summer).
  - **Helicopter hangar, maintenance facility, and helipad:** Because the majority of infield travel outside the ice road season would require the use of a helicopter, Alternative E would require a helicopter located onsite, with a second dedicated helicopter in Deadhorse for emergency response.

The onsite helicopter at Point Thomson would, in turn, require a dedicated hanger and heated maintenance shop adjacent to the helipad, located at the Central Pad (HDR 2011g). The gravel footprint for the helicopter facility are included in the measurements provided for the Central Pad.

East and West Pads

The East and West Pads would be constructed to contain production wells and associated facilities and to allow drilling the delineation/development wells that would target the oil rim. Both pads would be a combination of ice and gravel, with the gravel portion containing active and staged drilling equipment, fuel storage, and a small heated camp module large enough to accommodate an onsite crew and sufficient supplies for up to a week if conditions prevent access (HDR 2011g). The ice portion of the pad would accommodate accompanying support facilities to drilling activities.

These pads would each be located approximately 4 miles from the Central Pad. The East Pad would be approximately 17 acres of gravel, and the West Pad would be approximately 13 acres of gravel; an additional 11 acres of ice pad each would bring the pad to 28 and 24 acres, respectively. The East Pad would encompass the existing North Staines River State No. 1 Pad, to make use of the previously disturbed tundra. The North Staines River State No. 1 Pad contains an area that was impacted by a previous diesel spill (see Section 3.24 Contaminated Sites and Spill History). Known contamination at the East Pad would need to be addressed as part of the negotiations with the current lease holder and prior to construction. The West Pad would be located on an undeveloped site near the shoreline, in the same location as the West Pad in Alternative B.

Because of the lack of gravel road access, the inability of helicopters to fly during inclement weather, and on-tundra travel restrictions during breakup, both the East and West Pad gravel footprint would require a small, heated camp module large enough to accommodate an onsite crew and sufficient supplies for up to a week if storms prevented helicopter access (HDR 2011g).

Waste material, liquid, and/or cuttings would be stored on the East and West Pads until the ice road is available to facilitate the transport to the Class I disposal well, located on the Central Pad. During drilling, much of the East and West Pad areas would be occupied by drilling support facilities and services, including diesel fuel storage, temporary camps for the rig crew, and utilities. The gravel portion of the pad would be sized to accommodate up to eight wellheads and the equipment described for East and West Pads for all alternatives (see Section 2.4.2.1). Additionally, in this alternative, pad maintenance equipment and a heated storage building for onsite equipment would be required to allow for on-pad maintenance between ice road seasons and early preparations for ice road construction in the fall.

Power cables from the Central Pad would bring power to the local equipment room (LER), which would house communications equipment, and spill response storage units. Because access to the East and West Pads would be seasonal, spill response equipment (including D-8 CATs, loaders, and cranes) would be stored on the East and West Pads during operations to meet statutory requirements that an operator respond to a well blowout within 15 days.

The multiyear, multiseason ice extensions to the East and West Pads would be approximately 22 acres (11 acres each) of 6-foot-deep ice overlain by rig mats. They would be constructed in Year 4, prior to the arrival of the drill rig, and would be maintained for the 5 year duration of the drilling program. Over the course of the summer, each of the ice pad extensions would lose between 8 and 10 feet around each exposed edge to melting, and would need ice maintenance work early in the winter to recover that area before drilling could begin (HDR 2011c). Upon completion of the drilling program in Year 8, the rig mats would be removed and the ice pad extensions would be allowed to melt (HDR 2011g). Due to the size of the gravel pads, these ice pad extensions would need to be rebuilt any time additional wells were drilled at the East and West Pads as part of condensate or potential natural gas production in the future.

Access to the pads would be either by ice roads in the winter or by helicopter year-round. Under Alternative E, while supplies could be barged and stored at the Central Pad, they could not be moved to the East or West Pads until the ice roads were completed the following winter.

In emergency situations when helicopter travel between the pads is not possible, a tundra-safe, low ground pressure vehicle would be used as transportation between the Central Pad and the East and West Pads. Tundra-safe, low ground pressure vehicles (with load limitations) may be used on the tundra year-round except for a 2- to 3- month period during breakup.

The East and West Pads would include a helipad to accommodate year-round helicopter access, given that they would not be connected by infield gravel roads and only seasonally by ice roads. Helicopters would be used for routine access to the pads. When weather complicates access to the East and West Pads during the summer and results in no-fly days (sometimes up to a week or more), tundra-safe, low ground pressure vehicles would be used (except during breakup).

Pad and Infield Infrastructure Maintenance

Pad and infrastructure maintenance would be ongoing. Maintenance equipment would be kept at the East, West, and Central Pads and would be used weekly or as needed during the summer season to maintain the integrity of both the gravel pad and ice extension.

In addition to routine maintenance, work would begin in early winter to rehabilitate the ice pads for drilling activity. After the completion of the drilling stage, all equipment and rig matting would be removed from the ice pad extensions and the pads would be allowed to melt (see above).

2.4.6.2 Alternative E: Pipelines

Export Pipeline

An elevated export pipeline approximately 22 miles in length would be constructed and would run from the Central Pad to the existing Badami common carrier pipeline, which connects to TAPS Pump Station No. 1. The pipeline route would be the same as described for Alternative B and would generally be located between 1 and 2 miles from the coastline.

Infield Pipelines

Approximately 10 miles of infield, 8-inch gathering pipelines would be constructed to deliver the produced hydrocarbons from the East and West Pads to the CPF. As described in Alternative B, these gathering lines would be built on VSMs in the T configuration (see Figure 2.4-7). The supports in Alternative E, however, would be designed to accommodate the weight of an additional 18-inch gathering line in the event of natural gas production, which is considered a reasonably foreseeable future action.

Pipeline Construction

Pipeline construction would occur over three construction seasons, with the export pipelines being installed in the first two construction seasons and the infield pipelines installed in the third season. Pipelines would be built in the winter using ice roads for access.

2.4.6.3 Alternative E: Access and Transportation

Under this alternative, a number of transportation modes would be used to transport personnel, materials, and equipment to and from Point Thomson as summarized in Table 2.4-20. Barges would bring large modules; smaller modules, equipment, and supplies would be transported by either barge or over ice roads. Personnel would be flown in and out of Point Thomson. Personnel would travel by helicopter between the pads during summer and over ice roads in the winter. Tundra-safe, low ground pressure vehicles would be used to access the East and West Pads in case of emergency when helicopter access was not possible. The only infield gravel road would be between the Central Pad, the airstrip, the C-1 storage pad, and the water source.

Table 2.4-20: Alternative E — Transportation Modes for Materials, Equipment, and Personnel by Phase

	Ice Road	Gravel Road[a]	Barge	Airplane	Helicopter
Construction					
Personnel	To/From (TF), Infield (IF)	IF	—	TF[b]	TF, IF
Materials and Equipment[c]	TF, IF	IF	TF	TF	TF, IF
Drilling					
Personnel	TF, IF	IF	—	TF	TF
Materials and Equipment[c]	TF, IF	IF	TF	TF	TF
Operations					
Personnel	TF, IF	IF	—	TF	TF, IF
Materials and Equipment[c]	TF[c], IF	IF	TF	TF	TF, IF

[a] The only infield gravel road that would be built would be between the Central Pad and the C-1 storage pad and water source.

[b] The airstrip could be used for personnel and equipment transportation late in the second year of construction.

[c] While a wide variety of transportation modes would be used, the mode used would ultimately be determined by the size of the equipment needed and the time at which it was needed, e.g., the size of the permanent camp in this alternative requires barge transport to Point Thomson.

[d] Alternative E would not likely have an access ice road each year; if an ice road were constructed, however, it would be used as a resupply route for the duration of the ice road season.

The total number of trips to Point Thomson by mode and phase of the project is detailed in Table 2.4-21. Land transport numbers in construction and drilling include the overland transportation of large fuel tanks, modules, and the drill rig by way of the access ice road before barging would be established. Because infield traffic levels would be directly related to daily activities, no estimates for infield traffic levels were developed for this analysis. Additional discussion of the logistics of Alternative E can be found in Section 2.4.6.5

Table 2.4-21: Alternative E — Round Trips to Point Thomson by Mode and Phase

Mode	Construction (total for phase)	Drilling (total for phase)	Operations (annual)
Land Transport (ice access road)	4,510	9,480—11,070	0
Barge	170 (coastal) 10 (sealift)	170—250 (coastal)	20 (coastal)
Fixed-wing Aircraft	1,975	1,775	765
Helicopter	5,070	2,500—3,000	5[a]

Source: ExxonMobil 2011a, Tables 1A and 1B

[a] Alternative E is the only alternative with routine infield helicopter travel between pads. While Table 1A of ExxonMobil 2011a lists a total 730 flights, these were confirmed to be infield flights, in addition to the routine flights between Deadhorse and Point Thomson (HDR 2011c).

Ice Roads

Ice roads are essential to Alternative E. During construction, at least two separate routes of tundra ice roads would be constructed the first two or three winters. The first ice road would extend 44 miles between the Endicott Spur and Point Thomson for transporting materials, supplies, and modules. This ice road would be constructed at the beginning of each of the three construction seasons. A second 22-mile tundra ice road would be built for two construction seasons between Badami and Point Thomson for support of export pipeline construction. In addition to the tundra ice road, the Applicant may construct a 47-mile sea ice road to maximize the ice road season during any or all years of construction.

Except for the road between the Central Pad and airstrip, infield roads for Alternative E would be ice roads. 11 miles of 40-foot-wide, 1-foot-thick ice roads would provide access to the East and West Pads for both standard equipment and the drill rig during drilling. During operations, these roads would be 35 feet wide and approximately 6 inches thick.

During operations, there are no planned ice access roads to Point Thomson. If, however, a piece of equipment was required at Point Thomson during the winter that exceeded the capacity of the mid-sized aircraft that could use the airstrip, and the project could not wait for the summer barging season, an access ice road may be required. It is conservatively estimated that such an ice road may be required once every 5 years. If an ice access road were constructed, the project would use that ice road as an opportunity for midwinter resupply, though traffic would be much less than during construction and drilling.

Barging

Under Alternative E, both coastal and sealift barging would be used to transport supplies and modules, respectively. As in Alternative B, a service pier would be constructed adjacent to a sealift facility to accommodate both types of barging. Construction activities would be the same as described in Alternative B.

Airstrip

Air service to support drilling and initial construction activities would be provided by helicopter and a seasonal sea ice airstrip during the winter until the gravel airstrip has been constructed and is useable. The ice airstrip would have the dimensions capable of accommodating a fully loaded Lockheed C-130 Hercules aircraft (5,600 feet by 200 feet).

A 3,700-foot by 200-foot gravel airstrip would be constructed and located south of the Central Pad, approximately 2 miles inland from the coast. The gravel airstrip would provide the only year-round fixed-wing aircraft access to the Point Thomson area beginning in Year 4.

The gravel airstrip would enable the small passenger and cargo aircraft to access the site, such as those used for passenger transport in all alternatives (see Section 2.4.2.3; Appendix D, RFI 62). The length and width of the airstrip would not allow the use of a Lockheed C-130 Hercules cargo plane, which could limit the ability of the project to bring large equipment (such as potential emergency response equipment) to Point Thomson during drilling and operations. An ice extension to this airstrip size was considered but was eliminated as a project component (see Section 2.3.1.3).

The gravel airstrip and associated features would occupy approximately 29 acres.

Helipad

Because of Alternative E's reliance on infield ice road travel, transportation between the East, West, and Central Pads during the summer would largely be restricted to helicopter transport. A helipad and heated maintenance facility would be housed at the Central Pad. The East and West Pads would also have small helipads along with short-term emergency camp facilities equipped with supplies in case weather precludes helicopter travel and workers cannot return to the Central Pad. Gravel footprints required for the maintenance facilities and helipads are included in acreages for the pads. During operations, infield summer travel would require approximately 730 infield round trips per year.

Infield Gravel Roads

While most of the infield surface access would be via ice road, a 4-mile infield gravel road would be constructed to connect the Central Pad with the airstrip, gravel mine and stockpile, C-1 storage pad, and water source. Stream crossings would be accomplished as necessary by bridges and culverts, and the road would be constructed as described in Section 2.4.2.3, Gravel Roads (Appendix D, CS 4).

2.4.6.4 Alternative E: Other Infrastructure

Water Distribution

During operations, an intake structure at the C-1 mine site would provide water via a 3- to 4-inch pipeline with insulation elevated on 7-foot, T-shaped supports similar to those used for the gathering and export pipelines (HDR 2011f). The insulation on the pipeline would result in a 10 to 12-inch external diameter. The HSMs would also accommodate power lines to the airstrip. The rehabilitated Point Thomson gravel mine would be available as a secondary water source for the life of the project.

Power Distribution

Operational power and fiber optic communication cables to the airstrip would be located in cable trays on the water pipeline from the Central Pad to the point on the pipeline nearest the airstrip. In the vicinity of the road to the airstrip, the cables transition from the cable trays into an 8-inch conduit pipe and would be trenched within the tundra to the airstrip, with junction boxes similar to those described in Alternative B located approximately every 1,000 feet along the trenched route (see Figure 2.4-11; HDR 2011f).

Gravel Source

Alternative E would require approximately 1.7 million cubic yards of gravel from a new gravel mine site located approximately 2 miles south of the Central Pad and just north and east of the proposed airstrip, the same location as that provided for Alternative B.

As described in Alternative B, the goal would be to complete gravel mining in two winter seasons, after which the mine would be rehabilitated. This new reservoir could be used as a secondary water source as needed during field life.

Additional Pads

Development of other gravel pads would include a gravel storage pad, the existing C-1 storage, and a water source access pad, as described in Section 2.4.2.4 Additionally, Alternative E would develop:

- **Badami auxiliary pads:** Alternative E would require two small gravel pads at Badami similar to Alternative B. The first gravel pad would be approximately 100-foot by 120-foot connected to the existing Badami pad by a short gravel road. A second pad would be located south of the Badami Main Pad in order to facilitate the ice road crossing of the export pipeline. These pads and connector road would require a combined single acre of fill using approximately 8,000 cubic yards of gravel.

In addition to gravel pads and the multiyear ice pad extensions described in Section 2.4.6.1, single-season ice pads would be required to support construction. Table 2.4-22 gives approximate sizes and locations of additional pads.

Table 2.4-22: Alternative E — Additional Pad Requirements

Pad	Estimated Size (acres)	Anticipated Location
C-1 Storage Pad	4	Current location
Water Source Access Pad	1	Next to C-1 mine site
Gravel Storage Pad	11	Adjacent to the gravel mine
Badami Auxiliary Pads	1	Badami
East and West Pad Ice Extensions[a] (5 year)	11 each	Adjacent to the gravel drilling pad at East and West Pad locations
Construction Camp Ice Pad[b] (1 year if needed)	14	South of the Central Pad
Overburden Storage Ice Pad[b]	29	Adjacent to gravel mine

[a] Multiyear, multiseason ice pads.

[b] Ice infrastructure that would be constructed annually and melt each spring.

Water Sources

Freshwater would be required for the construction of ice roads and pads, camp operations, and drilling. Water needs for the construction of infrastructure associated with Alternative E are identified in Table 2.4-23.

Table 2.4-23: Alternative E — Water Needs for Infrastructure Construction

Infrastructure Item	Estimated Size	Estimated Quantity of Water Needed (Gallons)
Sea Ice Airstrip (5,600 feet x 200 feet)	39 acres	5,7000,000
Sea Ice Road (3 years if needed)	47 miles	32,700,000
East Pad Ice Extension [a]	11 acres	1,700,000
West Pad Ice Extension [a]	11 acres	1,700,000
Tundra Ice Road for VSM and Export Pipeline Construction [b] (2 seasons)	22 miles	21,300,000
Tundra Ice Road for Transporting Materials and Supplies [b] (3 seasons)	44 miles	30,800,000
Construction Camp Ice Pad [b] (1 year if needed)	14 acres	2,100,000
Overburden Ice Pad [b] (2 years)	29 acres	4,300,000
Infield Ice Roads [b] (annual)	11 miles	11,000,000

[a] Multiyear, multiseason ice pads; water needed includes initial construction in Year 4.
[b] Ice infrastructure that would be constructed annually and melt each spring.

Freshwater for construction would typically be transported by truck from the C-1 mine site, and by elevated water line during operations.

Water tanks on the East and West Pads would be refilled with local surface water collected by truck. Table 2.4-24 lists estimated water use by phase for Alternative E.

Table 2.4-24: Alternative E— Water Consumption by Phase

Phase	Estimated Use (Gallons)	Example Activities
Construction	310,800,00	All activities listed in Table 2.4-23, camp use, gravel watering, and dust suppression, and pipeline hydrostatic testing
Drilling	283,900,00	Camp use, drilling mud production
Operations	13,200,000[a]	Camp use, dust suppression, annual infield ice roads

Source: ExxonMobil 2011a, Table 1B
[a] Operations water use is annual, rather than by phase.

2.4.6.5 Alternative E: Logistics and Sequencing

The logistical challenges of Alternative E would be similar to those described in Alternative B. Additional challenges would be posed by the use of infield ice infrastructure and coastal barging for operational resupply. The Central Pad would be larger because it would need to house 10 months' worth of supplies that would be delivered by barge but that, unlike Alternative B, could not be distributed to the East and West Pads until the ice roads were functional. The size of the Central Pad would necessitate additional winter geotechnical surveys and summer hydrology studies to complete detailed engineering. These studies and engineering would occur the first year after the issuance of the ROD.

The drill rig would be limited in its movements due to the seasonal nature of access to each of the satellite pads: ice roads are typically not completed until mid-January, and the 5 month ice road season, rather than the hydrocarbon drilling window, would dictate the drilling schedule. As a result, the drilling program in Alternative E would require five seasons, and the rig would be demobilized from Point Thomson by ice road in the early winter of Year 8. See Figure 2.4-28 for greater detail.

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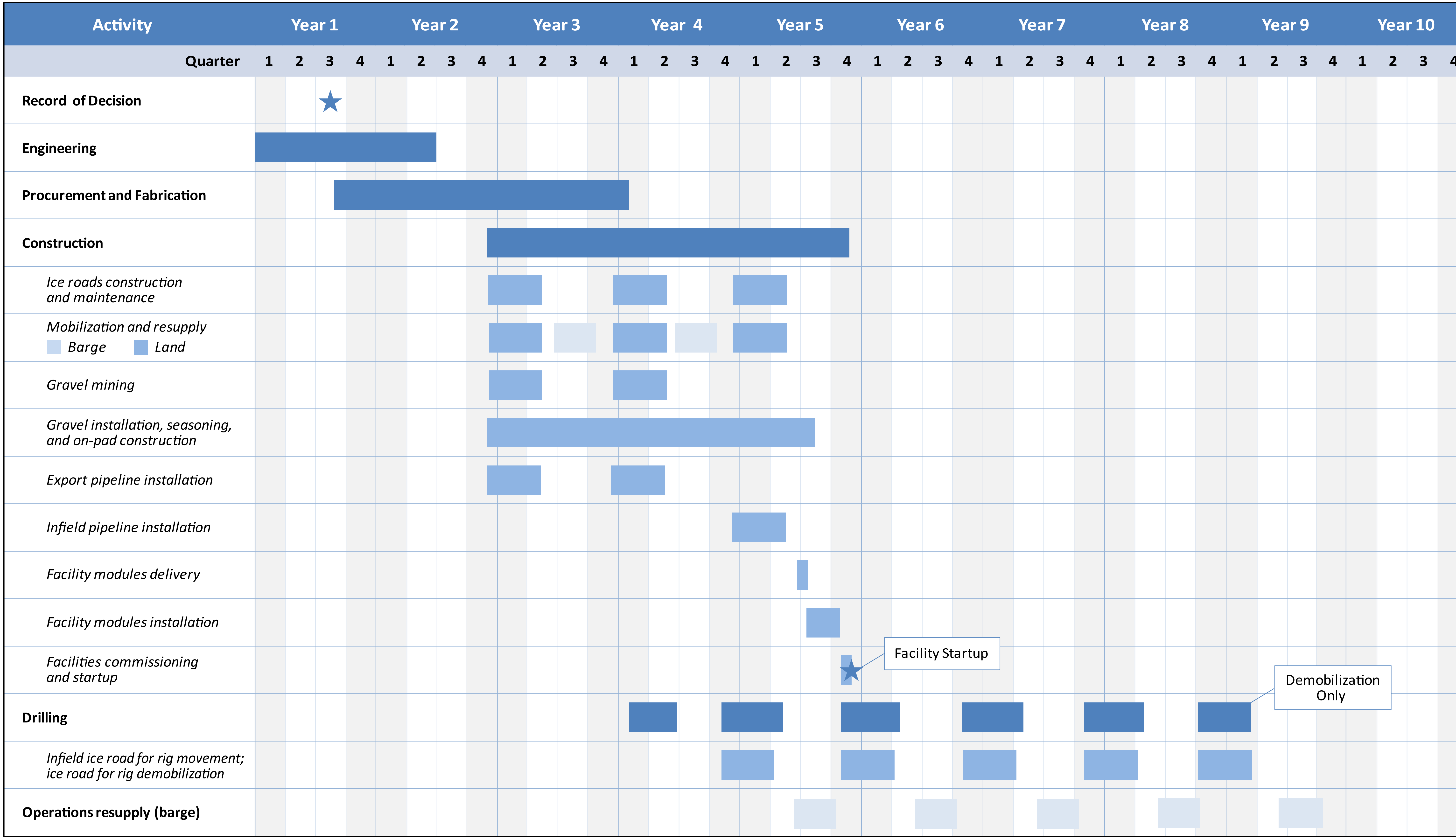

Figure 2.4-28
Alternative E Logistics and Sequencing

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Drilling Sequence

The drilling program in Alternative E would be scheduled as follows:

- Year 4 Spring Drill disposal well
  Summer Complete PTU-15 and PTU-16
- Year 5 Spring Surface drill East Pad well
- Year 6 Spring Drill West Pad well and complete
- Year 7 Spring Drill East Pad well to depth and complete
- Year 8 Spring Drill fifth well and complete
- Year 9 Spring Demobilize rig

Workforce Trends

Alternative E would have a total of five camps, four of which would demobilize with the construction and drilling crews. The workforce onsite would peak in the winter of Year 4, when 740 personnel would be housed at the construction and drilling camps (see Figure 2.4-29). During drilling in Years 7, 8, and 9, the drilling crew would include 140 staff members housed at the drilling camp and an additional 60 personnel to create and maintain the ice access road for drilling resupply. These 60 personnel would be housed at the permanent operations camp.

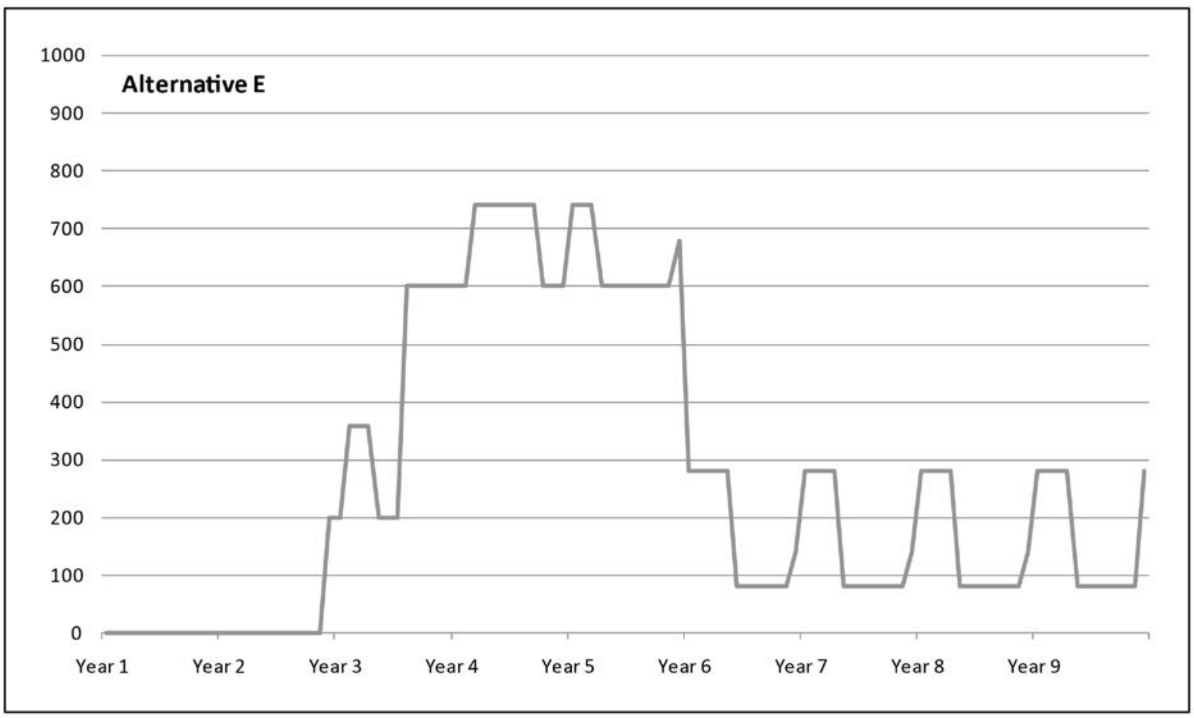

Figure 2.4-29: Alternative E — Onsite Workforce in Beds Occupied Over Time

Note: The workforce totals in this figure are based on the assumption that each camp would be occupied to capacity, though there may be times in which the activities occurring would not require the camps to operate at capacity.

2.5 COMPARISON OF REASONABLE ALTERNATIVES

The Corps performed a detailed impact analysis of the No Action Alternative, the Applicant's proposed action, and three action alternatives to the proposed action. The section below gives further information about the design of the alternatives that may not be initially evident to the reader. The subsequent section provides a summary of impact to the resources analyzed in this Draft EIS. Chapter 5 further describes and compares the impacts of each alternative by resource. A short discussion about the spill risk analysis is at the end of this section.

2.5.1 Additional Context of Alternatives

The alternatives to the Applicant's proposed action (Alternative B) were developed to address concerns raised by agencies and the public during scoping. These alternatives were further refined to respond to issues identified during development of the Draft EIS. Inherent in the development of these action alternatives are trade-offs that may not be implicitly stated within either the descriptions of alternatives in this chapter or within the analysis of impacts to resources in Chapter 5. This section is intended to provide additional context and relevant factors that the agencies and public can use during consideration of this project.

Despite its onshore location, the project area functions like an island in that it is completely detached from existing land-based infrastructure. Year-round transportation of goods and supplies can only be accomplished by air, which can be impacted by weather, or by the construction of permanent gravel infrastructure to the site. Water-based transportation can be accomplished for a short time during the open water season, but inclement weather and concerns for marine subsistence activity can reduce the amount of time available for barge travel. In winter, ice roads can provide land-based access to the project area, but require months to construct and are only available for up to 4 months. Within this geographical context, the primary challenge for each alternative would be to optimize the shipping seasons and transportation modes within that alternative.

2.5.1.1 Alternative C: Inland Pads with Gravel Access Road

Alternative C was developed to minimize impacts to coastal resources (such as marine mammals and fish), subsistence activities, nearshore processes, and potential impacts to the project facilities from coastal erosion. To minimize these impacts, this alternative would move project components inland. The primary trade-offs with this alternative would result from 1) moving the pads inland, thereby reducing access to the reservoir; 2) the fuel and other supply constraints of seasonal access to the site; 3) the cost and environmental impacts of developing an all-season gravel road; and 4) the challenges of overland module transportation.

With currently available public information, it is not possible to determine how far inland the pads could be moved and still access the reservoir to fully develop the resource. The optimal location for well heads to fully develop the resource would be from a barrier or manmade island (ExxonMobil 2009b), based on the offshore location of the majority of the reservoir. Extended reach drilling technologies for similar reservoir pressures and conditions is limited to 10,000 to 13,000 feet of horizontal reach (Appendix D, RFI 63). Moving the East and West Pads inland by one-half mile (or 2,600 feet) would potentially reduce the extent to which the reservoir can be effectively produced.

At this time it is not possible to determine the consequences of potentially reducing reservoir coverage in terms of recoverable cubic feet of gas and barrels of product. The proposed project is, in part, intended to provide additional reservoir information in support of a more comprehensive development plan. For use in this EIS, a rough estimate of reservoir coverage (in two dimensions) was determined by assuming a 13,000-

foot drilling reach and a homogeneous reservoir (which is very unlikely). Under these assumptions, Alternative B would access approximately 88 percent of the reservoir (HDR 2011h). Moving the drill pads inland by one-half mile under Alternative C would result in being able to access approximately 79 percent of the reservoir (HDR 2011h), which may not be sufficient coverage to fully develop the resource as described in the project purpose and need.

Moving the pads inland would have the potential trade-off that future additional pads may be needed to fully develop the Point Thomson resource. Additional pads near the coast could be deemed necessary if, upon fully delineating the reservoir and determining the extent of reservoir connectivity, it is determined that access into more northern or eastern portions of the reservoir would be required to fully develop the resource. Here again, the proposed project is, in part, intended to provide additional reservoir information in support of a more complete development plan.

A second challenge of this alternative would be the seasonal access to the site during construction. Because the only access to the site would be ice roads and air transport for construction and the first two years of drilling, this alternative would require that sufficient fuel be transported in winter to accommodate both the activities of that winter season and all activities until the next ice road season. This would result in an estimated 7.5 million gallons of fuel being transported via ice road each year. Currently, the only fuel depot in Deadhorse does not have the capacity for that amount of fuel, and would require an upgrade to keep a stream of one truck every hour, 24 hours a day, to Point Thomson for the duration of the ice road season (HDR 2011g).

A third consideration under this alternative would be substantial costs incurred from the building and maintenance of a 44-mile gravel access road. However, because project costs were not determined as part of development of alternatives, there is no basis for determining an order-of-magnitude cost for comparison.

Finally, the scope of the transport scenario for the facility modules in Alternative C is unprecedented on the North Slope. Modules would be transported over an ice road by SPMT. SPMT requires a SPMT operator and guides to walk the entire distance with the module, and over long distance also requires sufficient staff to repair the SPMT should it malfunction. The subzero temperatures of the North Slope would double the required crew of SPMT operators and guides to allow crews to warm and rest themselves. The largest module transported over ice roads to date was 1,500 tons (including the weight of the SPMTs) transported approximately 40 miles from Endicott to the Alpine development (HDR 2011g). The largest of the Point Thomson facility modules would be 1,700 tons, including the weight of the SPMTs, and would travel up to 60 miles depending on the ice road route at the time of transport.

2.5.1.2 Alternative D: Inland Pads with Seasonal Ice Access Road

Alternative D was also developed to minimize impacts to coastal resources, similar to Alternative C, and would move project components inland and as far away from the coast as practicable and feasible. The primary trade-offs with this alternative would result from 1) moving the pads inland, thereby reducing access to the reservoir, and 2) having limited, seasonal overland access to the site throughout drilling and operations.

As discussed with Alternative C, moving the drill pads inland would reduce the extent of reservoir coverage by 9 percent (HDR 2011h), relative to coastal drill pad locations. Based on existing publically available information there is no way to determine how this reduction in coverage would translate to cubic feet of gas and recoverable barrels of product, or whether additional coastal drill pads would be necessary to fully develop the reservoir. Therefore, like with Alternative C, additional pads near the coast could be deemed necessary if, upon fully delineating the reservoir and determining the extent of reservoir connectivity it is determined that coastal drill pads would be required to fully develop the resource.

Access to the project area under Alternative D would be via seasonal ice roads and a gravel airstrip. As with Alternative C, all fuel and supplies during construction would be transported via an ice road. Challenges with the current size of the fuel depot in Deadhorse would limit the ability to support one fuel truck every hour, 24 hours a day, to Point Thomson for the duration of the ice road season would be the same as for Alternative C (HDR 2011g). Modules would also be delivered by SPMTs over ice roads, as under Alternative C.

The difference between the two alternatives is that resupply throughout drilling and operations would continue over ice road under Alternative D since no gravel access road would be built. Air transport would be the only year-round access to Point Thomson, but would be dependent on adequate weather conditions for flying. Under Alternative D transporting any large equipment or materials over the lifetime of the project would occur only during winter ice road seasons. A consequence of this logistical trade-off could include delayed development and production of the resource (e.g., materials or equipment not arriving within the necessary time frame, thereby missing a subsequent construction or drilling season). No estimates of cost risks related to logistics were completed, so cost cannot be used as a comparison between alternatives.

2.5.1.3 Alternative E: Coastal Pads with Seasonal Ice Roads

Alternative E uses the same pad locations as Alternative B and therefore has the same potential to develop the majority of the reservoir. Alternative E was developed to minimize the infrastructure footprint to reduce impacts to wetlands and surrounding water resources. This alternative would require less gravel fill overall, by not having infield gravel roads and using multiyear ice pads during drilling. The primary trade-offs of this alternative would result from 1) logistical challenges of having only seasonal overland access between pads and 2) technical and logistical challenges of using untested hybrid drill pads of gravel and multiyear ice.

Under this alternative the access to the East and West Pads would be either by helicopter, low ground pressure tundra vehicle, or by ice road in the winter. Potential effects of this logistical constraint include: not having year-round emergency response access due to no-fly days, limited ability to perform maintenance activities in the summer season, and a limited 3-month ice road window to move large equipment and materials. As with Alternative D, the logistical trade-off could include delayed development and production of the resource (such as due to missing an ice road window to move the drill rig or not being able to resupply). No estimates of cost risks related to logistics were completed, so cost cannot be used as a comparison between alternatives.

Alternative E would use multiyear ice pads adjacent to smaller, permanent ice pads in an effort to minimize gravel fill in wetlands. Multiseason ice pads (two winters, one summer) have been used elsewhere for drilling exploration wells; however, no examples were found where a multiyear ice pad was used in support of production drilling. As intended in Alternative E, the multiyear ice pad would be used for storage of equipment and materials in support of well development. A multiyear ice pad has several potential challenges such as the viability and annual maintenance of multiyear ice, safety concerns associated with irregular melting and structural integrity, and creation and maintenance of a viable connection with the permanent gravel pad.

2.5.2 Comparison of Impacts

Table 2.5-1 provides a side-by-side comparison of impacts across the five alternatives. Each resource is represented, along with impacts that are able to be quantified and/or allow for differentiation among the alternatives. Additional impacts are discussed in Chapter 5.

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Table 2.5-1: Comparison of Impacts[a]

Impact Category	Alternative A (No Action)	Alternative B (Applicant's Proposed Action)	Alternative C (Inland Pads with Gravel Access Road)	Alternative D (Inland Pads with Seasonal Ice Access Road)	Alternative E (Coastal Pads with Seasonal Ice Roads)
Geology and Geomorphology (Section 5.1)					
Petroleum hydrocarbon production	No impact	For all action alternatives, 10,000 bbl per day of condensate and up to 10,000 bbl per day of oil, if oil rim production is viable; impacts would be irreversible but this is the project purpose			
Gravel use	No Impact	2.2 million cubic yards (mcy) of gravel would be mined; impacts would be negligible due to regional abundance.	5.4 mcy; impacts would be negligible due to regional abundance.	2.5 mcy; impacts would be negligible due to regional abundance.	1.7 mcy; impacts would be negligible due to regional abundance.
Geomorphologic features	No impact	Impacts to geomorphologic features from gravel infrastructure and the mine would last at least the life of the project.	Greater impacts due to gravel access road and associated gravel mines.	Impacts similar to Alternative B	Least impact due to reduced infrastructure
Soils and Permafrost (Section 5.2)					
Soil compaction and alteration of the thermal regime of the permafrost due to gravel fill placement	No impact	215 acres	605 acres	285 acres	155 acres
Potential for decreased albedo, increased thermal conductivity, and promotion of earlier spring thaw due to dust/snowplow/gravel spray	No impact	135 acres	590 acres	185 acres	60 acres
Gravel mining could lead to talik formation and permafrost degradation	No impact	55 acres of gravel mine footprint	130 acres of gravel mine footprint	65 acres of gravel mine footprint	45 acres of gravel mine footprint
Compaction of underlying soil and inhibition of vegetation regeneration due to multiseason ice pads	No impact	None	None	None	20 acres
Meteorology and Climate (Section 5.3)					
	No impact				
Air Quality (Section 5.4)					
State and federal air quality standards	No impact	Air pollutants, including GHGs, would be emitted but state and federal air quality standards would be met.	Emissions would be similar to Alternative B except drilling impacts would be of greater duration (4 years compared to 3 years). State and federal air quality standards would be met.	Emissions would be similar to Alternative B except drilling impacts would be of greater duration (5 years). State and federal air quality standards would be met.	Emissions would be similar to Alternative B except drilling impacts would be of greater duration (5 years). State and federal air quality standards would be met.

Table 2.5-1: Comparison of Impacts[a]

Impact Category	**Alternative A** (No Action)	**Alternative B** (Applicant's Proposed Action)	**Alternative C** (Inland Pads with Gravel Access Road)	**Alternative D** (Inland Pads with Seasonal Ice Access Road)	**Alternative E** (Coastal Pads with Seasonal Ice Roads)
Emissions from transportation would vary depending on the types and numbers of trips. Relative emissions produced in each alternative would generally be proportional to the number of trips by mode.	No impact	Fuel truck trips are particularly noteworthy relative to air quality because they produce fugitive dust and combustion emissions themselves and are associated with emissions produced by combustion of the fuel in construction equipment. About 883 fuel truck trips would be required during construction. See Transportation, below, for other trip information.	About 3,458 fuel trucks would be required during construction. The additional fuel trucks would produce fugitive dust and combustion emissions above that produced in Alternative B and E. Additional emissions would also be associated with combustion of the additional fuel in construction equipment. Local air quality would not likely be measurably changed compared to Alternatives B and E because the emissions would tend to be scattered intermittently over a wide area. See Transportation, below, for other trip information.	About 3,458 fuel trucks would be required during construction. The additional fuel trucks would produce emissions above that produced in Alternative B and E. Additional emissions would also be associated with combustion of the additional fuel in construction equipment. Local air quality would not likely be measurably changed compared to Alternatives B and E because the emissions would tend to be scattered intermittently over a wide area. See Transportation, below, for other trip information.	About 883 fuel truck trips would be required during construction. See Transportation, below, for other trip information.
Physical Oceanography and Coastal Processes (Section 5.5)					
	Over time, the existing PTU-3 Pad could extend out into the sea more than the adjacent land, due to differential erosion along the coast.	Primary impacts would be from dredging and screeding associated with the barge offloading facility.	No barge offloading facility; impacts slightly higher than under Alternative A due to emergency boat launch ramp.		Similar to Alternative B
Hydrology (Section 5.6)					
Stream crossing structures	No impact	9 crossing structures could constrict channel flow during flood stage	50 crossing structures, including three at major water bodies	7 crossing structures	One crossing structure
Gravel roads	No impact	Gravel roads could alter streamflow and drainage pattern.	Gravel access road would increase the geographic extent of the streamflow and drainage pattern alterations. More sheetflow culverts could be required for infield gravel roads due to greater proportion of sheetflow versus defined channels compared to Alternative B.	More sheetflow culverts could be required for infield gravel roads due to greater proportion of sheetflow versus defined channels compared to Alternative B.	Gravel infrastructure is minimized under this alternative.
Gravel airstrip	No impact	48 % of Stream 22 (48 cubic feet per second (cfs)) would be diverted to another stream because the airstrip would block the natural drainage.	14% of Streams 18a and 18b combined (22 cfs) would be diverted.	15% of Stream 18b (15 cfs) would be diverted.	54% Stream 22 (55 cfs) would be diverted.
Water withdrawal	No impact	329.1 million gallons (MG) total for construction and drilling; 2.7 MG annually for operations.	512.9 MG total for construction and drilling; 2.9 MG annually for operations.	600.2 MG total for construction and drilling; 21.1 MG annually for operations.	594.7 MG total for construction and drilling; 13.2 MG annually for operations.
Gravel mines	No impact	Infield gravel mine would permanently alter drainage pattern.	Five additional gravel mines along gravel access road compared to other alternatives.	Greater impacts to drainage pattern due to Stream 24 diversion (see below).	Same as Alternative B
Stream 24 diversion	No impact	No diversion of Stream 24	Same as Alternative B	Up to 80 percent of Stream 24 would be diverted for 3 years during spring breakup to fill the mine site reservoir.	Same as Alternative B

Table 2.5-1: Comparison of Impacts[a]

Impact Category	Alternative A (No Action)	Alternative B (Applicant's Proposed Action)	Alternative C (Inland Pads with Gravel Access Road)	Alternative D (Inland Pads with Seasonal Ice Access Road)	Alternative E (Coastal Pads with Seasonal Ice Roads)
Water Quality (Section 5.7)					
Freshwater	No impact	Primary impact would be increased turbidity due to gravel mining, gravel infrastructure, and pipeline construction.	Greater impacts due to gravel access road and associated gravel mines and longer export pipeline.	Similar to Alternative B	
Marine Water	No impact	Construction and operation of the barge offloading facility (including dredging and screeding) would cause temporary turbidity increases.	The Central Processing Pad would be located inland, thus decreasing potential impacts.		Similar to Alternative B
Vegetation and Wetlands (Section 5.8)					
Area of wetlands and uplands impacted through fill for gravel roads and pads and excavation for gravel mining	No impact	285 acres (<1% of mapped area) of wetlands and water bodies.	740 acres (1% of mapped area) of wetlands and water bodies More than 1,500 acres of fill and excavation associated with the gravel access road.	355 acres (<1% of mapped area) of wetlands and water bodies	205 acres (<1% of mapped area) of wetlands and water bodies
Area of vegetation and wetlands affected adjacent to gravel roads and pads (from dust, snow impoundment, and thermokarst effects)	No impact	610 acres	2,635 acres	845 acres	260 acres
Vegetation modification from ice infrastructure	No impact	985 acres of modification from ice roads during construction and drilling. During operations the impact would be reduced because an ice access road would be constructed approximately every 5 years.	1,125 acres of modification from ice roads during construction and drilling. During operations ice roads would not be constructed.	890 acres of modification from ice roads. Impact from an ice access road would occur annually for the life of the project.	875 acres of modification from ice roads and multi-season ice pads during construction and operations. Vegetation recovery from multi-season ice pads could take 10 years or more. Impact from infield ice roads would occur annually for the life of the project.
Birds (Section 5.9)					
Habitat loss and alteration from gravel and ice infrastructure	No impact	1,365 acres of bird habitat lost or altered from gravel infrastructure 500 acres of bird habitat altered from ice infrastructure (<1% of available habitat)	5,710 acres of bird habitat lost or altered from gravel infrastructure 685 acres of bird habitat altered from ice infrastructure (3% of available habitat)	1,955 acres of bird habitat lost or altered from gravel infrastructure 455 acres of bird habitat altered from ice infrastructure (1% of available habitat)	636 acres of bird habitat lost or altered from gravel infrastructure 415 acres of bird habitat altered from ice infrastructure (<1% of available habitat)
Disturbance from air (helicopter and fixed-wing take off/landing) and boat (barge and spill response skiff) traffic	Helicopter overflights to monitor wells when birds are present near the central pad could cause temporary disturbance to birds.	1,070 acres of bird habitat disturbed by air and boat traffic.	890 acres of bird habitat disturbed by air traffic.	950 acres of bird habitat disturbed by air traffic.	1,557 acres of bird habitat disturbed by air and boat traffic. Helicopter flights for infield travel could have moderate impacts on birds in affected areas.

Table 2.5-1: Comparison of Impacts[a]

Impact Category	Alternative A (No Action)	Alternative B (Applicant's Proposed Action)	Alternative C (Inland Pads with Gravel Access Road)	Alternative D (Inland Pads with Seasonal Ice Access Road)	Alternative E (Coastal Pads with Seasonal Ice Roads)
Terrestrial Mammals (Section 5.10)					
Habitat loss, alteration, and disturbance from gravel infrastructure	No impact	880 acres of terrestrial mammal habitat (<1% of available habitat). Traffic on infield gravel roads may cause disturbance to calving caribou.	3,450 acres of terrestrial mammal habitat (1% of available habitat). Gravel access road crosses through caribou calving habitat, muskoxen wintering habitat, and potential brown bear denning habitat. Traffic on gravel roads may cause disturbance to calving caribou.	1,205 acres of terrestrial mammal habitat (<1% of available habitat). Infield gravel roads extend south farther into caribou calving habitat than Alternative B. Traffic on the infield gravel roads may cause disturbance to calving caribou.	460 acres of terrestrial mammal habitat (<1% of available habitat). Vehicle traffic disturbance during caribou calving would be limited to the gravel pads, but this disturbance may be replaced by noise from helicopters traveling between the pads.
Pipeline/roads within 500 feet of each other	No impact	Central Pad – 1,340 ft Badami tie in – 5,955 ft	Central Pad – 2,555 ft Near Airstrip – 2,395 ft Water reservoir – 2,840 ft Water pipeline on timbers has potential to fragment caribou and muskoxen herds.	Near Airstrip – 11,480 ft Badami tie in – 4,955 ft West Pad – 1,235 ft	Central Pad – 6,355 ft Badami tie in – 3,955 ft Water reservoir – 5,160 ft
Habitat fragmentation and disturbance from water distribution method	No impact	Trucking water would increase traffic on infield roads which may disturb calving caribou.	Caribou and muskoxen would be reluctant to cross the water pipeline elevated 12 inches above the ground, which could fragment herds.	No impact	
Marine Mammals (Section 5.11)					
Barging	No impact	Noise from barge operations could affect bowhead whales and ringed seals.	No impact		Noise from barge operations could affect bowhead whales and ringed seals.
Habitat loss from gravel and ice infrastructure	No impact	390 acres of polar bear critical habitat lost to gravel infrastructure. 985 acres of polar bear critical habitat seasonally lost to ice infrastructure (impact would be reduced after drilling). .	745 acres of polar bear critical habitat lost to gravel infrastructure. 1,140 acres of polar bear critical habitat seasonally lost to or disturbed by ice infrastructure (impact would end after drilling).	355 acres of polar bear critical habitat lost to gravel infrastructure. 895 acres of polar bear critical habitat seasonally lost to ice infrastructure (impact would occur annually for the life of the project).	205 acres of polar bear critical habitat lost to gravel infrastructure. 900 acres of polar bear critical habitat seasonally lost to ice infrastructure (impact would occur annually for the life of the project for infield roads, but would be reduced after drilling for the access road).
Habitat disturbance from all project infrastructure (gravel roads, ice roads, pipelines, pads, airstrip)	No impact	28,414 acres of polar bear critical habitat (impact from ice access road would be reduced after drilling)	27,823 acres of polar bear critical habitat (impact from gravel access road would continue for the life of the project)	24,863 acres of polar bear critical habitat (impact from ice access road would continue for the life of the project)	22,362 acres of polar bear critical habitat (impact from ice access road would be reduced after drilling; impact from infield ice roads would continue for the life of the project)
Disturbance from air traffic	Minimal impacts to polar bears and polar bear critical habitat from helicopter overflights to monitor wells.	17,312 acres of polar bear habitat potentially disturbed by overflights.			

Table 2.5-1: Comparison of Impacts[a]

Impact Category	Alternative A (No Action)	Alternative B (Applicant's Proposed Action)	Alternative C (Inland Pads with Gravel Access Road)	Alternative D (Inland Pads with Seasonal Ice Access Road)	Alternative E (Coastal Pads with Seasonal Ice Roads)
Fish, Essential Fish Habitat, and Invertebrates (Section 5.12)					
Stream crossings	No impact	4 streams crossed with bridges (all fish bearing, one anadromous downstream of the crossing site) 5 streams crossed with culverts/culvert batteries (2 fish bearing)	27 streams crossed with bridges (all fish bearing, 6 anadromous) 21 streams crossed with culverts/culvert batteries (many fish bearing) Some anadromous streams provide EFH.	2 streams crossed with bridges (both fish bearing, neither anadromous) 5 streams crossed with culverts/culvert batteries (2 fish bearing)	One stream crossed with a bridge (fish bearing but not anadromous)
Water withdrawal from fish bearing lakes	No impact	Moderate potential to affect overwintering fish habitat through water withdrawal.		Highest potential to affect overwintering fish because of the high annual water requirements for ice access roads (Alternative D) and infield ice roads (Alternative E).	
Diversion channel	No impact			Diversion of water from Stream 24 to the gravel mine site under Alternative D could impact the ability of Dolly Varden to move up and downstream during spring runoff in the initial years when the reservoir is filling.	No impacts
Essential Fish Habitat	Marine Essential Fish Habitat in the study area is designated for arctic cod and five species of Pacific salmon (although salmon are uncommon in the Beaufort Sea. Freshwater Essential Fish Habitat for pink and chum salmon occurs in the western portion of the study area. Impacts to Essential Fish Habitat from all alternatives would be a temporary occurrence in localized areas depending on the activity.				
Land Ownership, Use, and Management (Section 5.13)					
	Would be counter to state and NSB management objectives for their lands.	No change in underlying land ownership for state, federal (Arctic Refuge and Bullen Point lands), and holders of Native Allotment rights. The state would continue to manage land in the area for oil and gas leasing.	Same as Alternative B, but is also most likely to contribute to other industrial uses in the future due to permanent gravel road accessing presently undeveloped project area.	Similar to Alternative B.	
Arctic National Wildlife Refuge (Section 5.14)					
	No impact	Proximity of project to the Arctic Refuge may influence management in the Arctic Refuge due to potential impacts to polar bear movement, subsistence and traditional land use, recreation, wilderness perception, and research activities. Proximity of industrial facilities could be perceived as an effect to wilderness values and lead to an increase the national perception that wilderness qualities would be diminished.			
Socioeconomics (Section 5.15)					
Community characteristics and culture	No impact	Greater potential for displacement of subsistence resources along coast due to barge traffic and nearshore infrastructure;	Fewer impacts to user access along the coast due to absence of barge traffic and nearshore infrastructure. Greater disruption as a result of the gravel access road.	Fewer impacts to user access along the coast due to absence of barge traffic and nearshore infrastructure.	Greater potential for displacement of subsistence resources along coast due to barge traffic and nearshore infrastructure.
Employment and income	No impact	Employment peaks at 1,100 in Year 5.	Construction employment overall could be up to 50% higher than Alternative B due to gravel access road construction and transport and assembly from Deadhorse. Employment peaks at 1,500 workers in Year 6.	Similar to Alternative C, but fewer workers due to construction of ice road rather than gravel access road. Employment peaks at 1,200 in Year 5.	Similar to Alternative B. Employment peaks at 1,210 in Year 5. Additional construction crews would be needed each winter during operation for ice road construction.

Table 2.5-1: Comparison of Impacts[a]					
Impact Category	**Alternative A** (No Action)	**Alternative B** (Applicant's Proposed Action)	**Alternative C** (Inland Pads with Gravel Access Road)	**Alternative D** (Inland Pads with Seasonal Ice Access Road)	**Alternative E** (Coastal Pads with Seasonal Ice Roads)
Income and tax base	No impact	Increased income primarily through shareholder dividends and Alaska Permanent Fund for residents of NSB and state. Temporary increase in NSB operating budget and bonding ability during construction. Addition of approximately $1 billion to actual and true property value of NSB and could generate annual tax revenue of $47.45 million to the state.	Similar to Alternative B, but would require additional employment and contract opportunities due to increased amount of infrastructure resulting in slightly larger income and tax base revenue generation impacts.		Similar to Alternative B
Utilities, community facilities, and services	No impact	Utility services would largely be onsite; NSB would not see large benefits nor demand on services.	Similar to Alternative B, however greater demand on material supply chains in Deadhorse and throughout Alaska for storage areas and facilities and other infrastructure. Possible adverse impacts on local and regional fuel and raw materials supplies due to logistics of resupplying the facility during construction. Would require 60 temporary fuel trucks for construction and increased demand on tank fabrication shops in Fairbanks for over 2 years to accommodate storage of up to 6 million gallons of diesel fuel during construction. Likely to require expansion of Deadhorse fuel depot infrastructure.		Similar to Alternative B
Environmental Justice (Section 5.16)					
Environmental Justice Finding	Potential impacts to subsistence resources, subsistence user access, and human health would not be disproportionately high and adverse impacts on the minority and low-income communities of Kaktovik and Nuiqsut.				
Transportation (Section 5.17)					
Trips (land, water, and air)	No impact	Approximately 11,000 trips on ice roads; 300 coastal barge trips; and 1,500 trips by helicopter and fixed-wing aircraft.	Approximately 20,000 trips on ice and gravel roads; and 7,500 trips by helicopter and fixed-wing aircraft. Reliance on winter ice roads to transport materials and supplies during construction. Greater potential for accidents due to increase in trucks operating in Deadhorse unloading barges and transporting contents.	Approximately 20,000 trips on ice and gravel roads; and 7,500 trips by helicopter and fixed-wing aircraft. Similar to Alternative C.	Approximately 15,500 trips on ice roads; 400 coastal barge trips; and 12,000 trips by helicopter and fixed-wing aircraft. Reliance on helicopters to move equipment or materials would be expensive, weather dependent, and increase potential safety issues.
Recreation (Section 5.18)					
	Occasional helicopter operations for site monitoring and the protective wellhead covers for the two wells and rig mats would be noticeable to recreationists.	Approximately 280 acres lost for recreation at footprint. Limitations on usability for recreation on 16,600 acres at project site and 19,300 acres along export pipeline. Export pipeline location parallel to coastline would be visible from coastline and ocean. Coastal hunters and subsistence hunters would likely be inhibited from shooting in direction toward pipeline. Public access to facilities on coast would likely be restricted.	Approximately 750 acres lost for recreation at footprint. Limitations on usability for recreation on 39,000 acres at project site and 47,400 acres along export pipeline and gravel access road. Road activity on gravel road would likely inhibit recreational hunters from shooting in directions toward road and pipeline. Inland location of pipeline, E&W Pads, and CPF would help protect existing coastline recreational experience. Limited public access at the drilling pad, but not as great as Alternatives B and E.	Approximately 350 acres lost for recreation at footprint. Limitations on usability for recreation on 22,700 acres at the project site and 20,000 acres along export pipeline. Other impacts similar to Alternative C, with exception of the gravel road.	Approximately 200 acres lost for recreation at footprint. Limitations on usability for recreation on 10,000 acres at project site and 22,000 acres along the export pipeline. Other impacts similar to Alternative B, but increased use of helicopters between pads likely would be visible and audible to recreationists.

Table 2.5-1: Comparison of Impacts[a]

Impact Category	Alternative A (No Action)	Alternative B (Applicant's Proposed Action)	Alternative C (Inland Pads with Gravel Access Road)	Alternative D (Inland Pads with Seasonal Ice Access Road)	Alternative E (Coastal Pads with Seasonal Ice Roads)
Visual Aesthetics (Section 5.19)					
Viewshed	Well caps, existing gravel pads, and rig mats would be visible during snow-free seasons from the coastline.	Project would contrast strongly with the surrounding viewshed from many different vantage points and distances; components would be visible during daytime and nighttime for a long time period; and would be visible within the coastal corridor and from the northwest corner of the Arctic Refuge with weak to strong contrast, depending on the project phase and lighting conditions.	Project would contrast strongly with the surrounding viewshed from many different vantage points and distances; components would be visible during daytime and nighttime for a long time period; and would be visible within the coastal corridor and from the northwest corner of the Arctic Refuge with weak to strong contrast, depending on the project phase and lighting conditions.	Project would contrast strongly with the surrounding viewshed from many different vantage points and distances; components would be visible during daytime and nighttime for a long time period; and would be visible within the coastal corridor and from the northwest corner of the Arctic Refuge with weak to strong contrast, depending on the project phase and lighting conditions.	Project would contrast strongly with the surrounding viewshed from many different vantage points and distances; components would be visible during daytime and nighttime for a long time period; and would be visible within the coastal corridor and from the northwest corner of the Arctic Refuge with weak to strong contrast, depending on the project phase and lighting conditions.
Views from Key Observation Points	Well caps visible from coastline	Major project features (pads, facilities, export pipeline, and airport) would be visible from some or all key observation points due to location on coastline.	Pads and facilities setback further from the coastline, reducing visual impacts compared to B and E, but not substantially.	Pads and facilities setback further from the coastline, reducing visual impacts compared to B and E, but not substantially.	Same as Alternative B
Noise (Section 5.20)					
Potential for project-related noise effect on Arctic Refuge	Minor predicted increases in noise due to helicopter flights.	Greatest predicted increase in noise at Sea Coast during construction, drilling, and operations. Increase of less than 10 dBA predicted in Arctic Refuge at a distance of 10 miles from the western border.	Greatest predicted increase in noise at Sea Coast during construction, drilling, and operations. Increase of less than 10 dBA predicted in Arctic Refuge at a distance of 10 miles from the western border.	Greatest predicted increase in noise at Sea Coast during construction, drilling, and operations. Increase of less than 10 dBA predicted in Arctic Refuge at a distance of 10 miles from the western border.	Greatest predicted increase in noise at Sea Coast during construction, drilling, and operations. Increase of less than 10 dBA predicted in Arctic Refuge at a distance of 10 miles from the western border.
Potential for project-related noise in study area	Infrequent helicopter flights would have minor effect, particularly in areas directly in the flight path.	Larger increase in noise compared to Alternative C & D at Brownlow Spit, Flaxman Island and the Sea Coast monitoring locations during winter construction and at Mary Sachs Island during summer construction and drilling.	May experience a slightly larger increase in noise at Sea Coast during summer construction and drilling.	May experience a slightly larger increase in noise at Sea Coast during summer construction and drilling.	On a long-term basis, operational noise from Alternative E is distinctly different from the other build alternatives due to the extensive use of helicopters.
Cultural Resources (Section 5.21)					
Unidentified cultural resources	No impact	No direct impacts to cultural resources; 43 sites would be potentially indirectly affected.	One cultural resource site potentially directly affected as a result of the all season gravel road; 44 sites potentially indirectly affected with construction of optional sea ice road; 12 without optional sea ice road.	No cultural resource sites potentially directly affected as a result of the all season gravel road; 42 sites potentially indirectly affected with construction of optional sea ice road; 27 without optional sea ice road.	No cultural resource sites potentially directly affected as a result of the all season gravel road; 43 sites potentially indirectly affected with construction of optional sea ice road; 37 without optional sea ice road.
Documented cultural resources sites	No impact	Low probability for discovering unidentified cultural resources in the Point Thomson area due to continuous alteration of coastal areas and barrier islands.	Low probability for discovering unidentified cultural resources in the Point Thomson area due to continuous alteration of coastal areas and barrier islands.	Low probability for discovering unidentified cultural resources in the Point Thomson area due to continuous alteration of coastal areas and barrier islands.	Low probability for discovering unidentified cultural resources in the Point Thomson area due to continuous alteration of coastal areas and barrier islands.
Subsistence and Traditional Land Use (Section 5.22)					
Caribou harvest	Minor impacts to the harvest amount of caribou for Kaktovik due to noise/traffic for monitoring activities; however, impacts are unlikely.	Minor impacts to the harvest amount of caribou for Kaktovik are probable.	Minor impacts to the harvest amount of caribou for Kaktovik are probable. Increased helicopter traffic could affect local caribou behavior and distribution and result in additional effects on hunter success or increased user avoidance during periods of helicopter activity.	Minor impacts to the harvest amount of caribou for Kaktovik are probable. Increased helicopter traffic could affect local caribou behavior and distribution and result in additional effects on hunter success or increased user avoidance during periods of helicopter activity.	Minor impacts to the harvest amount of caribou for Kaktovik are probable. Increased helicopter traffic could affect local caribou behavior and distribution and result in additional effects on hunter success or increased user avoidance during periods of helicopter activity.
Fish and/or seal harvest	No impact	Impacts to fish and seal harvests for Kaktovik. User avoidance would likely be higher in due to coastal infrastructure and barging activity.	Impacts to fish harvest for Kaktovik. Impacts to Kaktovik caribou harvests would likely be higher due to more widespread disruption, increased caribou displacement, and decreased hunter success as a result of the gravel access road.	Impacts to fish harvest for Kaktovik	Impacts to fish and seal harvests for Kaktovik. Increased disturbance to caribou may result from increased helicopter activity. User avoidance would likely be higher in due to coastal infrastructure and barging activity. Increased disturbance to caribou may result from increased helicopter activity.

Table 2.5-1: Comparison of Impacts[a]

Impact Category	Alternative A (No Action)	Alternative B (Applicant's Proposed Action)	Alternative C (Inland Pads with Gravel Access Road)	Alternative D (Inland Pads with Seasonal Ice Access Road)	Alternative E (Coastal Pads with Seasonal Ice Roads)
Human Health (Section 5.23)					
	No impact	Negative impacts from exposure to hazardous materials and changes in anxiety/depression prevalence. Positive impacts from increased tax revenues to fund health care clinics and services.	Negative impacts from exposure to hazardous materials, reduced dietary consumption of subsistence resources, increased roadway incidents and injuries, and an increase in utilizations/clinic burden from nonresident influx due to accidents and injuries. Positive impacts from increased tax revenues to fund health care clinics and services.	Negative impacts from exposure to hazardous materials, reduced dietary consumption of subsistence resources, increased roadway incidents and injuries, and increase in utilizations/clinic burden from nonresident influx due to accidents and injuries. Positive impacts from increased tax revenues to fund health care clinics and services.	Negative impacts from exposure to hazardous materials, changes in anxiety/depression prevalence. Positive impacts from increased tax revenues to fund health care clinics and services.

[a] The quantities in this table have been rounded to whole units. See Chapter 5 for additional detail.

2.5.3 Spills

The Corps concluded, based on historic spill data, that the probability of a small or even a medium size spill occurring over the life of the project is relatively high. The likelihood of large spills is substantially less; however, the consequence of larger spills is greater. Based on past experience on the North Slope, the likelihood of a very large spill associated with the project is very low and might approach zero as the size of the potential spill increases. The fate of spilled materials is affected by response actions (e.g., containment and cleanup), response time, and environmental factors such as:

- Physical and chemical properties of the spilled material
- Environmental degradation processes acting directly on the spilled material
- Season of the year
- Weather conditions at the time of the spill and for days to weeks thereafter
- Location relative to sensitive habitats and resources

While highly unlikely, a very large spill event would be catastrophic and could be exacerbated by environmental conditions that could enhance the spread of spilled materials or interfere with response and cleanup. A very large spill from either a blowout or uncontrolled release or from a major containment berm failure would be likely to reach both land and adjacent water bodies, especially if the spill occurs in the ice-free seasons. The proximity of the drilling and production wells to streams near the pads may be the most important factor in such spill scenarios. In general, if the spilled material flows to upland tundra, the spill probably would not disperse far. However, if a very large spill reaches a flowing stream, the spill could be dispersed substantial distances downstream and eventually to Lion Bay. Whether a very large spill would reach these streams would depend on several variables, including the spill type, ambient water and air as well as oil temperature and volume of material released; the topographic relief and slope; presence of snow or vegetation; and response time and actions.

The most likely spill scenario is a very small or small spill of material such as diesel, hydraulic fluid, transmission oil, or antifreeze, on gravel or ice infrastructure. Rarely would these spilled materials reach the tundra or water bodies. If they were to occur, the spills would impact the area adjacent to the road or pad and would be limited in effect. Some of these small spills could result from slow and small (pin hole) leaks of produced fluids or export fluids from the proposed pipeline, and they could occur on the tundra or into water bodies remote from the roads and pads.

A similar scenario exists for medium-to-large spills except they are much less common and occasionally reach the tundra or water bodies adjacent to the roads, pads, and airstrips. These spills would be more likely to consist of produced fluids or condensate, although medium to large spills of antifreeze, diesel, and drilling muds may occur.

The actions taken by the Applicant and its contractors, including oil spill response organizations (OSRO), would influence the potential impacts of any spill to the natural environment and human uses of it. The Applicant has designed and committed to a comprehensive slate of processes, procedures, and systems to prevent, detect, and mitigate potential spills that could occur during drilling, as well as construction, maintenance, and operation of the proposed pipeline.

2.6 IDENTIFICATION OF THE AGENCY'S PREFERRED ALTERNATIVE

The Corps initiated the NEPA process as part of its permit review process. The Corps makes a decision on the permit according to its NEPA regulations, a public interest review, and the CWA Section 404(b)(1) Guidelines. NEPA and the 404(b)(1) Guidelines require the Corps to consider all reasonable alternatives, even if they may not generally be considered available to the applicant. The following sections discuss the regulatory requirements and Corps approaches in addressing and identifying the NEPA's preferred alternative and the CWA's least environmentally damaging practicable alternative or LEDPA.

2.6.1 Corps' Preferred Alternative

NEPA guidance directs an agency to identify a preferred alternative in the Draft EIS if one exists "… unless another law prohibits the expression of such a preference." (40 CFR 1502.14[e]). The Corps, in the establishment of their regulatory rules (51 FR 41220), clearly stated their neutrality in issuing permits by affirming that they are "neither a proponent nor opponent of any permit proposal." To maintain this neutrality, the Corps will not identify a preference within a draft or final EIS, but rather will identify the Applicant's proposal as the "Applicant's preferred alternative" in the final EIS (33 CFR 325, Appendix B). The Corps cannot take a position on a permit, and will thus not identify its selected alternative until after the public interest review and finding of conformity with the 404(b)(1) Guidelines, which will be summarized in the Corps ROD for the permit.

The cooperating agencies may identify separate preferred alternatives in the Final EIS, due to differing agency statutory missions and responsibilities. The agencies' rationale and perspectives for determination of their agency-preferred alternative will be presented in the Final EIS.

2.6.2 Environmentally Preferred Alternative

An environmentally preferred alternative is one that would best meet the goals set forth in Section 101 of NEPA (42 USC §4331). The environmentally preferred alternative generally would cause the least damage to the biological and physical environments and "best protects, preserves, and enhances historic, cultural, and natural resources." (50 FR 15618). The environmentally preferred alternative or alternatives could be the agency-preferred alternative, but may not be, due to considerations made by each agency based on their statutory mission.

An environmentally preferred alternative has not been identified at this time. The Corps is accepting comments from the public and agencies regarding their views and supporting rationale in the selection of an environmentally preferred alternative.

2.6.3 Least Environmentally Damaging Practicable Alternative

The 404(b)(1) Guidelines require the Corps to determine whether the Applicant's proposal is the LEDPA. To be practicable, an alternative must be generally available, achieve the overall project purpose, and be feasible in terms of cost, technology, and logistics. Only the LEDPA can be permitted. Within this Draft EIS, the Corps has analyzed the impacts of four action alternatives and one no-action alternative. The Corps and cooperating agencies examined the full scope of possible alternatives and components and systematically arrived at the range of reasonable alternatives as described earlier in this chapter. Through this process, the Corps believes that it has captured all of the alternatives and components necessary to determine whether the Applicant's proposed project is the LEDPA, and ultimately make a permit decision. The Corps has the option to deny the permit, issue the permit, or issue the permit with modification; see Appendix C for the *Draft Section 404(b)(1) Guidelines Evaluation*.

2.7 MITIGATION

Mitigation is considered by the Corps in two ways during the NEPA process: Applicant-proposed avoidance and minimization measures (identified in this Draft EIS as *Design Measures*), and resource-specific mitigation measures intended to offset or compensate for unavoidable adverse impacts (referred to as *Mitigation Measures*).

Design measures are project components that have been incorporated into the design of an action alternative, and are described in the Draft EIS. A listing of design measures is found in Chapter 4 of the EIS and under applicable resource discussions in Chapter 5. Mitigation measures will be addressed in the Final EIS and Record of Decision, and will include consideration of measures suggested by the public and agencies during the Draft EIS comment period, for mitigation to compensate for unavoidable impacts.

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Chapter 3. Affected Environment

This chapter describes the environmental resources in the project area. A key information section starts each section to provide the most important information in the affected environment section. It is intended to help the lay reader and NEPA decision-maker find the information they need to evaluate the affected environment and understand the impacts and consequences discussed in Chapter 5. This chapter also describes the bases of reference materials used for each resource. Appendix H contains data adequacy tables for each resource.

The Point Thomson project area is north of the Arctic Circle within the ACP north of the Brooks Range on the North Slope of Alaska. This is an expansive ecoregion bounded by the Arctic Ocean on the north and west and extending across Alaska and into Canada. The area is dominated by permafrost, including vegetation and wildlife communities that occur in this harsh climate.

The sun does not rise above the horizon for about two months in the winter, which leads to an average minimum winter temperature in the project area of -24°F. In summer, the continuous sunlight only results in an average maximum temperature of 55°F due to the latitude. The project area is covered with snow for about 8 months of the year; however, snow may fall at any time of the year.

The Point Thomson project is located approximately 60 miles east of Deadhorse and 60 miles west of Kaktovik, on the coast of Lion Bay, and is named after a local geographic landform called Point Thomson. The project area is defined to include all possible facilities and access roads that are part of any of the alternative scenarios considered in this Draft EIS. The project area is defined to extend eastward from Deadhorse to the Staines River and from the lagoon side of Flaxman Island and the Maguire Islands along the Beaufort Sea coast south to approximately 8 miles inland from the coast line.

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3.1 GEOLOGY AND GEOMORPHOLOGY

The study area for geology and geomorphology is the northeastern portion of the ACP physiographic province, a mostly flat, low-lying plain that includes low terraces, broad shallow depressions, and floodplains.

3.1.1 Key Information About Geology and Geomorphology

The dominant geomorphic feature of the project area is the Canning River fan, a complex of unconsolidated sediments that forms a symmetrical convex-northward arc along the Beaufort Sea coast. Surface features include thaw lakes and drained thaw lake depressions, most of which are oriented and elongated in a north-northwest direction. Also prominent are mound-like pingos and polygonal surface patterns.

The coastal area along the ACP is generally low and flat, and barrier islands and alongshore spits are frequently present. These spits support little vegetation and lagoons typically develop behind them.

The Canning River fan consists of Quaternary sand-gravel outwash covered by fluvial and eolian sand. Gravel is an important geologic resource in the area. These sediments are underlain by Mississippian through Pliocene sedimentary rocks of the Ellesmerian-Beaufortian and Brookian Sequences, which contain a number of prolific North Slope oil and gas reservoirs, including the Thomson Sand. All of these units generally dip gently north-northeast at approximately 1 to 3 degrees with little to no structural complexity in the shallow subsurface. The pre-Mississippian basement comprises Silurian and Ordovician metamorphic rocks, as well as limestones and dolomites of Ordovician and older ages.

Deep groundwater is highly saline and therefore nonpotable.

An understanding of geologic hazards is important for minimizing risks to people and the environment from the project. The North Slope is considered an area with low-to-moderate seismic risk. Most seismicity in the area is shallow (less than 20 miles deep), indicating near-surface faulting, but no active faults are recognized at the surface in this area.

Fossils potentially present in surficial deposits in the project area include marine and terrestrial mammals such as otter, seal, whale, mammoth, moose, caribou, musk ox, bison, camel, horse, and lion, as well as birds.

3.1.2 Review and Adequacy of Information Sources for Geology and Geomorphology

Table H-1 in Appendix H discusses the publications, reports, and data available for geology and geomorphology that are cited in the EIS and their relevance to the proposed project. Most of the documents contain general information regarding geology in Alaska, including the North Slope and the study area; while some of the documents are specific to the North Slope and the study area. These latter studies were mostly conducted by consulting firms for oil and gas exploration and by the State of Alaska for area lease sales. Full references for the studies cited in this EIS are in Chapter 9, References.

3.1.3 Geomorphology

The entire project is located within the ACP physiographic province, a mostly flat, low-lying plain that includes low terraces, broad shallow depressions, and flood plains (Wahrhaftig 1965). One of the dominant terrain features in the study area is thaw lakes and drained thaw lake depressions, most of which are oriented and elongated in a north-northwest direction (Tedrow 1977). ***Periglacial*** features in the study area include patterned ground (frost polygons), ***hummocks***, frost boils, and ***thermokarst troughs***. The entire area is underlain by continuous ***permafrost*** with the exception of deep lakes and river channels (Ferrians 1965, Péwé 1975). The ACP was never glaciated, but has been subject to intense freezing and thawing that produces permafrost development and weathering. This tundra lowland is treeless with flat topography and poor drainage. Thaw lakes and polygonal surface patterns are the dominant interlake terrain features. Ice wedges progressively become larger as winter contraction fractures in the surface soils fill with water during the brief summer thawing period, and then freeze again during winter. As this seasonal process repeats, the ice wedges grow and the surface polygons become the most recognizable features over the ACP. Another prominent feature on the lowlands is scattered ***pingos***, which are low mound-like features formed in permafrost environments, as soil-covered water freezes and expands upward.

The dominant geomorphic feature within the ACP encompassing the project area is the Canning River fan. The Canning River fan is a complex of unconsolidated Quaternary (last 2 million years) sediments that forms a symmetrical convex-northward arc along the Beaufort Sea coast. The point of origin of the Canning River fan is approximately 25 miles inland from the coast, where the trend of the Canning River turns from northwesterly to northeasterly. Exposure of the fan along the coast is typically less than 3 feet high, except where originally higher areas have not been dissected by flow. These areas typically expose lake-deposited silt, sand, and organic material overlying wind-deposited sand (ExxonMobil 2009b).

The western part of the Canning fan is sandy-gravel outwash covered with ***eolian*** sand that was deposited as low southwest-trending longitudinal dunes. These low dunes were deposited when the central part of the fan was active and free of vegetation (ExxonMobil 2009b). Thaw lakes with long axes parallel to the trend of the dunes are present between the dunes. The central part of the fan is inactive, except for drainage that originates on the fan surface. The central part of the fan consists of sandy-gravel outwash (Canning gravel) covered with a thin veneer of ***fluvial*** and eolian sand. The eastern part of the fan is currently active, with the Canning River and associated alluvial terraces covering approximately one-third of the fan surface.

The Canning River fan extends into the submarine environment as a delta, and deposition of the fan has been more or less continuous through at least several seawater advances and retreats caused by changes in sea level (Wolf et al. 1985). Wind-deposited or lake-deposited sediments, which overlie Flaxman mud near the coast and outwash inland of the coast, are present on topographically high areas along the seaward margin of the fan, on Flaxman Island, and on the adjacent topographically high area that includes Bullen Point (Rawlinson 1990).

The Canning River transitions from south to north as a meandering channel into a highly channelized delta discharging to the Beaufort Sea. The broad delta plain consists of a network of active and abandoned channels (oxbow lakes) separated by either tundra-vegetated or shallow water areas that form extensive wetland habitats. Lakes are frequently elongated perpendicular to the prevailing winds near the coast and become more rounded and generally smaller farther inland (BLM 1998).

The coastal area along the ACP is generally low and flat, and barrier islands and alongshore spits are frequently present. These spits support little vegetation, and lagoons typically develop behind them. The Beaufort Sea continental shelf is relatively narrow, extending for 35 to 50 miles offshore with depths up to 600 feet, before steeply dropping off into the Arctic Ocean Basin. The overall surface circulation of the Beaufort Sea is dominated by a ***clockwise gyre*** in the Arctic Ocean Basin. During the short summer when coastal waters are generally free of ice (called "open water season"), currents along the coastline can be highly variable in response to local wind patterns. During open water season, the prevailing winds determine sea ice movement. Easterly winds produce offshore currents, which in turn cause pack ice to move seaward. Westerlies produce onshore currents that bring ice toward shore, occasionally restricting ship traffic, especially around Point Barrow (Colonell and Niedoroda 1990).

The ***surficial soils*** within the Point Thomson area have been deposited predominantly by streams originating from the south. Permafrost is continuous in the region, and the distribution and amount of ice in the permafrost greatly affects the surface morphology. Wind-oriented ***thaw lakes*** dominate the landscape in the coastal zone. The thaw lake basins originate in areas of restricted drainage, where shallow ponding results in a warmer surface temperature that causes the underlying ground ice to thaw, resulting in subsidence. Most of the ponds and lakes are relatively shallow.

The thaw lakes are considered dynamic and impermanent, and often go through a cycle of development, expansion, drainage, and redevelopment of lakes (Jorgenson and Shur 2007). Ice tends to be concentrated in the top few meters of the permafrost (Sellman et al. 1975). Of several types of ice that occur in the near-surface sediments, segregated ice and ice wedges represent as much as 50 percent of the ground by volume (Bruggers and England 1982). Natural and human-induced differential thawing of this near-surface ice generally results in uneven lowering of the ground surface, which may lead to ponding of water or preferential erosion, or both (Rawlinson 1993).

3.1.4 Basement Complex and Overlying Sedimentary Strata

The subsurface geology of the northeastern Alaska coastal plain in the project area consists of pre-Mississippian (more than 360 million years old) through Pliocene (less than 5.3 million years old) sediments (EPA 2010a). The pre-Mississippian basement comprises Silurian and Ordovician metamorphic rocks, as well as limestones and dolomites of Ordovician and older ages (Plafker and Berg 1994). The basement rocks are unconformably overlain by the Ellesmerian (Mississippian through Triassic age)-Beaufortian (Jurassic through lower Cretaceous age) Sequence, which contains a number of prolific North Slope oil and gas reservoirs, including the Thomson Sand (see Figure 3.1-1 and Figure 3.1-2).

The Point Thomson Field is a high-pressure gas reservoir with a thin oil rim. At 12,000 feet deep and under pressures over 10,000 psi, the Point Thomson Reservoir is deeper and under much higher pressure than the other North Slope oil and gas reservoirs (for example, Prudhoe Bay is less than 5,000 psi [White 2011]). Gas reserves are estimated at 8 trillion cubic feet. The Point Thomson natural gas is a "wet gas," which means that it contains liquid in vapor form. This liquid condenses out when the gas is brought to the surface and pressure and temperature are reduced. The Point Thomson Field has two layers of oil. The larger one (depicted in Figure 3.1-2 as the "oil rim") lies under the natural gas. The smaller oil layer is closer to the surface in the Brookian sandstones and is discontinuous (White 2011).

The lower Ellesmerian sequence comprises sandstones overlain by marine carbonate rocks, and the upper Ellesmerian sequence includes primarily siltstones and sandstones. The overlying Beaufortian sequence comprises primarily interbedded siltstones and sandstones (Plafker and Berg 1994).

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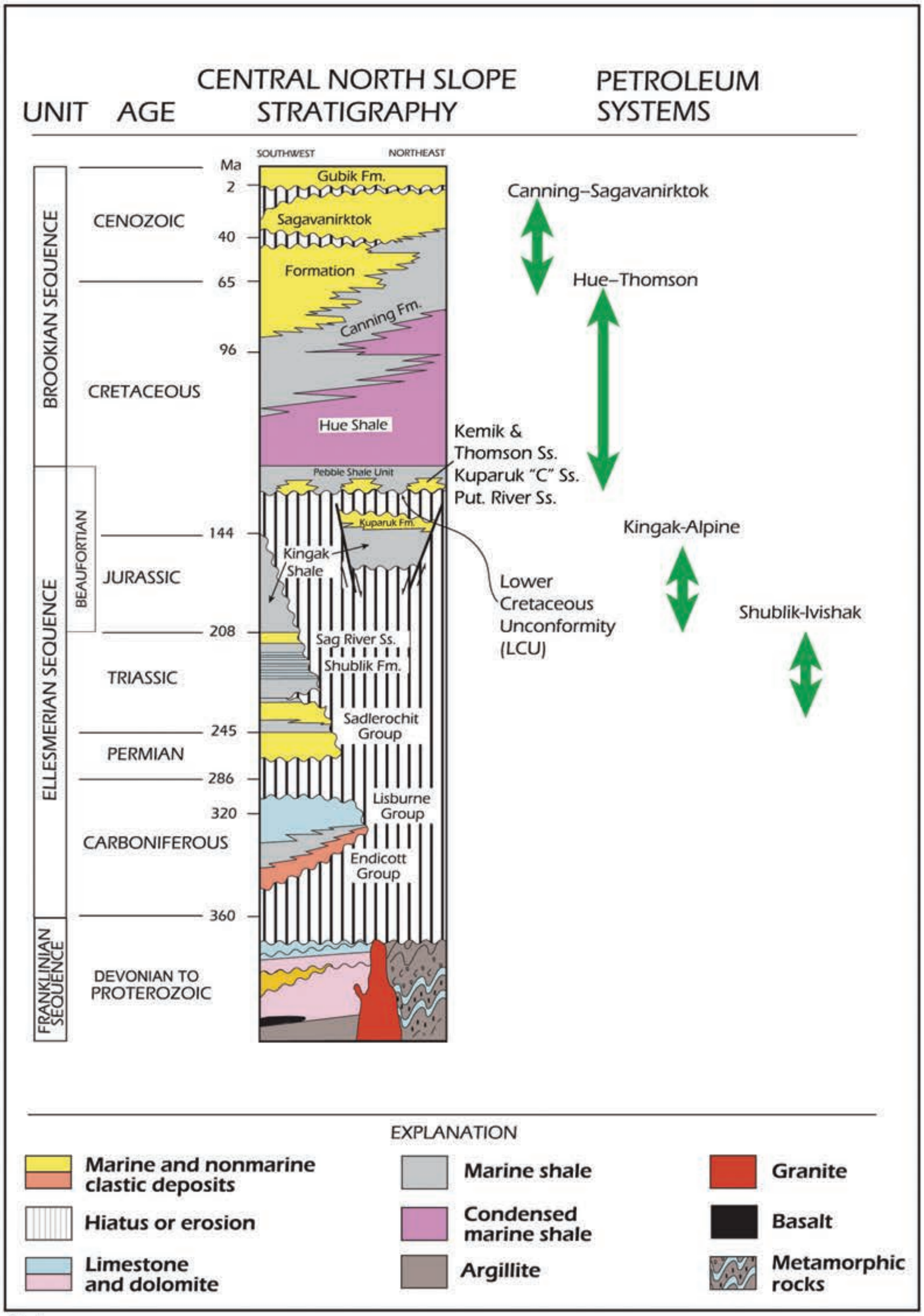

Notes:

Fm. = Formation
Put. River = Putuliguyuk River
Ss. = Sandstone

Figure 3.1-1

Stratigraphic Column for the Central North Slope, Alaska

Sources: Schenk, C.J., and Houseknech, D.W. 2008

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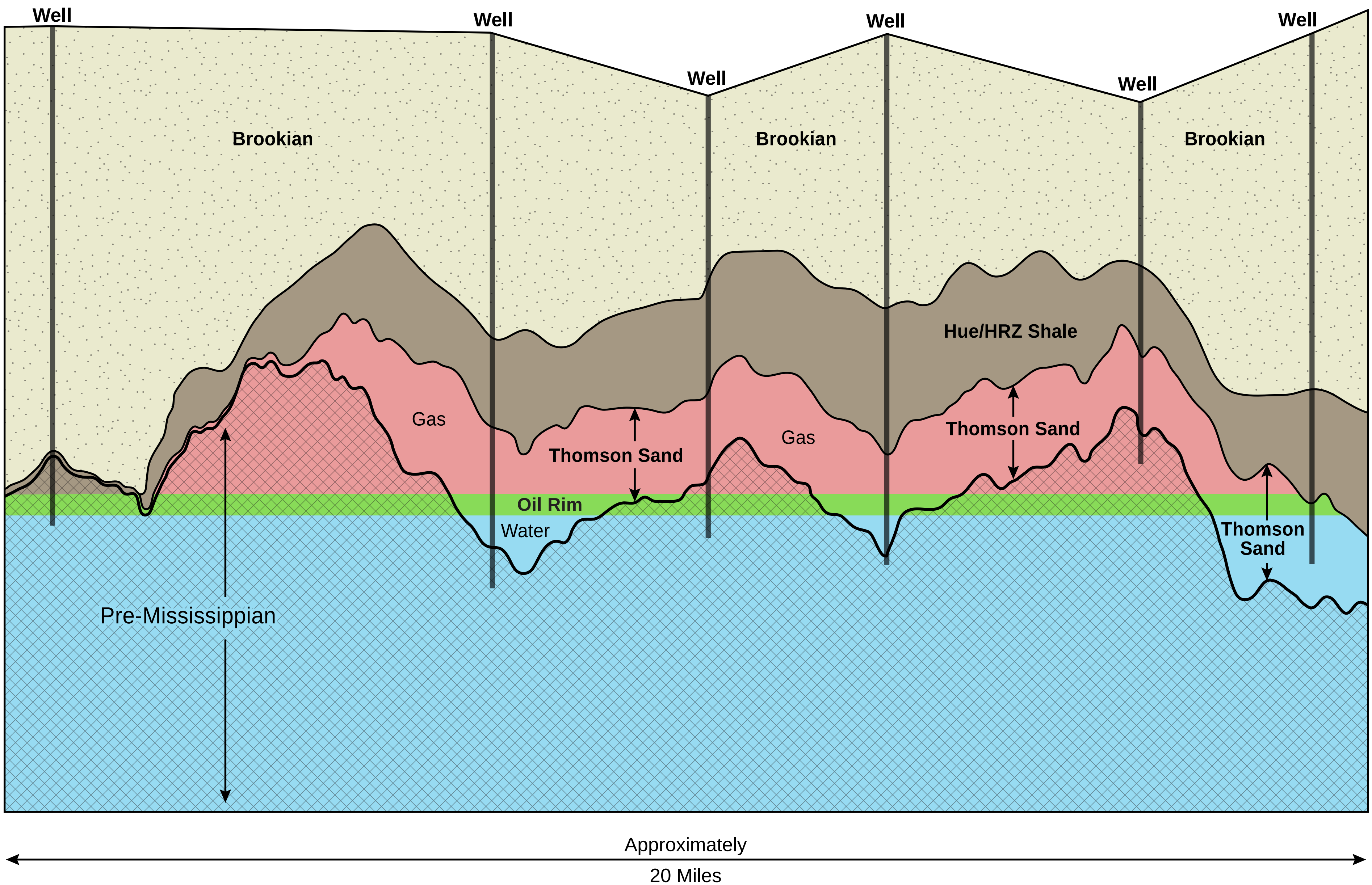

POINT THOMSON PROJECT EIS

Figure 3.1-2

Generalized Cross Section of Point Thomson Field

Source: ExxonMobil 2002, Environmental Report, Point Thomson Project

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Overlying the Ellesmerian-Beaufortian Sequence is the Cretaceous and Tertiary-aged Brookian Sequence, containing benthonic shales, sandstones, conglomerates, and minor coals deposited in marine basinal to nonmarine settings. These units generally ***prograde*** north from the Brooks Range across the North Slope. The total Brookian section ranges up to 13,000 feet thick (Plafker and Berg 1994).

In the vicinity of Point Thomson, the Brookian Sequence is composed of, from the bottom up, the Hue/Highly Radioactive Zone (HRZ) shale, the Canning Formation, and the Sagavanirktok Formation. The total age range represented by this sequence is from lower Cretaceous through upper Pliocene. The Hue and HRZ shales are radioactive, distal, condensed shales. The Canning Formation is a thick prograding delta slope mudstone facies with turbidites in its lower portion. Generally overlying the Canning, the Sagavanirktok is a thick, shallow marine to nonmarine (deltaic to coastal plain) formation. The Canning and Sagavanirktok are ***diachronous*** (defined as cutting through laterally adjacent time-stratigraphic sequences) and contain interfingering tongues in the Paleocene to Eocene section in the immediate vicinity of Point Thomson. The Staines Tongue of the Sagavanirktok and the Mikkelsen Tongue of the Canning are the most notable and are prominent in the project area. Both tongues can be traced 20 to 30 miles to the south and west in the subsurface (Molenaar et al. 1986).

The sandstone beds in the Canning Formation are generally less than a few feet thick, and are at most 60 feet thick (EPA 2010). The Sagavanirktok Formation consists of fine-medium grained sandstone and bentonitic shale, with some conglomerates and coals in areas more southerly than the Point Thomson area. In the Point Thomson area, as logged in well PTU-1, the Staines Tongue of the Sagavanirktok is more than 300 feet thick. Sandstones within the Brookian Group have potential hydrocarbon resources.

There is little to no structural complexity in the shallow subsurface in the vicinity of Point Thomson (Plafker and Berg 1994). All of these units generally dip gently north-northeast at approximately 1 to 3 degrees.

3.1.5 Near-Surface Materials

The entire onshore project area is underlain by deep permafrost. In winter, frost extends to the ground surface, except for thaw pockets that are typically located beneath deep lakes and large river channels. By the end of summer the seasonal thaw depth is generally 1 to 4 feet. Deeper active layer depths (4 to 7 feet) can be found in ice poor substrates and along gravel bars and riverbanks (ADNR 2006).

Soils in the area typically consist of a surficial layer of organic material and silt, with sand and gravel located at greater depth (Appendix D, RFI 46). The base of the silt is typically 8 to 10 feet beneath the surface in the coastal zone (ADNR 2006). The silt base is generally shallower to the east and south of the proposed export pipeline route, with sand and gravel deposits at 3 to 6 feet below the ground surface in this area. Soils vary from the eastern end of the proposed pipeline route to the western end. The eastern end tends to have more silt and the west more gravel.

Within the project area, underlying surficial materials include peat and/or organic silt to depths of from 0.2 to 6.5 feet (Appendix D, RFI 46), which is in turn commonly underlain by 0.8 to 22 feet of massive ice, some with organic soil and/or gravel. Some ice zones occur as segregated interbeds within sand and gravel layers in the transition zone between the uppermost organic surface layer and the underlying granular outwash materials described below.

The underlying granular outwash material is typically composed of sandy gravel and gravelly sand with some traces of silt and clay (ADNR 2006; Appendix D, RFI 46). Although much of the outwash material is ice-bonded, the ice content is generally small in these soils. Occasionally massive bodies of segregated ice are found in this area. In general, the ice content in soils found from the surface to a depth of 50 feet typically ranges between 15 and 20 percent by volume (ADNR 2006). In geotechnical boreholes located within the project area, sand and gravel layers include varying amounts of fines, with some silty sands and silty gravels present. Local silt/clay interbeds ranging in thickness from 1 foot to 26.5 feet occur at depths up to 95 feet below the ground surface (Appendix D, RFI 46).

3.1.6 Geotechnical Conditions

Permafrost makes a good foundation as long as it remains frozen. Permafrost temperatures at shallow depths vary, depending on the season, depth, moisture content of the ***active layer***, ***albedo*** of the ground surface, solar exposure, and insulation provided by snow cover. Temperature profiles taken at borings located inland from Bullen Point in April 1982 exhibited a near-linear temperature increase from 5°F to 17°F from the ground surface to a depth of 30 feet and a constant temperature from 30 to 50 feet depth (ADNR 2006). Soil temperatures measured in 1998 in the general vicinity of the pipeline right-of-way route were 16.6 to 19.2°F at a depth of 40 feet.

The most recent measurements in the project area indicate depths to permafrost at undisturbed tundra surfaces ranging from 0.9 feet to 4.2 feet, with an average of about 1.5 feet (Appendix D, RFI 46). The greater permafrost depths were measured adjacent to water bodies.

When ice-rich permafrost thaws, settlement occurs as the soils consolidate. The amount of soil consolidation depends on the soil type but is generally high for ice-rich silts, a common soil type on the North Slope. The resulting soil consolidation is known as thaw settlement and may occur as the result of surface disturbance that thaws the underlying permafrost. Thaw settlement is prevented or minimized by constructing pads of gravel or ice, which provide protection for the permafrost as well as the structures and equipment being supported.

3.1.7 Deep Groundwater

Groundwater is present at depth below the permafrost in the project area, but it is highly saline and therefore nonpotable (EPA 2010). An underground source of drinking water (USDW) is defined as an aquifer that is currently serving as a source of potable water or which, by virtue of its potential productivity and natural water quality (i.e., less than 10,000 milligrams per liter [mg/l] of total dissolved solids [TDS]), could serve as a public water supply. The federal regulations at (40 CFR 144.7, 146.4, 146.4 [b][2]) allow aquifers to be exempt from protection as a USDW provided they meet several criteria. With TDS of approximately 40,000 mg/l, the groundwater below the permafrost in the project area is similar to numerous other areas on the North Slope and is significantly more saline than drinking water aquifers.

Based upon a review of the information provided by ExxonMobil, the EPA granted a “No USDW” ruling on February 3, 2003 for the Point Thomson area, since the TDS exceeded the 10,000 mg/l threshold required for a USDW (40 CFR 144.3, 146.3). This determination was reconfirmed on February 3, 2003 (EPA 2010).

Shallow groundwater in the project area is described in Section 3.6, Hydrology.

3.1.8 Seismicity

The project area is in the North Slope seismic region, 70° to 71° N Latitude and 146° to 151° W Longitude. The North Slope is considered an area with low-to-moderate seismic risk (Combellick 1994; ADNR 2006). However, there is seismic activity in the region surrounding the project area. Within a 250-mile radius there were 360 earthquakes recorded between April 1973 and January 2010, with the largest cluster of earthquakes to the southeast of the project area. During that time, there were two magnitude 5.0 or greater events that were less than 60 miles from the project area (USGS 2010a). Page et al. (1991) describe the seismicity of northeastern-most Alaska as a broad zone of diffuse activity extending from the northeast Brooks Range, across the ACP and onto the Beaufort Shelf, with notable inactivity beneath the North Slope.

Grantz et al. (1983) mapped the northeast-striking, right-lateral displacement Canning River Displacement Zone along the Canning River Valley to the southeast of the project area. Page et al (1991) describe the Canning River Displacement Zone as a young, active, mainly strike-slip shear zone along which the Brooks Range is moving northward and upward relative to the lowland to the west. There are no other records of faults recognized at the surface in the area.

Most seismicity in the area is shallow (less than 20 miles deep), indicating near-surface faulting, but no active faults are recognized at the surface in this area (USGS 2010a). Seismic engineering calculations for this area typically use a 10 percent probability of exceeding 0.05 g earthquake-generated horizontal acceleration in bedrock during a 50-year period (see Figure 3.1-3) where g equals the acceleration due to the earth's gravitational field. This design criterion is based on the methodology accepted by the International Building Code (IBC) and adopted for structures by the State of Alaska.

Ground accelerations in areas underlain by thick, soft sediments tend to be higher than ground accelerations in bedrock due to the acoustic wave propagation characteristics of relatively more deformable soft sediments. Thick permafrost, which underlies the project area, will act more like bedrock due to the more brittle nature of the interstitial ice, limiting lower-frequency ground shaking and tending to prevent earthquake-induced ground failure phenomena such as ***liquefaction*** (Pinney and Combellick 2000).

Peak ground acceleration (PGA) is generally less than 0.10g (g = the acceleration due to gravity, 32.2 feet per second squared) for the project area based on probabilistic seismic hazard mapping for Alaska in the 475-year return period (Wesson et al. 2007). The 2,475-year return period (2 percent probability of exceedance in 50 years) PGA ranges from 0.13g (Wahrhaftig 1965) to 0.22g (Wesson et al. 2007; see Figure 3.1-3).

The North Slope region was previously classified as Design Seismic Zone One, the lowest-risk category in Alaska, under the previous governing code (the Uniform Building Code). The current governing code is the IBC, 2003 edition, Section 1615, which requires that designs be based on the mapped spectral accelerations for the proposed site location. The current code designates that more than one design seismic zone exists in the project area.

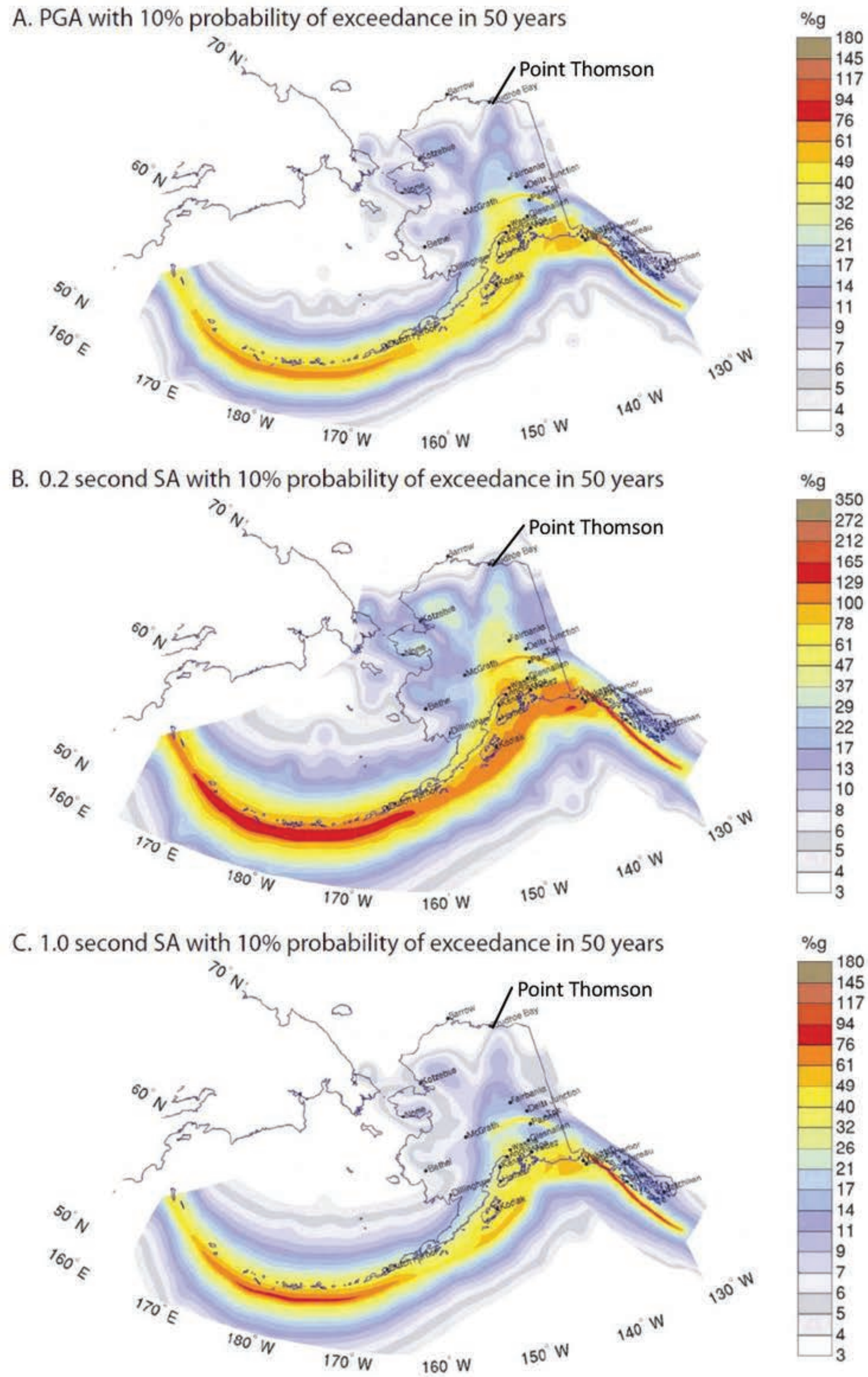
3.1.9 Paleontology

Paleontological resources are any physical evidence of past life, including fossilized remains, imprints, and traces of plants and animals. These resources are protected by federal and state acts, including the Antiquities Act of 1906, Federal and Land Policy and Management Act of 1998, Archaeological

Resources Protection Act of 1979, and the Alaska Historic Preservation Act. The North Slope is particularly rich in paleontological remains. The oldest fossil from that area is a tooth plate from a vertebrate fish found in a Middle Devonian rock formation from 380 million years ago. Post-Devonian sedimentation on the North Slope has, in some cases, developed up to 20,000 feet of fossil-bearing strata (BLM 2002a).

The paleontological record of the Point Thomson project area ranges in age from the Paleozoic through Cenozoic. Bedrock underlying the Point Thomson project area consists of thousands of feet of fossil-bearing sedimentary strata. These sedimentary rocks are overlain by fossil-bearing unconsolidated fluvial and eolian deposits. Fossils found in these rocks elsewhere on the North Slope range from single-celled organisms to large vertebrates. Marine invertebrate fossils include: bryozoans, brachiopods, pelecypods, gastropods, ostracods, crinoids, trilobites belemnites, ammonites, and coral. Marine plants also occur in these sedimentary rocks.

Because the project area is underlain by eolian silts and granular outwash materials comprising sands and gravels of late Quaternary age, the occurrence of fossils in the project area is limited to those taxa found in such materials across the North Slope region. These might include marine and terrestrial mammals such as otter, seal, whale, mammoth, moose, caribou, musk ox, bison, camel, horse, and lion, as well as birds that have been found in Quaternary deposits on the North Slope (BLM 2002a). Invertebrate fossils from the Quaternary Period have been found on the barrier islands and on the coast in several locations (APD 2009).



Probabilistic ground motion with a 10-percent probability of exceedance in 50 years for peak ground acceleration (A), 0.2 second spectral acceleration (B), and 1.0 second spectral acceleration (C).

PGA: Probabilistic ground motion
SA: Spectral acceleration

Figure 3.1-3

Probabilistic Ground Motion

Source: Wesson, R.L. et al. 2007

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3.2 SOILS AND PERMAFROST

The study area for soils extends west from the Canning/Staines River to the Endicott Spur Road and south from the coast approximately 9 miles.

3.2.1 Key Information About Soils and Permafrost

Knowledge of the soils and permafrost in the project area is necessary for predicting potential project impacts on these resources and determining measures to minimize the impacts. Soils in the project area consist of an upper layer of organic peat and/or organic silt 0.2 to 6.5 feet thick. This organic layer overlies massive ice or sand and gravel layers with varying amounts of fines and silt/clay interbeds. Gravel is plentiful in the region and is used for construction of roads, facility pads, and airstrips.

Permafrost extends to depths from 650 to 2,100 feet below the land surface and is essential for the development of microgeographical features on the ACP. Increases in permafrost thickness and extent are driven by climatic cooling, maturation of vegetation, increased albedo (reflectance), and decreased snow cover. Climatic warming, removal or compaction of vegetation, and mass wasting will decrease the thickness or extent of the permafrost. The near-surface soils subject to seasonal thaw are referred to as the active layer. Active layer depths in the project area range from 0.9 to 4.2 feet, with an average of about 1.5 feet.

Climate is the dominant soil-forming factor in the ACP. The underlying permafrost creates an impermeable barrier that can lead to waterlogging of surface soils. The cold climate inhibits certain soil-forming processes such as weathering and movement of clay downward through the soil, while organic matter accumulation is heightened due to the reducing conditions caused by saturation, slowed decomposition in the cold, wet conditions, and churning of the surface organic materials to the lowest parts of the active layer and upper permafrost.

3.2.2 Review and Adequacy of Information Sources for Soils and Permafrost

Soils on the North Slope have been studied by private oil and gas companies. Oil and gas companies conduct studies to establish baseline information about the soils underlying the proposed study area.

Much of the information available for soils and permafrost on the North Slope is in peer-reviewed journals. Table H-2 in Appendix H discusses the publications, reports, and data available for soils and permafrost that are cited in this Draft EIS and their relevance to the proposed project. Full references for the studies cited in this Draft EIS are in Chapter 9, References.

3.2.3 Surface Features and Permafrost

The study area is covered with thaw lakes and drained thaw lake depressions that are oriented and elongated in a north-northwest direction. These lakes cover a greater percent of the land as one travels west (Tedrow 1977). Periglacial features in the area include patterned ground (frost polygons), hummocks, frost boils, pingos, and thermokarst troughs. On polygonal terrain along the coast, soil properties are strongly related to ice-wedge patterned ground development (Shur and Jorgenson 2007, Ping et al. 2008). Because the entire area is underlain by thick permafrost (Péwé 1975) that limits drainage, wetlands are abundant.

The cold arctic maritime climate maintains the permafrost and is essential for the development of ice wedges and ice-wedge polygons (Tedrow 1977), thaw lakes (Sellman et al. 1975), pingos, and thermo erosion troughs (Rawlinson 1993). Permafrost extends to depths from 650 to 2,100 feet below the land surface (Jorgenson and Brown 2005). Permafrost creates an impermeable layer that inhibits drainage and causes surface saturation on much of the landscape (Everett 1975). Polygonal patterning is caused by freeze-thaw cycles where winter contraction causes fractures in the surface soils, which then fill with water in summer, and freeze and expand in the winter. As this cycle repeats seasonally, subsurface ice wedges grow and the surface distortion of soil forms a recognizable polygonal structure (Washburn 1980). The near-surface soils subject to seasonal thaw are referred to as the active layer. Active layer depths in the project area range from 0.9 to 4.2 feet, with an average of about 1.5 feet (Appendix D, RFI 46). The areas with the deepest active layer were measured adjacent to bodies of water in the study area (Appendix D, RFI 46). Active layer depths in the surrounding area vary according to surface conditions and along the margins of water bodies, but average 1 foot in organic soils to more than 3 feet in coarse-textured soils (Jorgenson and Brown 2005).

The permafrost temperatures on the ACP are less than 20°F. On average, permafrost temperatures in the upper 3 feet in arctic Alaska have increased from 1°F to 3°F between 1977 and 2002 (Osterkamp 2005). In the Prudhoe Bay region, mean annual ground temperatures in the upper 10 inches have increased by up to 9°F since the mid-1980s (Romanovsky et al. 2003). Snow cover, which acts as an insulating blanket for soils and increases ground surface reflectivity (albedo), is decreasing in areal extent by 2.1 percent per decade (Brodzik et al. 2006), according to data derived from the 2006 NOAA National Environmental Satellite, Data, and Information Service (Ramsay 1998, Frei and Robinson 1999, Robinson and Frei 2000). The thickness of the active layer is governed by multiple variables, including mean annual air temperature, soil texture, water-holding capacity, and vegetation cover. Areas with thick moss cover or deep organic horizons tend to have a shallower active layer than other areas due to the insulation provided by the organic material (Kade et al. 2006).

Permafrost conditions are altered by natural and human causes. Increases in permafrost thickness and extent are driven by climatic cooling, maturation of vegetation, increased albedo, and decreased snow cover (Nelson et al. 1998). Ice-wedge polygons and pingos are landforms associated with amassing of ice-rich permafrost (Mull and Adams 1989). Alternatively, climatic warming, removal or compaction of vegetation, and mass wasting increase heat flux to the subsurface and decrease the thickness or extent of the permafrost (Jorgenson et al. 2006). Soils with high volumes and/or distribution of ice, either in the form of pore ice or massive ice are most susceptible to thermal erosion, thaw settlement, and collapse of the ground surface due to melting of massive ground ice, a process which can result in thermokarst (Péwé 1975).

The degree and extent of thermokarst development is largely dependent on the volume and distribution of ground ice present and mineral grain size (Walker et al. 1987a). Ground ice is found as either pore ice, occupying the pore space in organic or mineral soils, or as massive ice, found as ice wedges or pooled ice (Tedrow 1977). Ice tends to segregate as massive ice when the volume exceeds the available soil pore space volume. The resulting weakened soil structure is highly susceptible to thermal erosion. Wedge ice in the surrounding areas occupies about 20 percent by volume of the landscape within the permafrost (Jorgenson et al. 1996) and occasionally as much as 50 percent of total soil volume (Bruggers and England 1982). Organic or fine-grained mineral soils with high ice content are highly susceptible to mechanical failure and hydraulic and thermal erosion (Pullman et al. 2007). Conversely, coarse-grained mineral soils are generally well-drained, have lower volume of pore ice, and experience minimal thaw settlement (Pullman et al. 2007).

3.2.4 Gravel

Gravel is plentiful in the region and is used for construction of roads, facility pads, and airstrips. Based on geotechnical exploration, sampling, and analysis performed at Point Thomson by Harding Lawson Associates (HLA) between 1980 and 1982, the uppermost layer, called overburden in mining terms, is present throughout the Point Thomson area. The overburden generally comprises organic materials (peat and organic silt) to depths of between 0 and 6.5 feet below ground surface (Appendix D, RFI 46).

Beneath the overburden is a zone of sandy silt and silty sand to average depths of between 3 and 6 feet below ground surface (Bruggers and England 1982). Beneath the sandy silt and silty sand layers, the target materials (chiefly gravelly sand and sandy gravel with variable amounts of silt) are present to the depths explored in geotechnical borings to date (up to 95 feet below ground surface). Based on testing performed at Point Thomson by HLA in 1980, the target materials have an average dry density of 70 pounds per cubic foot and an average ice content of 25 percent (Bruggers and England 1982).

Massive ice is present at variable locations in the area proposed for gravel mining. The occurrence of massive ice is greatest between depths of 3 and 10 feet, and decreases measurably below 15 feet (Bruggers and England 1982). Massive ice constitutes as much as 50 percent of the total soil volume in the upper 10 to 15 feet of soil where fine-grained materials (such as silt layers) are more commonly present (Bruggers and England 1982).

3.2.5 Soils

The project area is located on the Canning River alluvial fan, an ancient accumulation of mostly silts and sands. It is likely that much of the sand and silt was deposited through eolian and loessial events, but may have been redistributed through alluvial and fluvial processes (Carter 1988). Based on geotechnical borings conducted in the project area, a surface organic layer of peat and/or organic silt varying in thickness from 0.2 to 6.5 feet typically overlies massive ice or a layer of sandy silt and silty sand. Massive ice is found at a depth of less than 1 foot and can extend to a depth of 23 feet. Along the margins of the massive ice, layers of sands and gravels are found interbedded with the ice, a result of bending and warping of the soil layers as ice wedges grow, a process referred to as ***cryoturbation***. Beneath the silts and massive ice are layers of gravelly sand and sandy gravel with variable amounts of silt and clay (Appendix D, RFI 46).

Climate is the dominant soil-forming factor in ACP soils. The underlying permafrost creates an impermeable barrier that can lead to waterlogging of surface soils (Walker et al. 2003). The cold climate inhibits certain soil-forming processes such as weathering by removal of calcium components and movement of clay downward through the soil (Tedrow 1977), while organic matter accumulation is heightened due to the reducing conditions caused by saturation, slowed decomposition in the cold, wet conditions, and churning of the surface organic materials to the lowest parts of the active layer and upper permafrost (Ovenden 1990, Ping et al. 2004, Ping et al. 2008). The lack of weathering and infiltration of organic acids that leach ***cations*** from the soil reduce the nutrient availability (Everett 1979, Everett and Brown 1982). Previous studies have shown that nonacidic soils tend to have a deeper active layer than acidic soils (Nelson et al. 1998; Walker et al. 2003) and that there is a strong soil pH-vegetation relationship (Walker et al. 2003).

The land cover types of the ACP are grouped by vegetation community and ***substrate*** chemistry by Raynolds et al. (2006) on the *Arctic Tundra Vegetation Map*, but small-scale variation is present within these categories. Generally speaking, nonacidic and near neutral tundra is east of the Colville River.

Bockheim and Tarnocai (1998) found that the thickness of the organic layer is lesser in ***circumneutral*** and nonacidic tundra and the amount of cryoturbation is greater. However, Ping et al. (2008) found there was less organic matter stored by cryoturbation from the surface down to the upper permafrost in circumneutral and nonacidic tundra than in moist acidic tundra. Differences in microtopographical elevations govern surface hydrology. Margins of thaw lakes, drained thaw lake basins, ice-wedge polygon troughs, and low-centered polygons tend to be saturated throughout the growing season and have high moisture-tolerant species (Raynolds et al. 2006).

3.3 METEOROLOGY AND CLIMATE

The study area for meteorology and climate is the eastern North Slope.

3.3.1 Key Information About Meteorology and Climate

The unique climate and weather conditions of the North Slope strongly influence the scheduling and construction methods for the projects implemented there. The project area lies north of the Arctic Circle (latitude 66° 33′ 44″) in the arctic climate zone and includes polar maritime climate subtype (influenced by the Beaufort Sea) and continental climate subtype (influenced by the North Slope and the Brooks Range).

At high latitudes, there are extreme differences in daily solar radiation depending on the time of year. The lack of solar radiation in winter leads to extremely low temperatures. In summer, the continuous solar radiation does not result in high temperatures due to the latitude. The average maximum summer temperature in the project area is about 55°F and the average minimum winter temperature is -24°F. The project area is covered with snow for about 8 months of the year and snow may fall at any time of the year. Snow and ice reflect a great deal of the incoming solar radiation during spring and fall.

Wind speed and direction in the study area are influenced by the Brooks Range. Surface wind speeds tend to be lower in winter when an inversion exists and the air is quite stable. In summer, inversions are less frequent and weaker. As temperatures climb, the inversions break, allowing clouds and precipitation.

During the summer, ice-free conditions in the ocean and long days result in the land always being warmer than the sea. The warm air over the land rises and the cool air over the water moves onshore to replace the rising air, generating a shoreward wind, commonly called a “sea breeze.”

Near the coast where maritime climate conditions dominate, winters are cold and stormy while summers are cloudy. The amount of precipitation is heavier toward the coast and lighter inland, but interior locations have much more severe winters than the coast.

3.3.2 Review and Adequacy of Information Sources for Meteorology and Climate

Meteorology and climate on the North Slope have been studied mostly by oil companies or University of Alaska Fairbanks on behalf of state and federal government agencies. The types of studies include annual or less regular snow surveys, as well as meteorological and climatological data collection.

Table H-3 in Appendix H discusses the publications, reports, and data available for meteorology and climate that are cited in this Draft EIS and their relevance to the proposed project. Full references for the studies cited in the following text are in Chapter 9, References.

3.3.3 Meteorological Variables

Meteorology is the study of the atmosphere, which is defined through measurements of many variables, including solar radiation and temperature, wind speed and direction, relative humidity, precipitation, and air pressure. While human activities can affect local microscale and regional weather measurements, larger geographical features tend to impact temperature and wind conditions on a broader scale.

Local features such as the presence of mountain ranges, oceans, or ice fields can affect the weather. Mountain ranges can impact wind speeds and direction or otherwise inhibit the flow of air into a given region. Oceans have a moderating effect, tending to warm colder areas and to cool warmer areas. In the case of the North Slope of Alaska, the ocean has a warming effect in the fall and early winter, but because large quantities of ice are present for much of the year, the warming effect does not continue year round.

3.3.3.1 Solar Radiation and Temperature

The sun emits radiation that is absorbed by the earth and heats the planet. This solar radiation is responsible for nearly all of the energy available to the planet. The amount of solar radiation absorbed by the earth at a given location is affected by factors such as albedo, cloud cover, and angle of incidence. Albedo is a measure of how the surface reflects the incoming radiation; white surfaces (such as fresh snow) have high albedos and will reflect the most incoming radiation while black surfaces (such as asphalt) have low albedos and will reflect the least incoming radiation. Snow and ice are present for most of the year in the project area, and reflect a great deal of the incoming solar radiation during the months the sun is above the horizon.

Cloud cover acts as a moderating effect on temperature as clouds tend to reflect solar radiation due to their high albedos, but they also absorb energy from the earth below and re-radiate that energy back to the earth. At high latitudes, there are extreme changes in daily solar radiation depending on the time of year. In winter, there is no solar radiation because the earth’s axis is tilted away from the sun, so the sun does not rise above the earth’s horizon, resulting in extremely low temperatures that can persist for weeks to months. In summer, the earth’s axis is tilted toward the sun, so the sun does not set. However, despite the continuous summertime solar radiation, the low sun angles preclude the occurrence of extremely high temperatures, even in mid-summer.

3.3.3.2 Wind Speed and Direction

Wind speed and direction in the project area are influenced by the Brooks Range, which lies mostly east-west across the northern third of Alaska. The effects of the mountains on wind speed and direction, cloudiness and precipitation, known as ***orographic*** effects, are greatest nearest the mountains and reduced with distance from the mountains. Generally, air flow near the Brooks Range tends to run parallel to the orientation of the mountain range.

Additionally, during the summer, ice-free conditions in the ocean and long days result in a thermal imbalance between the land and the sea, with the land always being warmer. This imbalance results in rising air over the land, with cool air over the water moving onshore to replace the rising air. This flow of air generates a shoreward wind (generally from the east-northeast) known as a sea breeze (Veltcamp and Wilcox 2007).

3.3.3.3 Relative Humidity

Relative humidity is an expression of the measure of the amount of water vapor in the air compared to the amount of water vapor the air could hold at that temperature. As described above, the temperatures in the project area are relatively cool to extremely cold, and as a result, the air typically has low absolute moisture content. However, relative humidity can be fairly high even at low temperatures if the air temperature and dew point temperature are near each other. When relative humidity reaches 100 percent, the air is considered to be saturated and condensation (i.e., fog) can occur. If a lifting mechanism for the air is present, precipitation can occur.

3.3.3.4 Precipitation

The potential amount of precipitation depends on the amount of water vapor available in the atmosphere and the opportunities for saturated air to be lifted. Generally, the amount of precipitable water vapor decreases with latitude. Opportunities for precipitation to occur are related to both the passing of large-scale storm systems and convection. Despite these opportunities for precipitation, the limited amount of moisture in the air results in a relatively arid environment.

3.3.3.5 Air Pressure

Air pressure is a measure of the force exerted by air, and changes in air pressure indicate a change in the type of weather a region is experiencing. Falling or low pressure is marked by clouds, precipitation, and increasing winds, while rising or high pressure is marked by clear skies and decreasing winds, although the sea breeze and orographic effects described above do not allow for frequent calm conditions.

3.3.4 Monitored Meteorological Data

Data were collected from January 2001 through September 2006 spanning a 62.1-mile stretch of the Beaufort Sea coast centered on Prudhoe Bay as part of the MMS Beaufort Sea Meteorological Monitoring and Data Synthesis Project (Veltcamp and Wilcox 2007). The data were collected at the Badami Development Facility, the Endicott Production Facility, and the Milne Point Production Facility. These data are shown in Table 3.3-1 along with data for the Deadhorse Airport from the National Climatic Data Center (NCDC 2009) over the same time period, and are representative of the project area. Meteorological data were also collected at Point Thomson from September 1, 2009 through August 31, 2010 (HCG 2010).

Table 3.3-1: Local Meteorological Data

Parameter	Badami[a]	Endicott[a]	Milne Point[a]	Deadhorse[a]	Point Thomson[b]
Wind Speed (mph)					
Average	13.2	11.9	11.4	12.1	14.9
Maximum	79.4	68.5	75.6	56.4	58.2
Temperature (°F)					
Average	12.7	13.3	12.9	12.6	13.8
Minimum	-49.5	-44.0	-46.5	-51.2	-40.9
Maximum	79.0	66.4	71.4	81.0	63.2
Relative Humidity (%)					
Average	85.0	86.0	86.0	84.0	85.6
Minimum	30.0	39.0	31.0	6.0	31.1
Maximum	100.0	100.0	100.0	100.0	--
Barometric Pressure (psi)					
Average	14.8	14.7	14.7	14.6	14.7
Minimum	14.2	14.1	14.2	14.1	14.2
Maximum	15.3	15.3	15.3	15.3	15.2
Solar Radiation (w/m^2)					
Average	103.9	100.5	95.4	—	94.7
Maximum	797.0	791.0	746.0	—	798.0

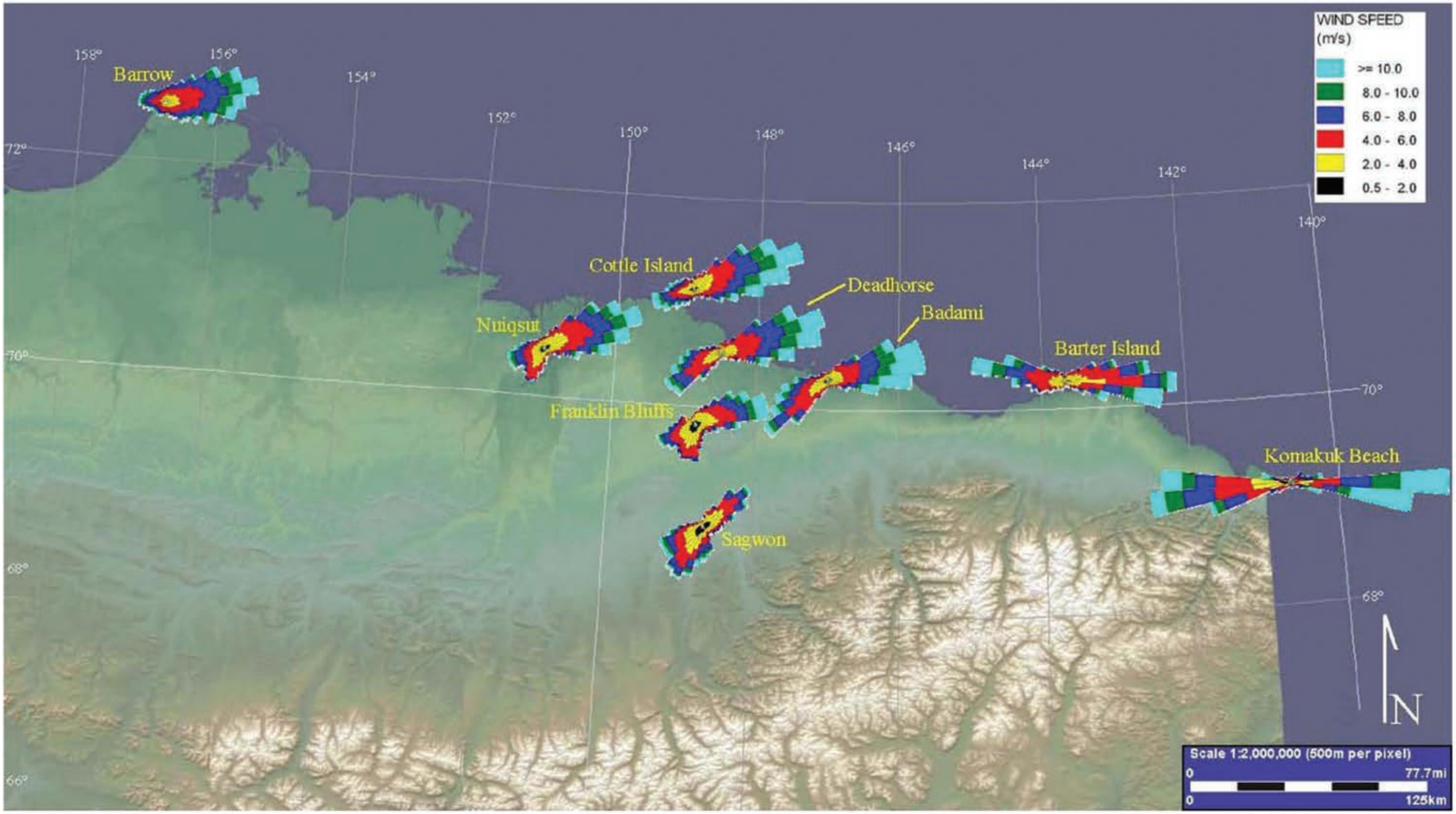
[a] Data collected January 2001 through September 2006.
[b] Data collected September 1, 2009 through August 31, 2010.
mph=miles per hour
psi= pounds per square inch
w/m^2= watts per square meter

Figure 3.3-1 and Figure 3.3-2 are wind roses for the region and the location nearest the project area (Badami, approximately 20 miles west of Point Thomson), respectively. Wind roses are divided into sectors that show the frequency of winds displayed as spokes, in this case at each of 36 (10 degree) direction sectors. Wind speeds are denoted by a color scale and are displayed as a percentage of time that the wind blows from a particular direction at a particular speed. These wind roses, which include all wind speed and direction data available during the MMS project's collection period, show that winds in the project area predominately occur in two directions aligning with the axis of the Brooks Range.

3.3.5 Climatology

The project area lies north of the Arctic Circle (latitude 66° 33′ 44″) in the arctic climate zone and includes polar maritime climate subtype (influenced by the Beaufort Sea) and continental climate subtype (influenced by the North Slope and the Brooks Range). Climate is defined as the long-term averages of meteorological variables, which can be influenced by natural external forces such as solar impacts, natural internal forces such as ocean-atmosphere regime effects, and human activity. The interrelation between high latitude and extended periods with low or no incoming solar radiation contributes to an environment where extremely cold temperatures can occur regularly and with great persistence, especially in winter months.

The main constant of an arctic climate is the extreme solar radiation conditions of high latitudes. Winters have little to no solar radiation, while summers have near constant solar radiation. However, the low angle of the sun means that even minor topographic features can cause major local climate differences due to shading. Additionally, the high albedo of snow and ice reflects incoming solar radiation and results in only small heat gain in spring and early summer, prior to snow melt, in spite of the constant solar radiation. The weather is generally controlled by persistent low-pressure systems located near the Aleutian Islands that are weak in the summer and stronger in the winter. During the cold season, high pressure is prevalent over the Canadian Arctic Archipelago and has a strong influence on the project area.



POINT THOMSON PROJECT EIS

Figure 3.3-1

Wind Roses Along the Beaufort Sea Coast and on the North Slope

Sources: Minerals Management Service (MMS) Beaufort Sea Meteorological Monitoring and Data Synthesis Project (HCG Inc. 2007)

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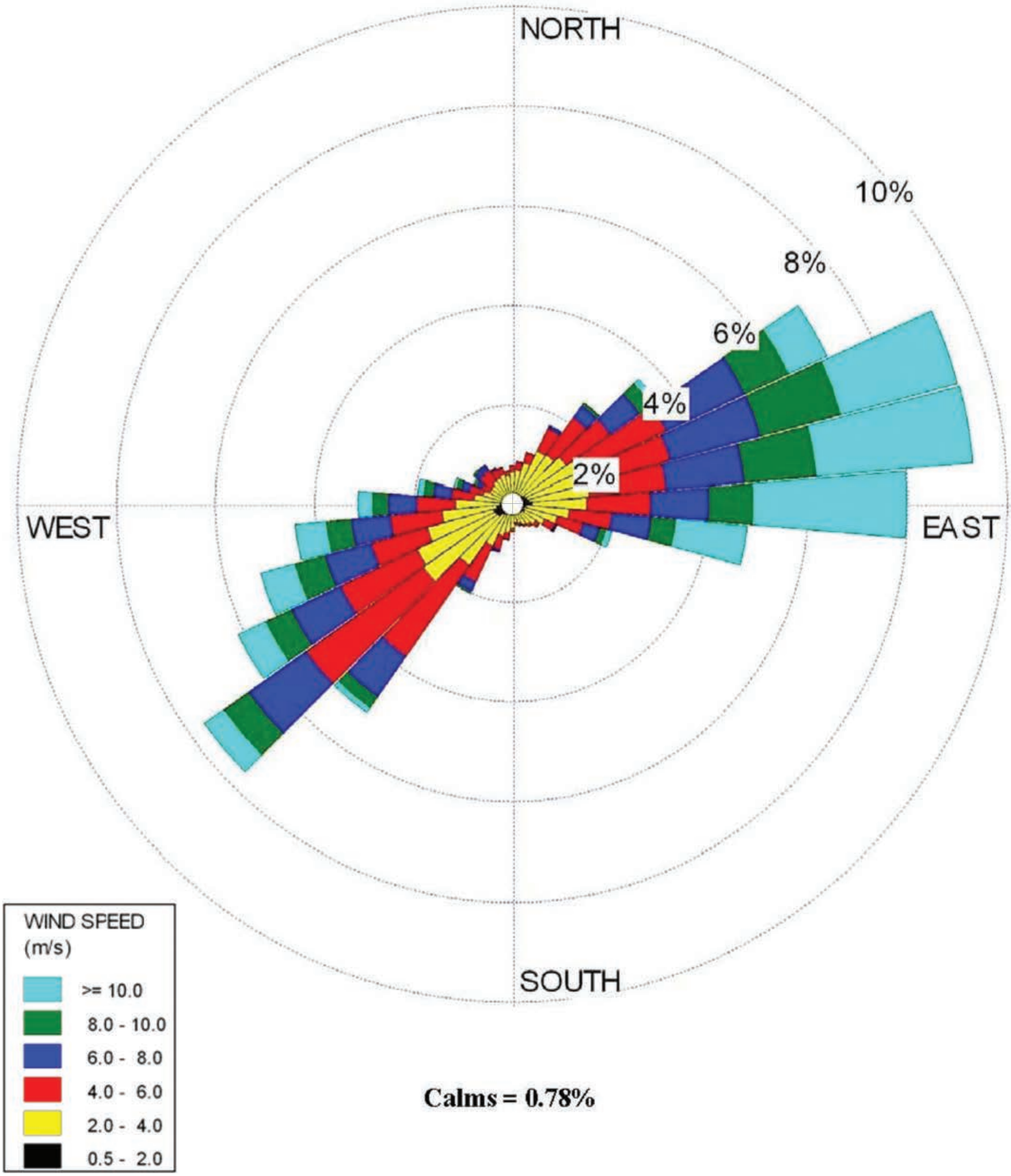

POINT THOMSON PROJECT EIS

Figure 3.3-2

Badami Wind Rose

Sources: Minerals Management Service (MMS) Beaufort Sea Meteorological Monitoring and Data Synthesis Project (HCG Inc. 2007)

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Near the coast and over the Arctic Ocean where maritime climate conditions dominate, winters are cold and stormy while summers are cloudy. Generally, the amount of precipitation is heavier towards the coast and lighter inland, although the interior locations have much more severe winters than along the coast. The entire North Slope can experience extremely low temperatures both in wintertime averages and in daily minimum temperature extremes compared to the averages throughout the entire year.

In winter, warm air frequently lies above a colder air layer near the surface, resulting in an inversion. The inversion acts as a barrier between the air above the level of the inversion and that below the inversion, and can decouple the surface wind from the stronger upper layer wind. For this reason, surface wind speeds tend to be lower in winter when an inversion exists and the air is quite stable. In summer, inversions are less frequent and weaker. As temperatures climb the inversion breaks, allowing clouds and showers to form.

Climate data for locations near the project area are presented in Table 3.3-2.

Table 3.3-2: Climatologic Data [a]

Parameter	Kuparuk	Prudhoe Bay	Barter Island
Temperature (℉)			
Average Maximum Summer (July)	55.9	55.4	45.4
Extreme Maximum Summer (July; year)	82 (2001)	82 (1994)	78 (1974)
Average Minimum Summer (July)	38.8	39.7	34.8
Extreme Minimum Summer (July; year)	18 (2005)	28 (1986)	24 (1967)
Average Maximum Winter (January)	-11.1	-11.9	-7.7
Extreme Maximum Winter (January; year)	37 (2008)	36 (1989)	39 (1962)
Average Minimum Winter (January)	-23.6	-24.0	-20.3
Extreme Minimum Winter (January; year)	-55 (1989)	-62 (1989)	-54 (1975)
Precipitation (inches)			
Maximum Total Precipitation (year)	7.30 (2002)	7.41 (1997)	12.88 (1954)
Average Total Precipitation	3.97	4.26	6.19
Minimum Total Precipitation (year)	2.12 (2007)	2.90 (1990)	2.93 (1974)
Maximum Total Snowfall (year)	53.5 (1997)	50.3 (1992)	106.1 (1954)
Average Total Snowfall	31.8	33.1	41.8

Source: WRCC 2010

[a] Although the climate period is typically identified as a 30-year period, the averages and extremes shown are for the period of record available at each site, taken from General Climate Summary Tables for temperature and precipitation at each site. The periods of record are: Kuparuk (1983-2010), Prudhoe Bay (1986-1999), and Barter Island (1949-1988) (updated as of August 27, 2010).

The project area is covered with snow for about 8 months of the year, although snow may fall any time of the year. Generally snow cover is from October through May and rain is the dominant precipitation from June through August (Sloan 1987).

The Natural Resources Conservation Service (NRCS 2010) recorded precipitation at Snotel sites at Barrow, Barter Island, and Prudhoe Bay from 1971 to 2000 (Table 3.3-3). Trace amounts of precipitation (less than 0.01 inch) are underestimated in the recorded values. This suggests actual precipitation is about 10 percent higher than published values (Benson 1982, Sloan 1987). Kane et al. (2009) concluded there is a strong relationship between elevation and summer precipitation, but the same is not true of solid precipitation (such as snow or hail). Higher elevations receive more rain, while the foothills region receives the greatest snow-water equivalent (SWE). SWE is the amount of water in snow if it were melted.

Table 3.3-3: Average Monthly Precipitation Reported from NRCS Snotel Sites, Recorded from 1971 to 2000 (inches)

SNOTEL Site Name	Elev.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Barrow	25	0.8	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.6	1.0	1.1	0.9	7.2
Barter Island	30	1.0	0.7	0.7	0.6	0.5	0.4	0.4	0.4	1.0	1.2		1.0	9.4
Prudhoe Bay	30	0.9	0.7	0.7	0.6	0.5	0.4	0.3	0.3	0.7	1.1		0.9	8.4

Snow surveys from the Sagavanirktok River east to Bullen Point were completed by Kane et al. (2006) and Berezovskaya et al. (2007, 2008, 2010). Sloan (1987) compares the results from surveys in 1977, 1978, 1979 in the National Petroleum Reserve–Alaska (NPR-A) and surveys across the North Slope region in 1982 and 1983. Average snow depths, densities, and SWEs are provided in Table 3.3-4. Generally, the more recent surveys that are focused along the east portion of the North Slope, near the project area, report slightly lower average SWEs than the earlier studies show for other areas. This may be attributable to different methodology; Sloan (1987) stated the methodologies for the surveys in 1982 and 1983 were essentially the same as those performed for the NPR-A surveys.

Table 3.3-4: Snow Survey Results from Three Separate Studies on the North Slope, Alaska

Description of Study Area		National Petroleum Reserve–Alaska (NPR-A)			North Slope[a]		Sagavanirktok to Bullen Point			
		1977	1978	1979	1982	1983	2006	2007	2008	2009
Overall	Depth (inches)	17	17	10	15	12	13	14	12	20
	Density (slug/ft³)	*0.565*	*0.630*	*0.654*	*0.656*	*0.640*	*0.459*	*0.435*	*0.460*	*0.506*
	SWE (inches)	5	6	4	5	4	3	3	3	5
ACP	Depth (inches)	—	—	—	—	—	13	12	12	19
	Density (slug/ft³)	—	—	—	—	—	*0.514*	*0.452*	*0.369*	*0.597*
	SWE (in.)	—	—	—	—	—	3	3	4	5
AF	Depth (inches)	—	—	—	—	—	12	16	13	23
	Density (slug/ft³)	—	—	—	—	—	*0.487*	*0.427*	*0.413*	*0.511*
	SWE (inches)	—	—	—	—	—	3	4	3	6
Mountains	Depth (inches)	—	—	—	—	—	14	12	11	18
	Density (slug/ft³)	—	—	—	—	—	*0.376*	*0.425*	*0.599*	*0.428*
	SWE (inches)	—	—	—	—	—	3	3	2	4
	Total Number of Sites	46	41	7	24	32	40	141	113	143

[a] Extending from near Wainwright to the Kongakut River

3.4 AIR QUALITY

The study area for air quality is the eastern North Slope, specifically from Point Thomson Project to Deadhorse.

3.4.1 Key Information About Air Quality

Ambient air quality is regulated by federal, state, and local agencies. EPA has established standards for six criteria pollutants. The State has generally adopted and/or proposed standards that are the same as the federal standards but include two additional pollutants. The project area does not violate any federal or state air quality standards and therefore is designated as an attainment area.

Existing ambient air quality must be characterized in order to understand the potential impacts of proposed new emissions sources. Several sources of monitoring data are available to characterize background air quality in the project area. These include:

- Liberty Project Air Monitoring Program at the Endicott Production Facility
- Prudhoe Bay Ambient Air Monitoring Program at the Central Compressor Plant
- Alaska North Slope Eastern Region Monitoring Program at the Badami Development Facility
- Point Thomson Ambient Air and Meteorological Monitoring Project

3.4.2 Review and Adequacy of Information Sources for Air Quality

Most of the ambient air quality data available within Alaska is found in reports submitted to the State for potential air permitting projects. This monitoring data (both site-specific and representable data) was used to quantify the ambient (background) air quality within the proposed project area. Although the air permit application for the development project is still pending submittal to the State, the draft dispersion modeling files and proposed emissions calculations were analyzed based on preconstruction permit requirements in order to determine impacts to air quality. Consequently, findings may be impacted due to processing of the final application and permitting by the State.

Table H-4 in Appendix H discusses the publications, reports, and data available for air quality that are cited in this Draft EIS and their relevance to the proposed project. Full references for the studies cited in this Draft EIS are in Chapter 9, References.

3.4.3 Air Quality Standards

Ambient air quality is regulated by federal, state, and local agencies. EPA has established National Ambient Air Quality Standards (NAAQS) for six criteria pollutants: particulate matter (PM_{10} particulates and $PM_{2.5}$ particulates), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxide (NO_2), ozone (O_3), and lead (Pb). The NAAQS were developed to protect human health (primary standards) and human welfare (secondary standards). State air quality standards cannot be less stringent than the NAAQS. With the exception of newer NAAQS that are not yet adopted by the State of Alaska, the State has generally adopted and/or proposed Alaska Ambient Air Quality Standards (AAAQS) under Alaska Statute 46.14 that are the same as the NAAQS for all criteria pollutants. Alaska also has standards for two additional pollutants: ammonia and reduced sulfur compounds. The AAAQS do not include secondary standards. Table 3.4-1 lists the NAAQS and AAAQS for the six criteria pollutants.

Table 3.4-1: National and Alaska Ambient Air Quality Standards

Pollutant	Time Frame	Primary	Secondary
PM_{10}	Annual[a]	Revoked	Revoked
	24-hour[b]	150 µg/m^3	150 µg/m^3
$PM_{2.5}$	Annual[c]	15 µg/m^3	15 µg/m^3
	24-hour[d]	35 µg/m^3	35 µg/m^3
SO_2	Annual[e]	0.030 ppm (80 µg/m^3)	NA
	24-hour[e,f]	0.14 ppm (365 µg/m^3)	NA
	3-hour[f]	NA	0.5 ppm (1,300 µg/m^3)
	1-hour[g]	0.075 ppm (196 µg/m^3)	NA
CO	8-hour[f]	9 ppm (10 mg/m^3)	NA
	1-hour[f]	35 ppm (40 mg/m^3)	NA
NO_2	Annual	0.053 ppm (100 µg/m^3)	0.053 ppm (100 µg/m^3)
	1-hour[h]	0.100 ppm (189 µg/m^3)	NA
O_3	8-hour[i]	0.075 ppm (147 µg/m^3)	0.075 ppm (147 µg/m^3)
	1-hour[j]	Revoked	Revoked
Pb	3-month rolling[k]	0.15 µg/m^3	0.15 µg/m^3
	Quarterly	1.5 µg/m^3	1.5 µg/m^3

Sources: EPA 2010b, ADEC 2010a.

[a] Due to a lack of evidence linking health problems to long-term exposure to coarse particle pollution, the EPA revoked the annual PM_{10} standard of 50 µg/m^3 in 2006 (effective December 18, 2006).

[b] Not to be exceeded more than once per year on average over 3 years.

[c] To attain this standard, the 3-year average of the weighted annual mean particulate matter less than 2.5 microns in diameter concentrations from single- or multiple community-oriented monitors must not exceed 15.0 µg/m^3.

[d] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3 (effective December 17, 2006).

[e] The annual and 24-hour SO_2 NAAQS will be revoked 1 year after the 1-hour standard is designated by EPA as being attained in any area.

[f] Not to be exceeded more than once per year.

[g] To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 0.075 ppm (effective August 30, 2010). AAAQS does not yet include a 1-hour primary standard for SO_2.

[h] To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 0.100 ppm (effective January 22, 2010). AAAQS does not yet include a 1-hour primary standard for NO_2.

[i] To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations, measured at each monitor within an area over each year, must not exceed 0.075 ppm (effective May 27, 2008).

[j] The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is < 1. As of June 15, 2005, the EPA revoked the 1-hour ozone standard of 0.12 ppm in all areas, except the fourteen 8-hour ozone nonattainment Early Action Compact Areas.

[k] Final rule signed October 15, 2008.

Notes:

µg = microgram(s) mg = milligrams NA = not applicable

m^3 = cubic meter(s) ppm = part(s) per million

3.4.4 Attainment Status

Areas that violate federal and/or state air quality standards are designated as ***nonattainment*** areas for the relevant pollutants, as opposed to areas that comply with federal and/or state air quality standards, and hence are designated as attainment areas (i.e., areas that have attained compliance) for the relevant pollutants. Areas where insufficient data are available are designated as attainment/unclassified areas, and are treated as attainment areas under the CAA. Areas that were previously nonattainment and have demonstrated compliance with NAAQS are designated "maintenance" for 20 years after the effective date of attainment, assuming they remain in compliance with the standard.

Alaska has established a State Implementation Plan (SIP), which describes how the state will comply with the CAA and achieve attainment with federal and/or state air quality standards; it consists of narrative, rules, technical documentation, and agreements that the state uses to maintain acceptable air quality and to improve air quality in areas with unacceptable levels of atmospheric contaminants.

Federal funding actions or other approvals in nonattainment and maintenance areas are subject to either Transportation Conformity rule requirements, which apply to certain types of transportation projects, or to General Conformity rule requirements, which can apply to other types of federal actions.

A General Conformity determination is required for federally sponsored or funded actions in nonattainment areas or in certain maintenance areas when the total direct and indirect net emissions of nonattainment pollutants (or their precursors) exceed specified thresholds (Section 176[c] of the CAA Amendments of 1990). This regulation ensures that federal actions conform to the SIP and agency NAAQS attainment plans.

Table 3.4-2 lists the attainment status for the project area for each of the criteria pollutants (EPA 2010c). Given the unclassifiable/attainment status for all pollutants, conformity requirements would not apply to federal actions in the project area.

Table 3.4-2: Project Area EPA Attainment Status Summary

Pollutant	Federal Designation
PM_{10}	Unclassifiable
$PM_{2.5}$	Unclassifiable/Attainment
SO_2	Attainment
CO	Unclassifiable/Attainment
NO_2	Unclassifiable/Attainment
O_3	Unclassifiable/Attainment
Pb	Unclassifiable/Attainment

3.4.5 Ambient Air Quality

- To characterize the ambient (background) air quality in the area of the project, representative data from several sources have been used. Ambient NO_2, SO_2, and CO data were collected for the Liberty Project Air Monitoring Program located at the Endicott Production Facility (approximately 40 miles from the project area) from February 2007 through January 2008 (ExxonMobil 2009b).
- Ambient NO_2, SO_2, O_3, and PM_{-10} data were collected for the Prudhoe Bay Ambient Air Monitoring Program located at the Central Compressor Plant (approximately 50 miles from the project area) from January 2007 through December 2007 (ENSR 2008). The O_3 data was collected for compliance with the 1-hour standard, which has since been revoked.
- Ambient NO_2, SO_2, O_3, and PM_{10} data were collected for the Alaska North Slope Eastern Region Monitoring Program located at the Badami Development Facility (approximately 20 miles from the project area) from January 1999 through December 1999 (ExxonMobil 2009b). The O_3 data was collected for compliance with the 1-hour standard, which has since been revoked.

- Ambient NO_2, SO_2, O_3, CO, $PM_{2.5}$ and PM_{10} data were collected at Point Thomson from September 1, 2009 through August 31, 2010 (HCG 2010). Both 1-hour and 8-hour O_3 data were collected. The 1-hour standard for O_3 has been revoked.

Figure 3.4-1 depicts the locations of the four monitoring sites with outlines of current and proposed development areas. A summary of the available regional background air quality concentrations is presented in Table 3.4-3. The available data confirm that pollutant concentrations in the project area are in compliance with the respective NAAQS and AAAQS. Information regarding the purpose of these monitoring sites, frequency of monitoring, monitoring methodology, and data quality assurance and quality control can be found in the monitoring reports submitted to ADEC.

POINT THOMSON PROJECT EIS

Figure 3.4-1

Monitoring Site Locations for Regional Background Air Quality Concentrations

Date: 27 June 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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Table 3.4-3: Regional Background Air Quality

Pollutant	Averaging Period[a]	Endicott Monitoring Data (µg/m³)/ (% of NAAQS)	Prudhoe Bay Monitoring Data (µg/m³)/ (% of NAAQS)	Badami Monitoring Data (µg/m³)/ (% of NAAQS)	Point Thomson Monitoring Data[b] (µg/m³)/ (% of NAAQS)
PM_{10}	24-hour	—	52.8 (35.2)	12.4 (8.2)	66.5 (44.3)
$PM_{2.5}$	Annual	—	—	—	2.6 (17.3)
	24-hour	—	—	—	12.7 (36.6)
SO_2	Annual	2.7 (3.3)	2.6 (3.3)	2.6 (3.3)	2.6 (2.9)
	24-hour	13.0 (3.6)	23.5 (6.4)	15.7 (4.3)	23.5 (6.6)
	3-hour	41.9 (3.2)	28.6 (2.2)	18.3 (1.4)	65.5 (5.1)
	1-hour	—	—	—	76.0 (38.8)
CO	8-hour	1,099 (10.7)	—	—	1,278 (12.8)
	1-hour	1,752 (4.4)	—	—	2,171 (5.4)
NO_2	Annual	11.3 (11.4)	18.9 (18.9)	3.8 (3.8)	7.0 (7.0)
	1-hour	—	—	—	132.9 (70.3)[c]
O_3	8-hour	—	—	—	86.0 (57.5)

Sources: ExxonMobil 2009b, ENSR 2008, HCG 2010.

[a] All short-term (1-hr, 3-hr, 8-hr, 24-hr) concentrations except 1-hour NO_2 represent overall highest measured values, although all the short-term standards allow one or more exceedances per year.

[b] Data reported for NO_2 and $PM_{2.5}$ are from RFI 57 (Appendix D). Other pollutant data are from HCG 2010.

[c] One-hour NO_2 value represents the 98th percentile of daily maximum 1-hour values over a 1-year period, in accordance with the form of the NAAQS (Table 3.4-1).

Notes:

µg = microgram(s)

m^3 = cubic meter(s)

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3.5 PHYSICAL OCEANOGRAPHY AND COASTAL PROCESSES

The study area for physical oceanography and coastal processes extends west from the Staines River to the Sagavanirktok River and from the coast offshore to and encompassing the barrier islands. The body of water that lies adjacent to the Point Thomson project area, between the mainland shore and Flaxman Island, is called Lion Bay. However, the entire water body that is formed by the Maguire Islands (of which Flaxman is easternmost) has historically been known as Lion Lagoon. This naming convention is maintained in the following discussion.

3.5.1 Key Information About Physical Oceanography and Coastal Processes

Along the Beaufort Sea coast, temperature and salinity of nearshore waters are strongly influenced by meteorological conditions, proximity to rivers, and sea ice. The circulation of nearshore waters is driven primarily by the wind such that, under easterly winds, currents flow generally westward, and vice versa. In the passes between barrier islands, as well as between barrier islands and the mainland, currents are aligned with the directional axis of the passes and are responsive to the overall action of wind on the lagoons contained between barrier islands and the mainland.

Water level variations along the Beaufort Sea coast are the result of tides, storm surge, and waves. Tides have a mean diurnal range of only 0.7 feet. Storm surges are a far more important cause of water level variation and are the result of strong winds blowing parallel to the coast. Strong easterly winds can produce negative storm surges of as much as 2 to 3 feet, while strong westerlies can produce positive storm surges of 4 to 6 feet or even more. Wave heights observed within Lion Lagoon during a 1982 study were mostly less than 2 feet, although occasional storms caused waves as high as 5 feet.

Sea ice begins to form in Beaufort coastal lagoons between mid-September and mid-October. Within Lion Bay, ice extends from the shore to the barrier islands and can grow to as much as 7 feet in thickness by April. When the sea ice cover is still thin (less than 1 foot) in early winter, it can be quite mobile in response to wind stress. On shorelines exposed to the open ocean, winds can push sea ice 100 feet or more onshore and 10 to 20 feet high in a process called sea ice ride-up and override which, in turn, can result in shoreline and seabed scouring.

During river breakup in early June, freshwater overflows the sea ice at the river mouths, causing some melting of the sea ice surface. Sea ice breakup begins in late June to early July, and progresses steadily seaward, such that nearshore waters are nearly ice-free by early August.

Most of the Beaufort Sea shoreline is erosional. The coastal bluffs contain large quantities of ice and fine-grained organic material and, consequently, provide little sediment to replenish the beaches as they erode. Within Lion Bay, barrier islands limit the amount of shoreline erosion by sheltering the mainland coast from extensive wave action. Aerial photos of the study area indicate average annual shoreline erosion rates of 1.2 to 4.1 feet per year, with the highest rates occurring at the proposed West Pad location.

Within the Point Thomson study area, the shoreline is composed of fine-grained soils and permafrost with no natural rock outcrops. Therefore, any manmade structures are capable of disrupting the natural littoral response of the shoreline to effects of wave and water level fluctuations.

3.5.2 Review and Adequacy of Information Sources for Physical Oceanography and Coastal Processes

Beaufort Sea coastal waters have been studied extensively by scientists and engineers under contract to governmental agencies and oil companies operating on the North Slope. Several oceanographic studies have been conducted within Lion Lagoon. While some study results have been published in peer-reviewed journals or books, much of the information on physical oceanography and coastal processes within the Point Thomson study area is available only in engineering reports prepared for oil companies and governmental agencies.

Table H-5 in Appendix H discusses the publications, reports, and data available for physical oceanography and coastal waters that are cited in this Draft EIS and their relevance to the proposed project. Full references for the studies cited in this Draft EIS are in Chapter 9, References.

3.5.3 Lion Bay and Lagoon

The body of water that lies adjacent to the Point Thomson project area, between the mainland shore and Flaxman Island, is called Lion Bay. However, the entire water body that is formed by the Maguire Islands (of which Flaxman is easternmost) has historically been known as Lion Lagoon. The Maguire Islands comprise a barrier island complex that shelters much of Lion Lagoon from exposure to storm waves that are generated in the Beaufort Sea during open-water periods. During winter these barrier islands also provide the shoreline some protection from large movements of sea ice.

Lion Lagoon is nearly 20 miles long and increases in width from about 2.5 miles at its eastern end to nearly 4 miles at its western extremity. The Maguire Islands are bisected by Mary Sachs Entrance, a 2.25-mile-wide pass between North Star and Flaxman Islands. East of Mary Sachs Entrance, Lion Lagoon is shallow with depths generally less than 10 feet, except in the 1,200-foot-wide channel between Point Brownlow and Flaxman Island, where the channel is occasionally scoured to a depth of 25 feet or more (URS 1999).

Water depths in Mary Sachs Entrance are typically 9 to 11 feet in the channel, which trends from northeast to southwest toward the project area. Exposure of the mainland shore to waves from the Beaufort Sea is evidenced by the well-developed sand spit and bar formation along the mainland shore opposite the entrance (OCS 1996, URS 1999).

West of Mary Sachs Entrance, Lion Lagoon widens from 1.5 miles near Point Thomson to 3.5 miles near Challenge Island. Water depths adjacent to the mainland near Point Thomson are 7 to 10 feet, and increase gradually to 16 to 20 feet at the west end of Lion Bay, which is known as Challenge Entrance (OCS 1996).

3.5.4 Ocean Processes

Several oceanographic studies have been conducted within Lion Lagoon (KLI 1983, Tekmarine 1983, URS 1999). These studies and others discussed by Colonell and Niedoroda (1990) have contributed substantially to the understanding of lagoonal responses to regional oceanographic processes of the adjacent Beaufort Sea, as summarized below.

Oceanographic processes and conditions in the nearshore coastal environments of the Beaufort Sea during the open water period are complex and highly variable. Salinity and temperature of nearshore waters are strongly influenced by meteorological conditions, proximity to rivers, and sea ice. The dominant factor in driving circulation of nearshore waters is wind stress, with water level variations and water density gradients having lesser influence. Nearshore currents are generally parallel to the shoreline and the local ***bathymetry*** and in the same direction as the prevailing wind stress on the water surface.

Astronomical tides in Lion Lagoon are small, with a mean diurnal range of only 0.7 feet; however, storm surges that are produced by strong coastal winds cause much larger variations in sea level. Storm surges, both positive and negative, result from the combined effects of wind stress on the water surface and atmospheric pressure variations, with wind having the greater effect. Effects of the Earth's rotation (called the "Ekman effect") cause strong easterly winds along the Beaufort Sea coast to propel surface water away from shore and thereby produce negative storm surges (i.e., depression of sea level) of as much as 2 to 3 feet. Strong westerlies have the opposite effect and produce positive storm surges (elevation of sea level) of 4 to 6 feet, or even greater with very strong winds (e.g., 50 to 60 knots). Storm surges are effective mechanisms for producing cross-shore mixing of water masses, while wind-generated currents moving parallel to shore are the primary factor in ***advecting*** water along the shore and promoting alongshore mixing of water masses.

In a coastal engineering assessment prepared for the Point Thomson Project, PND Engineers Inc. (PND 2009a) performed an extremal analysis of the 16-year (1993 to 2008) water level record from the Prudhoe Bay tide gauge, which is the only water level record actually measured for the region. This analysis enabled estimation of storm surge heights having annual probabilities of occurrence of 0.02 and 0.01, which are commonly known, respectively, as the 50-year and 100-year return intervals (see Table 3.5-1). Previous analyses based on hindcast storm conditions (Coastal Frontiers 2003) have suggested that the P=0.01 (100-year) storm positive surge heights could be 1 or more feet higher than PND's analysis.

Table 3.5-1: Estimated Storm Surge Heights from Extremal Analysis

Sea level change due to storm surge	Annual Probability of Occurrence (Return Interval)	
	P = 0.02 (50-year, ft)	P = 0.01 (100-year, ft)
Positive (sea level raised)	+5.0	+5.6
Negative (sea level depressed)	-3.0	-3.5

Source: PND 2009b.

There is historical evidence for significantly higher storm surges having occurred elsewhere on the Beaufort Sea coast, but no effort has been made to relate those observations to what might have occurred concurrently near Point Thomson. Hume and Schalk (1967) reported on the September 1963 storm that produced a surge of 11 to12 feet at Barrow, which they deemed to be at least "the 200-year event" because none of the village elders could recall having ever heard of a surge of that magnitude. In a more comprehensive study of storm surges along the Beaufort Sea coast, Reimnitz and Maurer (1978) estimated that the 10-foot surge observed during the September 1970 storm had not been equaled within the previous 90 to 100 years, again based on recollections of long-time residents.

Waves are generated by wind stress on the water surface. Wave properties such as height and period are functions of wind speed, duration of the wind, and ***fetch*** (length of water surface over which the wind is blowing). Wave heights are limited by water depth, due to friction of the seabed, as evidenced by their breaking as they travel into shallower water near the shoreline. As waves break in shallow water, their energy is dissipated in the water column, thereby providing another mechanism for mixing water mass properties. When waves approach a shoreline obliquely, and break when entering shallow water, an "alongshore" current develops that allows transport of sediment along the shore.

Waves were measured in Lion Lagoon during the summer of 1982 by Kinnetic Laboratories, Inc. (KLI 1983). Due to lack of strong wind events and lingering sea ice, observed wave heights were mostly less than 2 to 3 feet, although one storm event in August 1982 with winds over 20 knots produced waves up to 5 feet in height. Based on modeling conducted for the Point Thomson Project, the maximum breaking wave heights that would be expected under storm conditions are 4.3, 5.6, and 5.2 feet for the West, Central, and East pads, respectively (PND 2009a).

Currents were measured in the passes at each end of Flaxman Island from August through September of 1997 (URS 1999). In Mary Sachs Entrance, currents were generally less than 0.6 knots although, during a strong easterly storm, current speeds increased to nearly 1 knot. In the narrow channel between Brownlow Point and the east end of Flaxman Island, currents typically exceeded 1.2 knots with a maximum recorded value of 1.7 knots. Because actual current measurements in Lion Lagoon are available only for the passes, current speeds elsewhere can be estimated as 2 to 4 percent of the wind speed. Thus, a 30-knot wind would produce surface currents of 0.6 to 1.2 knots. These currents would diminish rapidly with depth.

Ocean processes do not cease during winter when sea ice covers the water column. Sea ice begins to form within Lion Lagoon, and elsewhere along the Beaufort Sea coast, as early as mid-September and almost always by mid-October. During freezeup ice movement is more likely than later in winter when the nearshore ice becomes thicker and landfast, and subsequently bottomfast. Although landfast, this ice may still be dynamic and subject to both wind and water movement. Under-ice observations of currents indicate that, while water movement remains aligned with the bathymetry, it is very slow with speeds generally less than 0.04 knot but with occasional “bursts” as high as 0.2 knot (Berry and Colonell 1985). Generally, within the lagoons along the Beaufort Sea coast, the landfast ice extends from the mainland shore to the barrier islands. By late winter, first-year sea ice along the Beaufort Sea coast is generally about 6.5 feet thick; thus, from shore to about a 7-foot depth, the ice is frozen to the seabed, forming a bottomfast and nearly immovable ice zone.

Wind stress applied to the ice sheet can trigger movement of the sea ice, which in turn can scour both shoreline and the seabed. On shorelines that are exposed to the open sea, onshore winds can push the sea ice onto the beach, producing ice pile up that can reach many meters high and extend inland several tens of meters. Any natural or manmade features exposed to this sea ice push are susceptible to damage. While onshore movement of floating ice is relatively common on exposed coasts, within the lagoons the ice is fairly stable and generally stationary. In Lion Lagoon, only the West Pad location has an exposure that renders it potentially susceptible to ice ride up and pile up and then only when winds blow from the northwest.

River breakup generally begins in early June, preceding sea ice breakup such that freshwater overflows the sea ice. Sea ice melting begins at the surface. Brine pockets that were isolated during freezeup form vertical channels through the sea ice. Meltwater on the surface eventually drains into these brine channels, further eroding and weakening the sea ice. Occasionally, strong vortices form as the freshwater drains through the sea ice cover, resulting in scour pits (called “***strudel scour***”) forming in the seabed.

Breakup of the nearshore sea ice (and within the lagoons) usually occurs by mid-June to early July. By mid-July most of the landfast sea ice has retreated from shore, leaving a band of brackish water along the shoreline. Easterly winds tend to prevail in early summer, driving the sea ice from shore to mingle with the multiyear ice farther offshore. Less common west winds will drive the sea ice back to shore, where it continues to melt and eventually disappear. However, it is not uncommon for ice floes to move into and out of nearshore waters until early August.

3.5.5 Coastal Processes

The term "coastal processes" refers to the combined actions of waves, currents, and water level variations that result in transport of beach sediments along and across the coastal zone which, in turn, is defined as that area of the coast that is subject to modification by these processes. Within the context of "coastal processes," the terms "***accretion***" and "erosion" refer, respectively, to the net addition or reduction of beach materials at a given location.

Along much of the Beaufort Sea coast, the bluffs that typically back the shoreline contain large amounts of ice and fine-grained organic material that is easily floated or transported away by coastal processes. Thus little sediment is actually available to replenish the beach as the bluffs are eroded. Consequently, there is a deficit in the sediment "budget," which results in a net shoreline retreat. Most beaches along the Beaufort Sea coast are erosional, so nearly everywhere within the project area the shoreline is retreating from the ocean, although at rates that vary according to local exposure to wave action.

This shoreline retreat is limited to the open-water period because during winter the beach is frozen and not subject to alteration by liquid ocean processes. However, entrainment of sediments during sea ice formation and their subsequent transport by movements of the ice sheet are also components of coastal processes that alter the beaches and coastline.

Within Lion Lagoon, and specifically along the shoreline at the Point Thomson Project, coastal processes are somewhat muted by the presence of Flaxman Island and the other barrier islands. Except at that portion of the mainland shore immediately opposite Mary Sachs Entrance, sediment transport rates are not large or dramatic.

The shoreline is characterized primarily by fine-grained soils, which are prevalent along most of the Alaska Beaufort Sea coast. These soils erode more rapidly than coarse-grained material such as that on the beaches of the Chukchi Sea (Hopkins and Hartz 1978).

The erosion process due to wave action at a shoreline is the combination of an alongshore response and a cross shore response parallel and perpendicular to the shoreline, respectively. Waves almost never arrive at the shore perpendicular to the beach so a component of wave action is applied parallel to the beach face. It is this parallel, or alongshore, component that moves sediment along the beach. Whether the sediment actually moves and what cross-shore profile develops is a function of the slope and composition of the beach material. Very fine-grained material produces a broad nearly flat beach face, while coarse material supports steeper beach angles and the formation of a berm or "step" at the back beach.

Arctic beaches introduce unique characteristics that impact both the erosion rate and the beach profile. Generally, permafrost underlies the beach, with the frozen horizon situated less than 3 feet below the surface. Under severe wave action conditions, the overlying material can be stripped away by the waves such that the permafrost zone is exposed. The frozen soil is more resistant to erosion than its unfrozen counterpart but the erosion process depends on both mechanical abrasion and thermal degradation. A permafrost-eroded beach will typically produce a vertical escarpment at the seaward limit of the storm splash zone, or if the shoreline is bluffed, significant undercutting of the bluff face can occur. The erosion of a beach underlain by permafrost is more episodic than an unfrozen beach because the waterline may hold its position for extended periods of time, appearing to be stable, and then undergo large episodic shifts as the berm face collapses due to the undercutting and melting of the permafrost. The collapsed bluff material is then transported away over time.

In the project area the shoreline is characterized as "soft," being comprised of largely fine-grained soils and gravels. No natural hard points or rock outcroppings occur. Therefore, anything artificially introduced as a hard point, or nonerosive structure, has the potential to disrupt or modify the natural littoral response of the shoreline to wave and sea ice interaction.

Average annual and maximum rates of shoreline retreat, termed "erosion rates," were determined at selected locations within the project area by analysis of aerial photography dating back to 1955 (PND 2009a). At each of the selected locations (i.e., the projected locations of the West, Central, and East Pads), several transects were established to measure erosion rates between successive aerial photographs. Two erosion rates were determined for each pad location (Table 3.5-2):

1. *Average annual* erosion rate over 53 years (= 2008 shoreline location minus 1955 location, divided by 53 years; and
2. *Maximum erosion rate* observed in *any* of seven available time spans between aerial photographs (1955 to 1977, 1977 to 1982, 1982 to 1991, 1991 to 1997, 1997 to 2001, 2001 to 2006, and 2006 to 2008) for each transect.

The reason for calculating two erosion rates for each location was to demonstrate the highly variable nature of the measured shoreline retreats, which showed little consistency between locations and also exhibited no consistent trends over time. For example, some of the greatest erosion on the West Pad shoreline occurred from 1955 to 1991 with recent photos showing a steadier, lower rate.

Table 3.5-2: Erosion Rates as Determined from Historical Aerial Photography

Location	Erosion Rates (ft/yr)	
	Average Annual Rate	Maximum Rate
West Pad	4.1	14.8
Central Pad	1.2	6.3
East Pad	2.0	5.3

The higher erosion rates at the West Pad location are indicative of the greater exposure to Beaufort Sea waves afforded by Mary Sachs Entrance. However, even these erosion rates are small, by nearly an order of magnitude, when compared to rates seen along sections of the Beaufort Sea coast that are exposed to the open ocean. For example, Reimnitz and Kempena (1987), Jones et al. (2009), and others have reported average annual rates of erosion of 25 to 50 feet/year for sections of the Alaska coastline that are exposed to the full force of the Beaufort Sea.

Extrapolation of the erosion rates listed in Table 3.5-2 in order to estimate the amount of erosion that might occur during a future period must be done with caution. With the reduction in the summer arctic sea ice cover attributed to global warming, there has been a concomitant increase in the "fetch" over which waves are generated by the prevailing winds. Upon presenting themselves at Mary Sachs Entrance, these waves, being longer and higher than those generated under lesser fetch conditions, have greater erosive capability due to their greater energy. Also, the reduced summer sea ice cover results in a longer open-water season during which the more energetic waves are capable of exerting their erosive power over exposed shorelines.

Despite ongoing shoreline erosion, the barrier islands that protect the coast adjacent to the project site are as "permanent" as any along the Alaska portion of the Beaufort Sea coast. Flaxman Island is the barrier island that provides the main defense of Point Thomson Project area against the Beaufort Sea. PND (2009a, Figure 4.2) provided a qualitative evaluation of shoreline changes in the Point Thomson area by overlaying the 1974 and 1996 editions of NOAA Chart 16045 (OCS 1996). While some changes in its shoreline are evident, the overall geometry and size of Flaxman Island remained essentially the same over the 22-year interval between chart editions. Additional confidence in the integrity of Flaxman Island may be gained by examination of the chart prepared by Ernest Leffingwell, who explored the region and documented its geology early in the 20^{th} century. Leffingwell's chart, from his USGS report (Leffingwell 1918), was included in PND (2009a, Figure 4.1). Leffingwell's representation of Flaxman Island is remarkably similar, if not nearly identical, to the present form of the island.

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3.6 HYDROLOGY

The study area for hydrology extends west from the Canning/Staines River to the Sagavanirktok River and south from the Beaufort Sea to the extent of the major rivers, only two of which extend into the Brooks Range.

3.6.1 Key Information About Hydrology

Surface water bodies provide habitat for listed species and other species important to the North Slope ecosystem. Surface water is also the primary source of water for domestic, construction, and industrial use.

Three major drainages are located in the western portion of the study area: the Sagavanirktok (5,570 square miles [mi^2]), Kadleroshilik (586 mi^2), and Shaviovik (1,555 mi^2) Rivers. Smaller streams between the Shaviovik and Staines Rivers originate on the Canning River fan and are completely within the ACP. Drainage areas of these smaller streams range from 0.2 to 95.6 mi^2.

Low flow on the North Slope is usually at or near zero during December or January for major rivers and earlier for smaller streams. The flooding regime for rivers in the study area is dominantly snowmelt-driven, in which more than half of the annual flow is observed in late May through mid-June. Streams draining the Brooks Range and the Arctic Foothills (AF) also have the potential to produce significant summer precipitation-driven flood discharges. Sediment transport in North Slope river systems is limited to a short period of time throughout the year, particularly for streams originating on the ACP where peak flows are generated during snowmelt breakup and summer precipitation peaks are not expected.

Streams originating on the ACP, such as smaller streams on the Canning River fan, are not expected to produce large ice floes or ice damming because these streams are typically dry during late fall and early winter, when the ice would form. Major rivers such as the Sagavanirktok, the Kadleroshilik, and Shaviovik, which are expected to sustain winter baseflows, have higher potential for ice dams and ice debris during spring breakup than smaller streams.

Thaw lakes (lakes formed when water melts and collects on the ground surface, above an unbroken permafrost layer) occur in abundance across the ACP and are one of the dominant ACP terrain features. Thaw lakes occur more often in the western ACP than in the eastern ACP. There have been no evaluations of pumping effects and recharge for lakes within the study area.

Shallow seasonal interstitial groundwater occurs in contact with thaw lakes, rivers, and streams. These shallow bodies of groundwater are isolated, and do not form a water table, even seasonally. The permafrost layer serves as a barrier to surface recharge.

3.6.2 Review and Adequacy of Information Sources for Hydrology

Hydrology studies of the Point Thomson study area have been sponsored by the State of Alaska, USGS, UAF, and oil companies. Data have been collected sporadically based on potential construction projects. No systematic area-wide hydrologic survey has been conducted in the study area. There are no peer-reviewed publications of hydrology for this area. Studies from other areas of the ACP provide basic hydrologic background and comparison.

Table H-6 in Appendix H discusses the publications, reports, and data available for hydrology related to the proposed project. Full references for the studies cited in this Draft EIS are in Chapter 9, References.

3.6.3 Physiography

Three hydrologically distinct ***physiographic*** provinces generally characterize the North Slope of Alaska: ACP, AF, and the Central and Eastern Brooks Range (Sloan 1987). The ACP is divided into two sections: the Teshekpuk to the west, which is flat and contains the project area, and the White Hills to the south and east, which is characterized by low hills that rise above the plain (Wahrhaftig 1965). Based on broad-scale observation, the occurrence of lakes is more prominent within the Teshekpuk compared to the White Hills.

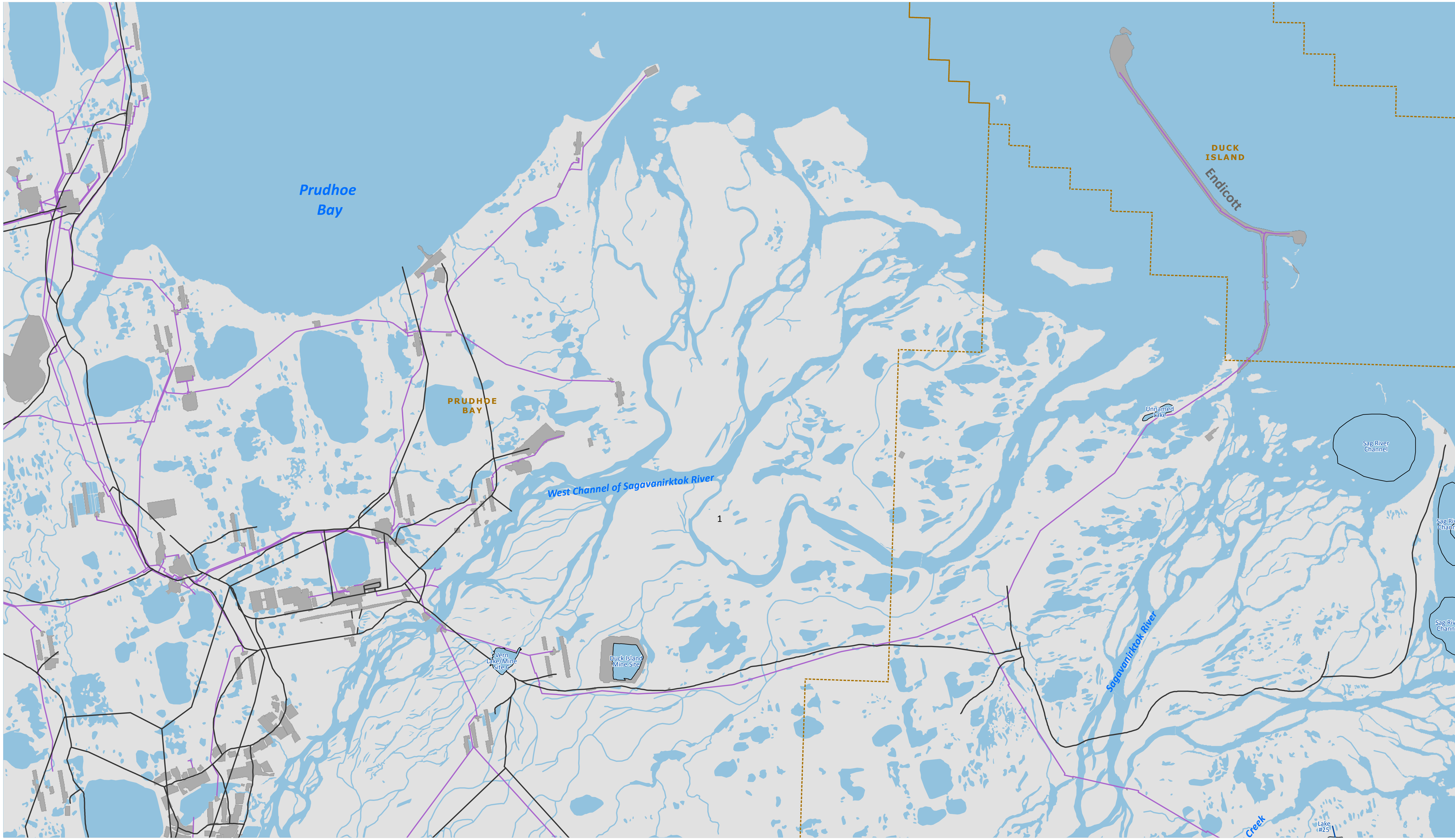
The project area extends from the Staines River on the eastern edge to the Sagavanirktok River on the west. The setting of the project area within the ACP physiographic province contributes to the hydrologic setting. Major rivers, such as the Sagavanirktok River, have headwaters in the Brooks Range. The Staines River is a distributary of the Canning River, which also defines the boundary of the Arctic Refuge. All the streams between the Canning River and the Shaviovik River originate on the Canning River fan, with the Canning/Staines River flowing over the eastern, active portion of the fan, and the Shaviovik River flowing across the western relict portion of the fan (Rawlinson 1993). The apex of the fan is near the boundary between the AF and the White Hills section of the ACP. Section 3.1.3 presents the geomorphology of the Canning River fan in greater detail.

3.6.4 Streams and Rivers

3.6.4.1 Watersheds Included in the Project Area

The western part of the project area contains portions of major watersheds (also referred to as drainage basins) drained by the Sagavanirktok, Kadleroshilik, and Shaviovik Rivers (shown on Figure 3.6-1, Figure 3.6-2, and Figure 3.6-3). These are the only rivers in the project area with drainage basins extending beyond the ACP. The Sagavanirktok River watershed is the largest, approximately 5,570 mi^2, with its headwaters extending high into the Brooks Range (PND 2009c). The Kadleroshilik River watershed (586 mi^2) extends only a short distance into the Brooks Range foothills and mostly drains the ACP. The Shaviovik River watershed (1,555 mi^2) drains a portion of the Brooks Range (HEL 1982). In the project area, the Kadleroshilik River has a floodplain up to 4,000 feet wide with an active floodplain 800 to 1,500 feet in width, while the floodplain of the Shaviovik River is up to 2 miles wide with a 1,500 to 2,000-foot-wide active floodplain (PND 2009c). Larger rivers have active gravel bars and braided deltas, indicating that they transport a significant volume of sediment.

Smaller streams between the Shaviovik and Staines Rivers originate on the Canning River fan and are within the ACP as shown on Figure 3.6-4. The areas drained by these streams range from 0.2 to 95.6 mi^2 (PND 2009b). Larger ACP streams have gravel bars and well-defined banks, while smaller streams may flow through shallow grass-lined swales or exhibit poorly defined or ***beaded channels***.



POINT THOMSON
PROJECT EIS

Legend

- PND 2009 Stream Survey Sites
- MBJ 1998 Stream Survey Sites
- Road
- Existing Pipelines
- Oil and Gas Development Unit
- Existing Facilities and Roads
- Arctic National Wildlife Refuge
- Potential Water Sources for Ice Roads

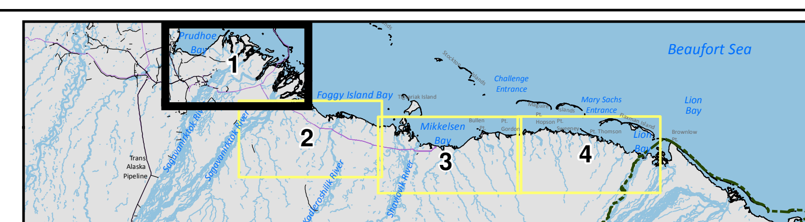


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Figure 3.6-1

Surface Water Hydrology
Sheet 1 of 4

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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POINT THOMSON PROJECT EIS

Legend

- PND 2009 Stream Survey Sites
- MBJ 1998 Stream Survey Sites
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- Existing Pipelines
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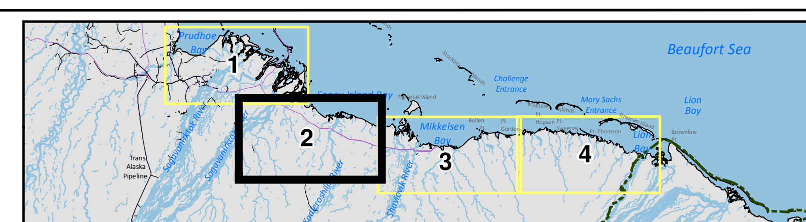

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Figure 3.6-2

Surface Water Hydrology
Sheet 2 of 4

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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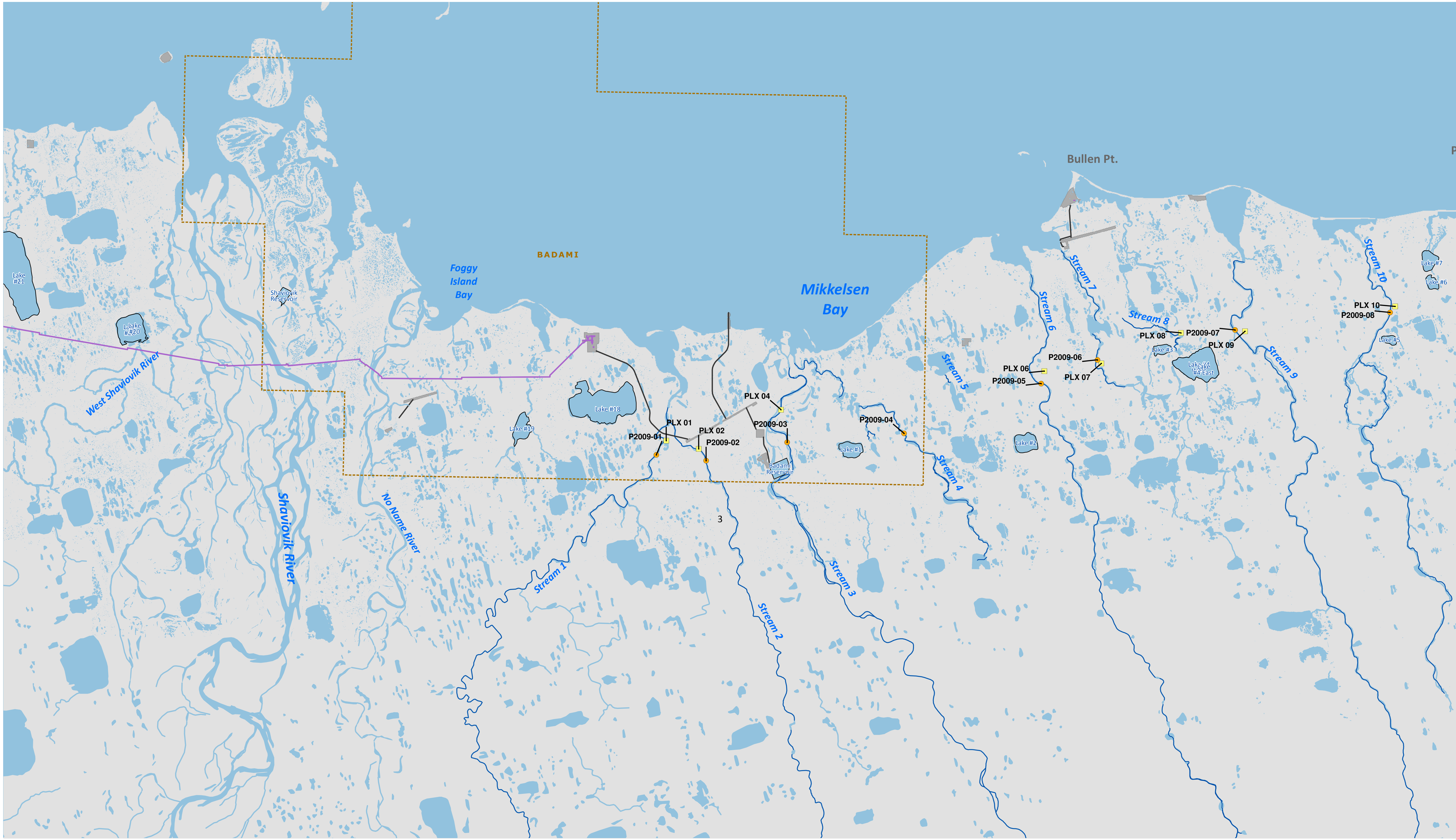

POINT THOMSON PROJECT EIS

Legend

- PND 2009 Stream Survey Sites
- MBJ 1998 Stream Survey Sites
- Road
- Existing Pipelines
- Oil and Gas Development Unit
- Existing Facilities and Roads
- Arctic National Wildlife Refuge
- Potential Water Sources for Ice Roads

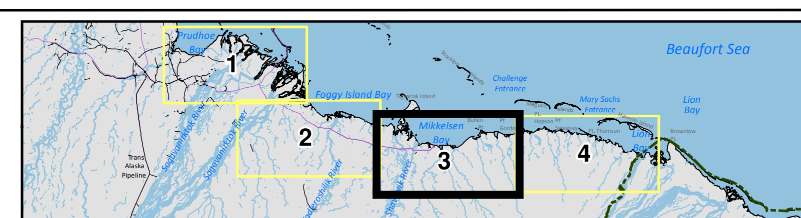

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Figure 3.6-3

Surface Water Hydrology
Sheet 3 of 4

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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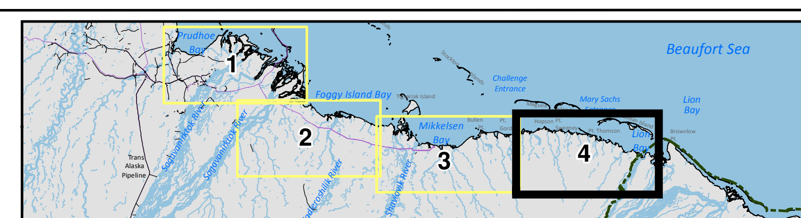
Legend

- PND 2009 Stream Survey Sites
- MBJ 1998 Stream Survey Sites
- Road
- Existing Pipelines
- Oil and Gas Development Unit
- Existing Facilities and Roads
- Arctic National Wildlife Refuge
- Potential Water Sources for Ice Roads



0 1 2 Miles

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Figure 3.6-4

Surface Water Hydrology
Sheet 4 of 4

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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Characteristics for smaller streams on the Canning River fan are presented in Tables I-1 and I-2 of Appendix I. Data summarized are primarily from studies conducted from 1998 through 2010 (MBJ 1998, URS 2003, PND 2009b, and WorleyParsons and PND 2010). The nomenclature for these streams differed between the studies, as there is not a conventional method established for naming the smaller streams found in these areas on the North Slope. Also, no individual study inclusively identified the same set of streams. Therefore, this EIS presents stream names that were determined to include all streams addressed in the above references. The naming convention numbers streams from west to east, which follows the trends by MBJ (1998) and PND (2009b). Figure 3.6-3 and Figure 3.6-4 show stream and stream measurement locations. All stream measurement locations from PND (2009b) are shown, but only locations from MBJ (1998) are shown where survey benchmark spatial coordinates are provided.

3.6.4.2 River Discharge Process

Streamflow on the North Slope generally follows a trend of being at or near zero during December or January; earlier for smaller streams. Low flow is followed by snowmelt runoff, during which more than half of annual flow is observed in late May and early June (Sloan 1987). Review of continuous flow records from North Slope rivers leads to some generalizations about streamflow patterns. Berezovskaya et al. (2008) consistently observed that melting snow starts contributing to runoff in streams in the southern foothills in May and melting on the ACP lags about a month later.

Discharge processes for basins of varying size may be compared by normalizing the discharge by the drainage area (i.e., the total surface area upstream of a point on a stream, where the water from precipitation that is not absorbed into the ground flows over the ground surface and through stream channels to reach that point), resulting in a metric described as unit runoff. The highest average unit runoff occurs in the mountains, while the lowest is observed on the ACP. This trend is consistent with precipitation patterns. Streamflow begins earliest in the spring in the mountains, and also persists longer in the fall in those longer rivers originating in the mountainous provinces (Sloan 1987). Figure 3.6-5 presents annual hydrographs, plotted as unit runoff, for three rivers with long-term datasets maintained by the United States Geological Survey (USGS). The gage for the Sagavanirktok River was at an elevation of 1,000 feet above mean sea level, approximately 60 miles from the coast with a drainage area of 2,208 mi^2. The gages for the other three rivers were located at the coast, with a gage elevation of less than 20 feet above sea level (NGVD 29; USGS 2010b). The Kuparuk River has a drainage area of 3,130 mi^2 and flows to the coast west of Prudhoe Bay. The mouth of the Putuligayuk River is also west of Prudhoe Bay and is situated between the Kuparuk and Sagavanirktok drainages. It is much smaller, at 176 mi^2. Nunavak Creek, located near Barrow, is the westernmost and smallest drainage, with a drainage area of 2.79 mi^2. These hydrographs show the distinct pattern of winter low flow, snowmelt-driven peak, and summer precipitation-driven peaks.

The Putuligayuk River is more representative of the smaller drainages originating on the ACP, although it is larger than those within the Canning River fan. Kane et al. (2009) suggest the Putuligayuk River has a low runoff ratio during the summer due to summer precipitation going to storage, rather than direct runoff. This is consistent with Sloan's (1987) finding that lowest unit runoff is observed on the ACP. Figure 3.6-5 illustrates this concept, showing the lack of a summer precipitation-driven peak for the Putuligayauk compared to the much higher summer peak flows of the Sagavanirktok, with significant contributing drainage area in the Brooks Range. The Sagavanirktok River gage is also at a higher elevation of 1,000 feet, with little to no contributing area on the ACP. The USGS gage at Sagwon captures nearly 40 percent of the total Sagavanirktok River drainage area, which is 5,570 mi^2 (PND 2009c).

The annual hydrographs at the USGS gage stations upstream in the drainage, at Sagwon and near Pump Station 3, exhibit different characteristics than the hydrograph at the delta. Daily flow data from 1988 at the Pump Station 3 gage was compared to the West Channel bridge (on the Endicott Road) and shows the delta is likely to experience relatively greater magnitude spring breakup peaks. Also, the rainfall peaks at the upper gages may be attenuated before reaching the delta, which appears to be an approximate 1 day lag between gages. This relationship was confirmed by data from 1982, 1985 to 87, and 1989 to 90 (PND 2009c).

The flow distribution between the West and East Channels at the Sagavanirktok River delta averages 50 percent. The diversion at the West Channel between 1982 and 1990 ranged from 35 to 75 percent of the total flow (PND 2009c).

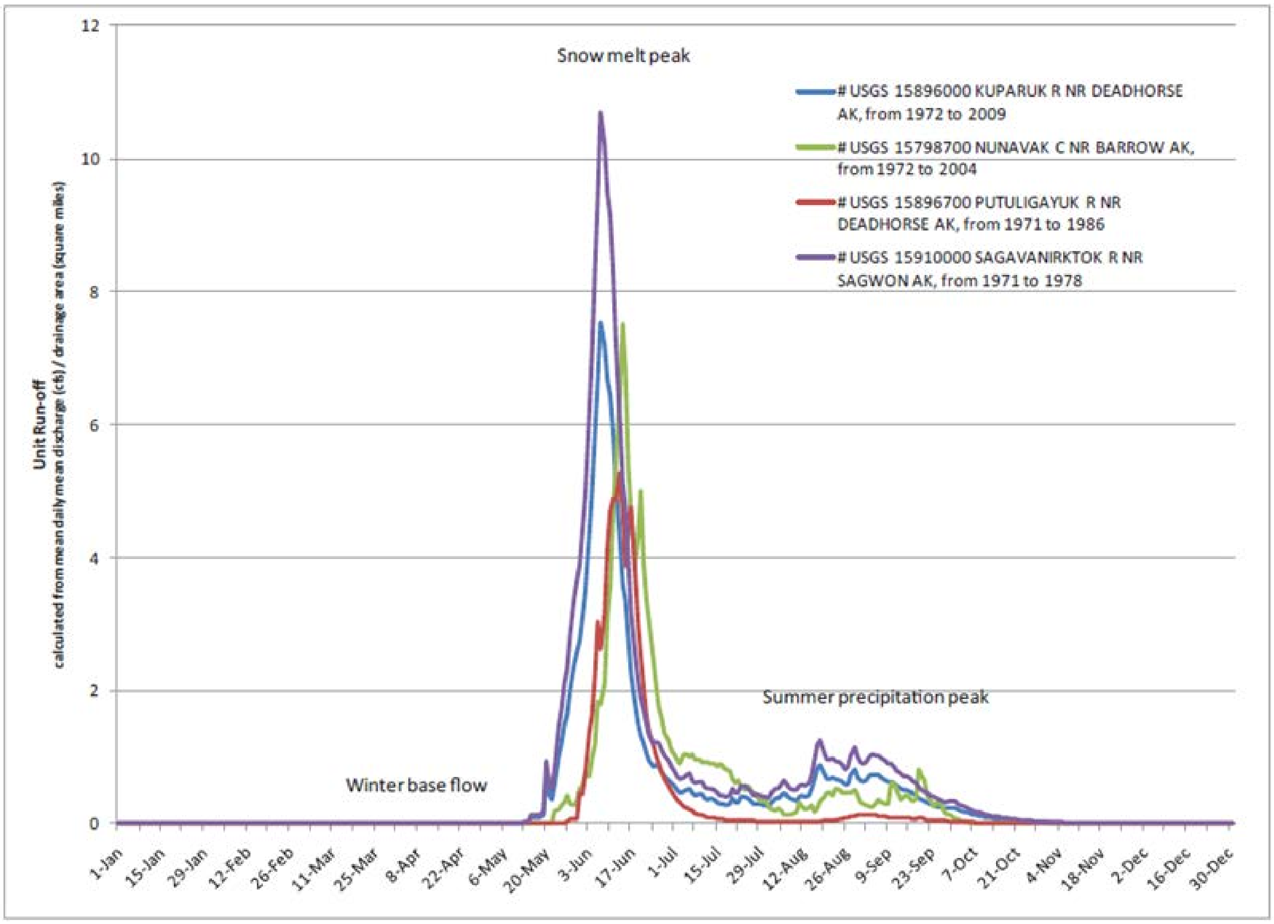

Figure 3.6-5: Annual Hydrograph for Four Gaged Drainages on the North Slope

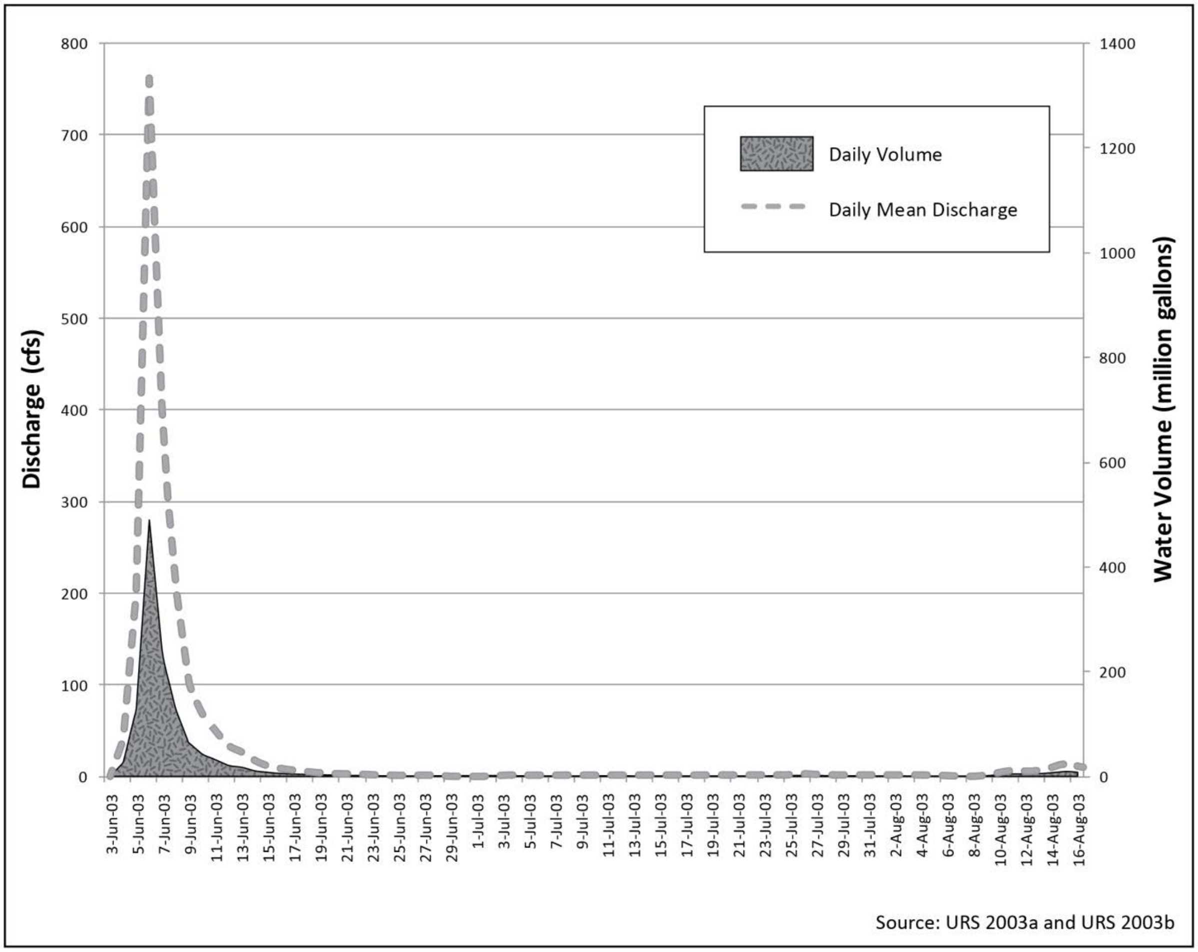

Figure 3.6-6: Stream 24 Hydrograph

3.6.4.3 Flooding Regime

Flooding regime for rivers in this area is dominantly snowmelt-driven, as shown by Figure 3.6-5 and Figure 3.6-6. This is particularly the case for smaller streams within the Canning River fan that originate on the ACP, and should display an annual hydrograph similar to the Putuligayuk River.

Streams draining the Brooks Range such as the Sagavanirktok River have the potential to produce significant summer precipitation-driven flood discharges. Streams draining the AF may also produce summer peak flows. The USGS (2010b) provides peak flow measurements for the Sagavanirktok River near Sagwon from 1969 to 1979. Of these 11 measurements, seven are likely snowmelt peaks. The highest peak recorded, at 34,900 cfs, was in August 1969, which would be due to summer rain events. The USGS (2010b) maintains a much longer peak discharge record for the Kuparuk River near Deadhorse, spanning from 1971 through 2009. Of these 39 records, only one peak flow falls outside of May 20 to June 15 time frame of snowmelt-driven peak flows.

Of the four USGS gauging station records presented, the Shaviovik River annual hydrograph characteristics are most comparable to the Kuparuk. The Kadleroshilik River will most likely produce less pronounced summer peak flows, because the contributing drainage area includes very little of the Brooks Range.

3.6.4.4 Flood Frequency Predictions

PND (2009c) performed flood frequency analyses for both the USGS gage near Pump Station 3 and at the delta using the West Channel flow data. Rainfall and breakup events were analyzed separately and compared. Spring breakup events result in greater peaks for both stations; however, the breakup peaks at the delta are relatively greater magnitude, confirming the comparison of the annual hydrographs.

PND (2009c) estimated breakup flood frequency and magnitude for the West Channel. Assuming the East and West Channels each carry approximately 50 percent of the total stream flow, the West Channel peak flows are assumed to be relevant to the East Channel. Flood frequency for the Sagavanirktok River East Channel determined from the flood frequency regression equations USGS Bulletin 17B Table 3.6-1 presents these predicted peak flows for recurrence periods ranging from 2 years to 200 years (PND 2009c).

Table 3.6-1: Flood Peak Discharge Estimates for the Sagavanirktok River East Channel

River Name	Drainage (sq. mi.)	Annual Flood-Peak Discharge (cfs)[a]			
		2-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)	200-Yr (cfs)
Sagavanirktok River	-	22,000	87,000	107,000	130,000

Source: USGS Bulletin 17B estimated flows using PEAKFQ. Sagavanirktok River flow distribution by east/west channel are based on assumed 50 percent flow distribution (PND 2009c).

Estimated peak discharges for the majority of the streams on the Canning River fan are provided in Table I-3 of Appendix I for recurrence periods ranging from 2 years to 500 years. These estimates were determined using the regression equations and methodology described in Curran et al. (2003) and based on measured data from 2010 (WorleyParsons and PND 2010). This table also contains peak discharge estimates from previous studies (MBJ 1998).

3.6.4.5 Sediment Erosion, Transport, and Depositional Processes

Sediment transport processes in North Slope river systems are limited to a short period of time throughout the year. The period of sediment transport is particularly limiting for streams originating on the ACP where peak flows are expected to be generated during the snowmelt breakup event and summer precipitation peaks are not expected.

McNamara et al. (2008) concluded that insufficient information exists to determine if rain events and snowmelt-driven events of equal magnitude would transport comparable material. Investigators have suggested, but not tested, that less sediment is available for transport during snowmelt breakup events due to ice and frozen banks (McNamara et al. 2008). However, it has also been suggested that ice plays an important role in sediment transport in arctic streams (Hodel 1986).

River systems originating in the Brooks Range will typically have a higher sediment load than those originating in the AF or ACP. The Sagavanirktok River, described as a braided system in its lower reaches, would likely have the greatest sediment load of the drainages in the study area. The Kadleroshilik River originates in the AF and is generally braided. The Shaviovik River has headwaters in the Brooks Range, but the majority of the drainage area is in the AF (CH2MHILL 2005). These rivers are expected to have greater sediment load than those streams originating on the ACP as supported by observations of the streambed and large unvegetated areas of the active channels.

Peak flows often occur when the ground is frozen during spring breakup, resulting in minor channel modification. Rainfall-driven peak flows causing scour, bank erosion, channel enlargement, and the formation of new channels have been observed. Up to 220 feet of bank erosion on the Sagavanirktok River occurred during an August 1992 rainfall flood (PND 2009c). Major channel development was documented in 1982 when part of the East Channel shifted to the West (PND 2009c).

Flows great enough to shape channel braids and gravel bars on the Kadleroshilik and Shaviovik Rivers have occurred when sediment is thawed, either from rainfall events or the receding limb of the spring breakup peak.

3.6.4.6 Ice Conditions

The ACP typically begins to freeze in September, with ice continuing to thicken until May. There is little winter baseflow below river and lake ice on the ACP (Brewer 1987). Seeps and springs that flow throughout the winter typically freeze upon emerging from the ground, forming thick sheets of aufeis, instead of running down stream channels (Kane et al. 2009).

From mid-September through May, most precipitation falls as snow. Late in May, temperatures rise above freezing and snow begins to melt. Snowmelt dates vary by year, and have been recorded on the ACP from May 24 to June 12 (Kane et al. 2009).

On average, 40 percent of the annual precipitation falls as snow and runs off into streams during a 1- to 2-week melting window. The rapid release of such a large volume of water leads to overbank flooding of the shallow drainage network. Two additional conditions may lead to large amounts of sheetflow (shallow meltwater runoff not contained in stream channels). First, streams and rivers that have water in them in September typically freeze to the bottom. This is true even of larger rivers such as the Shaviovik and Canning Rivers, which have been observed to freeze to the bed except in isolated deep potholes. Those that do not have water in them often drift in with dense, wind-packed snow during the winter (Brewer 1987). When meltwater begins to run, the stream channels are partially clogged with ice and snow and have very little conveyance, as observed during snowmelt measurements and observations (WorleyParsons and PND 2010). The second factor is the freezing of the thin active layer of soil in the fall. Where there is moisture in the active layer in the fall, it will be frozen and runoff will remain aboveground during snowmelt. Where the active layer is dry in the fall, it will provide some meltwater storage during spring runoff and sheetflow will not be as extensive.

When meltwater beings to run over the top of river ice in the spring, it erodes the ice, breaking it into pieces and eventually flushing it downstream. This ice may lodge in constricted parts of the channel, creating jams and forcing more water out of the stream channel.

Streams originating on the ACP, such as smaller streams on the Canning River fan, are not expected to produce significant ice floes or ice damming because the streams are typically dry during late fall and early winter. Major rivers such as the Sagavanirktok, the Kadleroshilik, and Shaviovik, have higher potential for ice dams and ice debris during spring breakup.

3.6.4.7 Lakes

Thaw lakes are abundant across the ACP. Many villages and other sites on the North Slope rely on the lakes as their primary water supply. They are also an important source for the construction of ice roads. They are the most available source in terms of access (Sloan 1987). The principal obstacle to using lakes as water supply is that most freeze to the bottom if they are less than 6 feet deep. Prospective users must apply for a water use permit with the ADNR. The ADNR sets permit limits for each source but no amount of water or proportion of water is guaranteed to a permitted user. As part of the permit requirements, the permitted user must show that the water source has sufficient recharge to support the amount of water being withdrawn.

Myerchin et al. (2008) evaluated three sites: two former gravel pits and one natural lake. The two gravel pits, Badami and Shaviovik, now serve as reservoirs and are shown as potential water sources under temporary water use permits (TWUP) in Figure 3.6-4. These were much deeper than the lake, about 18 and 14 feet deep, respectively. The lake was located between the Sagavanirktok and Kalderoshilik Rivers, farther to the west of the reservoirs. Under-ice water was not present in the lake; therefore, no measurements were recorded. The study concluded that gravel mining sites may serve as important reservoirs for winter water use if located in areas with adequate recharge.

Based on depth measurements in April or May of 2002, 2006, 2007, and 2008, only three reservoirs or lakes out of 19 that were studied had not frozen to the bottom within the Canning River fan (AIC 2002, White et al. 2006, Myerchin et al. 2008). These were: the former Badami gravel pit, Lake W0612, and Lake W0709 (Lake #17 North). Lake W0612 had a depth of 0.4 feet in 2006, but was dry in 2007. Lake W0709 had a depth of 0.5 feet in 2002 and 1.5 feet in 2007; the measurements were from different locations in the lake. Lake W0709 is located upstream of Stream 24a.

Kane et al. (2009) summarized physical measurements from numerous studies between 2006 and 2009, finding only two natural lakes and the two reservoirs (Badami and Shaviovik) to maintain under-ice water throughout winter that are also listed as TWUP-potential water sources. These natural lakes are identified as “Lake #22” and “Lake #17 North” in Figure 3.6-4. Table 3.6-2 presents water volume estimated by Kane et al. (2009).

Table 3.6-2: Physical Parameters from Select Lakes and Reservoirs with Measurable Water Under Ice (>4 inches) at End of Winter

Lake Designation[a]	Alternate ID (Presented as TWUP[b] potential water sources)	Region	Estimated Area (mi^2) [a]	Average Under-Ice Depth (feet)	Average Ice Thickness (feet)	Estimated Under-Ice Volume (million cubic feet)	Estimated Under-Ice Volume (million gals)
W0708	Lake #22	Bullen	0.277	0.69	4.89	17.30	131
W0709	Lake #17 North	Bullen	0.271	1.02	5.38	25.43	189
Badami	Badami Reservoir	Bullen	0.037	13.09	6.63	44.50	332
Shaviovik	Shaviovik Reservoir	Bullen	0.021	15.22	5.58	28.96	217

[a] USGS National Hydrography Dataset (Kane et al. 2009).
[b] Temporary Water Use Permit.

Lake water level changes in response to pumping were detectable and corresponded with calculated estimates of water-level changes for lakes west of the project area (Hinzman et al. 2006). Adequate recharge was monitored by confirming surface water level rose such that the outlet flow became active. Hinzman et al. (2006) observed no measurable negative effects of winter pumping on the lakes and the water use practices were in place at the time of the study. Pumping is conducted during winter months, so adequate recharge for this study was assumed to occur the following spring, summer, and/or fall before the next winter. Investigators surveyed lakes for recharge by observing water levels at lake outlets from May to June of 2003, 2004, and 2005. Snow pack was quantified; however, lakes in this study are located west of the Sagavanirktok River, which is west of the project area. No evaluations of lake recharge related to the effects of pumping on lakes within the project area were obtained for review.

Reservoir water levels at both the C-1 and Shaviovik pits were monitored with pressure transducer data loggers in 2010 to evaluate recharge (WorleyParsons and PND 2010). Observations suggest reservoir levels at both locations recharge from spring breakup surface runoff and flow through polygon cracks. Water levels in both subsequently decreased, the C-1 pit decreased greater than the Shaviovik pit, which was attributed to evapotranspiration. The studies did not quantify water withdrawal from either reservoir during the previous winter season.

3.6.5 Subsurface Water

3.6.5.1 Shallow Groundwater

Shallow seasonal interstitial groundwater is present within the project area. These shallow bodies of groundwater are in contact with thaw lakes, rivers, and streams. They are isolated and do not form a water table, even seasonally. The permafrost layer is considered a barrier to surface recharge (ADNR 2006). The permafrost thins offshore to the north, but the Sagavanirktok Formation (comprising fine-to-medium grained sandstone and bentonitic shale, as described above) dips and grades into the deeper marine facies of the Canning Formation to the north, forming an additional recharge barrier.

The frozen, fine-grained, and saturated conditions that typify the permafrost make it a confining layer that prevents percolation and recharge from surface water sources, and restricts movement of groundwater. This is manifested in the great number of lakes and poorly-drained areas present throughout the ACP. Because percolation and recharge are restricted, the formation of usable subsurface water resources is limited to soil zones above the permafrost (supra-permafrost soils), taliks (thawed zones) beneath relatively deep lakes, and hyporheic zones (thin zones of mixing of surface water and shallow groundwater) present in thawed sediments below major rivers and streams. In the project area, shallow supra-permafrost groundwater occurs seasonally within the active freeze-thaw zone above the impervious permafrost. The thickness of the active layer is typically 1.5 feet, but ranges from 1 foot under dense organic mats, to 4 feet in coarse-textured soil (Gryc 1988, Rawlinson 1993).

Sloan (1987) reported more than 50,000 exploration holes have been drilled on the North Slope to about a 100-foot depth, with few reports of groundwater. Thaw bulbs, which typically occur near stream watercourses, major rivers, and some deep lakes, have been used as water sources. Artificial thaw bulbs have been created by inducing thawing of shallow alluvium to access shallow groundwater. A number of case examples indicate that both surface water of a river and groundwater contribute to thaw bulbs. Alyeska Pipeline Service Company created these artificially thawed zones of shallow groundwater, or water galleries, at Franklin Bluffs, Happy Valley, and Pump Station 3 camps during pipeline construction. Some were successful; some were not, due to dewatering. The connection between rivers and adjacent shallow groundwater (also described as the hyporheic zone) in these instances is indicated by pools in a river being noticeably dewatered by pumping from galleries, subsequently decreasing overwinter storage in the river channel (Sloan 1987). Deep groundwater is addressed in Section 5.1, Geology and Geomorphology.

3.6.5.2 Springs

Springs are the discharge of groundwater at the surface. Sloan (1987) reported 36 major springs across the North Slope. The majority of the springs occur in the Brooks Range near the boundary of the AF physiographic province, but only one, along the Shaviovik River, was located in the project area. Few springs occur on the ACP, and no springs were shown on the Canning River fan in the Sloan (1987) study.

3.7 WATER QUALITY

The study area for marine and freshwater water quality extends from the Canning/Staines River west to the Sagavanirktok River. On the east side at the Staines River, the southern boundary is approximately 9 miles south of the coast and extends west to the Shaviovik River, where the boundary gradually shifts toward the coast until it meets the Sagavanirktok River approximately 4 miles from the coast. The northern boundary extends approximately 5 miles offshore.

3.7.1 Key Information About Water Quality

Knowledge of existing water quality conditions is important in determining potential impacts of proposed actions. Water quality in the study area is good. No marine or freshwater bodies are listed as impaired. No elevated concentrations of trace metals, nitrogen, or hydrocarbons have been detected in freshwater bodies or water sampled from Lion Bay.

Increased turbidity is typically observed during spring breakup as sediments, plant material, and other organic materials are flushed into the water system. During the peak discharge, Alaskan arctic streams can transport more than 80 percent of the total suspended sediments for the year.

In the study area, surface water would be the likely source of potable water. Treatment would be required by the State of Alaska Drinking Water Regulations and must meet primary standards and secondary standards for odor and taste.

Temperature and salinity in the Beaufort Sea varies depending on location and time of year. Sea ice typically begins to form in late September. Ice cover remains on the Beaufort Sea until spring breakup, which generally occurs in June in the freshwater rivers and streams. This results in sea ice melting first near the mouths of rivers and streams. The Canning/Staines River is the major freshwater input into Lion Bay in the project area. At the beginning of the open-water season there is a stratified water column that has a freshwater layer resulting from sea ice melt and freshwater runoff, up to 13 feet thick, over a marine water layer. During the summer, these layers mix together and the water gradually becomes more saline.

3.7.2 Review and Adequacy of Information Sources for Water Quality

Water quality studies of the Point Thomson study area have been sponsored by the State of Alaska and oil companies. Data have been collected sporadically based on potential construction projects. No systematic area-wide water quality survey has been conducted in the study area. There are no peer-reviewed publications of water quality for this area.

Table H-7 in Appendix H discusses the publications, reports, and data available for water quality that are cited in the EIS and their relevance to the proposed project. Full references for the studies cited in this EIS are in Chapter 9, References.

3.7.3 Regulations

The CWA is the primary law governing water pollution in U.S. waters protected under the CWA and includes all navigable waters and all waters with a “significant nexus” to navigable waters. Because the watershed of the proposed project drains directly into the Beaufort Sea (which is a navigable water of the U.S.), all surface waters are considered protected under the CWA. The CWA includes a wide array of requirements for maintaining water quality; only water quality standards and discharge of wastewater are discussed in this section.

Section 303(d) of the CWA lists the regulations for determining if any water body in any state is impaired for its designated uses. Each state is required to list those water bodies that do not meet water quality standards and establish a Total Maximum Daily Load (TMDL) for each parameter that is impairing the water body. The ADEC Division of Water is in charge of identifying and establishing TMDLs within Alaska. According to the ADEC, no marine or freshwater bodies are listed as impaired in the project area (ADEC 2010b).

All water bodies in the project area are designated for all uses, which include water supply, water recreation, and growth and propagation of aquatic life, and must meet the most stringent water quality criteria under Alaska Administrative Code (AAC) 18 AAC 70. In addition, water quality values must be compared to the Chronic Aquatic Life Criteria located in the ADEC *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances* (ADEC 2008a).

3.7.3.1 Water Quality Standards

The CWA contains requirements that water quality standards (WQS) must be established and water bodies must be monitored to determine if the water bodies meet the set standard. The EPA is in charge of ensuring that all WQS set by states are at least as stringent as the federal standards. ADEC is responsible for setting and regulating WQS for the State of Alaska.

There are three parts to a WQS: designated uses, water quality criteria, and antidegradation provisions. Protected water use classes in Alaska include the following:

- Freshwater:
  - Water supply
  - Water recreation
  - Propagation of fish, shellfish, other aquatic life, and wildlife
- Marine water:
  - Water supply
  - Water recreation
  - Propagation of fish, shellfish, other aquatic life, and wildlife
  - Harvesting for consumption of raw mollusks or other raw aquatic life

In the State of Alaska, all water bodies are designated for all protected water use classes unless otherwise stated (18 AAC 70.050). The antidegradation provision sets forth regulations that must be followed when addressing proposed activities that could degrade the existing uses of a water body, a high quality water body, and outstanding national resource waters.

3.7.3.2 Water Discharges

The CWA does not allow discharge of pollutants from a point source to the waters of the U.S. unless a discharge permit from the proper regulatory authority has been obtained. The permits set limits for various pollutants that a source can discharge at any given time. The effluent limits are included in the permit and are based on the more stringent of the technology-based or the water quality based standards for discharges. The State of Alaska is responsible for administering these permits through the APDES, which is required to comply with federal regulations.

The discharge of treated domestic wastewater to surface water requires a discharge permit from ADEC. The type of permit needed depends on whether discharge occurs in fresh (AKG-57-0000) or marine (AKG-57-1000) waters. Water discharges during construction require a separate permit (AKG-33-0000). Only activities specified in the permit are allowed. These permits require monitoring of specific parameters such as pH, turbidity, dissolved oxygen (DO), hydrocarbons, and other parameters as required by ADEC.

3.7.3.3 Safe Drinking Water Act

Like the CWA, the SDWA, enacted in 1974 and amended in 1986 and 1994, also sets standards to ensure the quality of drinking water. The SDWA is overseen by EPA, but is implemented and followed by local, state, and other drinking water suppliers.

The SDWA has two sets of drinking water standards—primary and secondary. Primary standards must be met unless states are issued variances or exemptions. The primary standards include contaminants such as arsenic, mercury, and cadmium. In most cases concentrations of the contaminant cannot exceed the Maximum Contaminant Level (MCL) or a violation occurs.

Secondary drinking water standards pertain to the aesthetic qualities of the drinking water supply (odor, color, zinc, etc). These standards are not federally enforceable but were set up as guidelines for the states.

3.7.4 Freshwater

Several thaw lakes and ponds along the coastal area and near the pad locations are influenced by saline water from storm surges, ocean spray, and inundated troughs (microlows) connecting the Beaufort Sea estuaries to coastal lakes. Lakes and ponds farther away from the coast are influenced by connections to one another through polygonal patterned ground complexes (see section 3.2.3) with inundated troughs throughout most of the summer season (Ping et al. 1998). They also are subject to surface runoff and flooding during spring breakup and precipitation events, which is the natural recharge mechanism for these lakes and ponds.

Streams in the project area are influenced by spring breakup, precipitation events, surface runoff, and by saltwater intrusion from the Beaufort Sea. They have little groundwater influence due to the permafrost conditions that exist in the soils (Sloan 1987).

Concentrations of TDS in both lakes and streams in the project area increase the closer they are to the Beaufort Sea. Upstream conductivity values indicate freshwater. Near the mouth where the stream empties into the bay, conductivity values indicates mixing of freshwater with marine waters. Closer to the coast, they tend to be dominated by sodium chloride (ocean-derived salt). Farther from the coast, water bodies are dominated by calcium bicarbonates, indicative of freshwater.

The seasonal effect of freeze-thaw cycles plays a major role in water quality on the North Slope. In winter, lakes shallower than 7 feet typically freeze to the bottom. The lakes in the project area vary in size and depth, but tend to have large surface areas and are shallow—averaging nearly 6.5 feet of ice. When water is found at greater depths, the concentration of suspended solids can be 30 times higher than in summer months (Hobbie 1980). There are previous gravel mine sites that have become reservoirs in the project area that do not completely freeze to the substrate in the winter due to the depths being greater than the naturally formed lakes. DO concentrations tend to be supersaturated when the ice forms, but over the winter months the concentrations are depleted by the oxygen demands of decomposition of organic matter that is present in the sediments of the lakes (Prentki et al. 1980).

During spring breakup, snow and ice melt brings lakes and streams back to their natural water levels and inundate the polygonal ground complexes with microlows in the project area. Lake volumes are largely dependent on the size of the drainage basin, runoff characteristics, amounts of precipitation, and amount of evaporation from the water surface. Stream discharge is a function of the volume of ice frozen in channels and drainage basin runoff. During peak discharge, high-sediment loads can affect water quality parameter concentrations (e.g., lower DO concentrations, higher metals concentrations). In many streams the leading edge of the meltwater can be seen moving downstream and results in bank overflow due to snow blockages (MBJ 1998).

3.7.4.1 Turbidity and Total Suspended Solids

Turbidity is cloudiness caused by small particles of solid matter suspended in water. It is measured by the amount of scattering and absorption of light rays caused by the particles and is reported in NTUs (Brooks et al. 2003). TSS, measured in mg/l, is a water quality parameter that refers to the weight of solids suspended in water that can be removed by a filter.

Turbidity measurements can be affected by many factors, including sediment load, organic matter concentration, particle size the stream discharge can carry, the season, and the amount of plant material in the riparian zone of the streams. The highest turbidity concentrations are typically observed during spring breakup event when discharge is high and overground runoff occurs. Sediments, plant material, and all other organic materials flushed into the water system are the primary causes of increased turbidity during breakup or high-flow events.

During the peak discharge that comes with spring breakup, Alaskan arctic streams and rivers can transport more than 80 percent of the total suspended sediment load for the entire year (Rember and Trefry 2004). Suspended solids and sediments have receptor sites on their surface where trace metals and organic carbon are attached. During spring breakup, when peak discharge of water occurs, suspended solids and organic carbon concentrations are transported downstream— an important part of the hydrologic cycle in the area (Trefry et al. 2009). During the rest of the year, suspended solid transport is relatively low.

3.7.4.2 Alkalinity and pH

Alkalinity is the quantitative capacity of water to neutralize an acid; that is, the measure of how much acid can be added to a liquid without causing a significant change in pH (Brooks et al. 2003). The pH is a measure of the degree of the acidity or the alkalinity of a solution as measured on a logarithmic scale of the relative concentrations of hydrogen and hydroxide ions (pH scale) of 0 to 14 standard units. The value of 7.0 on the pH scale represents neutrality. Values below 7.0 indicate acidity; values above 7.0 indicate alkalinity (Brooks et al. 2003).

In the project area, pH levels in the streams are near neutral to slightly alkaline: ranging from 7.35 to 8.32 standard units (Winters and Morris 2004). The pH is likely being buffered by the calcium bicarbonate concentrations, which could explain the slightly alkaline conditions. These values are consistent with those found in other areas of the North Slope. During spring breakup, the lower pH of snowmelt causes alkalinity to decrease; however, once spring high flows are over and water decreases, alkalinity will increase (i.e., higher pH) and continue to increase throughout the winter as water levels are lowered even further in ice conditions.

The lake pH values are slightly alkaline (about 8.2) in late September (URS 2002). During the winter months, the pH in the lakes that contain water (typically man-made reservoirs) can range between 6 and 7

(Myerchin et al. 2007, Chambers et al. 2008). The pH values of project area water bodies are within the ADEC Water Quality Standards for aquatic life in freshwater (6.5 to 8.5 standard units; 18 AAC 70).

3.7.4.3 Dissolved Oxygen

Two measurements often are provided for a water body to determine DO levels. The first is the concentration of DO in mg/L. This provides the concentration that is actually in the water body. The second is the percent saturation, which provides the percent of oxygen that the water body is holding compared to what it is capable of containing based on temperature, pressure, and TDS. In the Arctic, water tends to have higher concentrations of DO because temperatures are lower and the solubility of oxygen increases with decreasing water temperature. As the TDS concentrations increase in the streams in the project area, the DO concentrations decrease (Dodds 2002). During the summer months, these streams can have DO concentrations that range from 8.2 to 11.9 mg/L, with saturation percentages ranging from 82 to 98 percent (Winters and Morris 2004).

In the winter, DO concentrations in lakes and ponds are high when ice is first formed. As winter progresses, however, the DO concentrations can decrease due to oxygen requirements for decomposition of organic matter that is present in the sediments of the lake and pond bottoms, and for consumption by fish if any are present. In the project area, winter DO concentrations in lakes containing water were measured as low as 2.59 mg/L— a concentration that is unsuitable for most anadromous and resident fish. DO concentrations are depleted as winter progresses, thus making the lakes unsuitable for most fish (Myerchin et al. 2007). The biochemical oxygen demand (BOD) of most of the water bodies sampled in the project area was relatively low or nondetectable, except for water bodies that were smaller and surrounded by vegetation, which could create higher concentrations of organic material on the sediments in the water bodies (URS 2002). In the project area the lakes tend to be shallow with a large bottom and large sediment-to-water interface, which can cause the quality of liquid water under ice to be largely controlled by the ***benthic*** characteristics (Hobbie 1980, Prentki et al. 1980, Chambers et al. 2008).

According to WQS for Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife, DO concentrations must be greater than 7 mg/l in waters used by anadromous and resident fish (18 AAC 70). Water bodies that are not fish habitat but contain other aquatic life (such as aquatic invertebrates and aquatic vegetation) must have a concentration greater than 5 mg/L (18 AAC 70). The project area water bodies classified as lakes or streams had concentrations exceeding the water quality standard for DO except for a few water bodies in the winter that retained liquid water toward the end of the winter season. In most cases during the summer, DO concentrations exceeded the standard.

3.7.4.4 Potability

A potable water supply is a water supply that meets EPA and/or state water quality standards and is considered safe and fit for human consumption (Brooks et al. 2003). In the project area, surface water would be the likely source of potable water. Treatment would be required by the State of Alaska Drinking Water Regulations (18 AAC 80) and must meet primary standards as well as the secondary standards for odor and taste.

The project area surface water is likely to contain fecal coliform from intestinal waste from varying animal sources. The ADEC Division of Environmental Health advises that all surface waters in Alaska should be treated before consumption because of the likely contamination (ADEC n.d.).

3.7.4.5 Hydrocarbons

The project area contains exposed coal seams along river channels and natural shale outcrops that could release natural levels of hydrocarbons into nearby water bodies (Steinhauer and Boehm 1992). Hydrocarbons were not present at or above method detection limits in fresh and brackish water samples collected in 2002 (URS 2002). Records of petroleum spills and other potential sources of contaminants in the vicinity of the project area are discussed in Section 3.24, Contaminated Sites and Spill History.

3.7.4.6 Trace Metals

Trace metal concentrations in waters within the project area are variable throughout the year. Maximum concentrations of dissolved trace metals occur during spring breakup due to overland flow. Water in the area has longer residence times after spring breakup due to the permafrost layer inhibiting flow down through the soil. This leads to leaching of minerals and metals from the soils. The water remains on land areas as ice throughout the winter and then is flushed out of the system during spring thaw (Trefry et al. 2009).

In 2002, URS sampled total concentrations of arsenic, barium, chromium, lead, nickel, and zinc. Arsenic, chromium, and nickel were not detected in any of the freshwater samples collected. Barium concentrations in freshwater samples ranged from 20.0 to 56 µg/L. Lead concentrations ranged from 0.117 to 0.795 µg/L. Zinc was not detected at nearly half of the freshwater sampling locations and ranged from 12.6 to 37.2 µg/L at the other locations. All of the trace metal concentrations were in compliance with applicable surface and drinking water quality standards (URS 2002).

3.7.4.7 Organic Nutrients

Nitrogen was found in the form of ammonia from samples taken from the project area during 2002. The only sites that had detectable concentrations were part of the polygonal ground complex with microlows. The concentrations ranged from 0.22 to 0.48 mg/L, which is in compliance with the water quality standards for fish that are present in early life stages (URS 2002).

Nearly half of the annual total concentration of dissolved organic carbon is transported downstream during peak flows at spring breakup (Rember and Trefry 2004). Within the project area, the Canning/Staines River originates in the mountains and is fed by glaciers and snowfields; consequently, it typically has lower concentrations of organic carbon (Rember and Trefry 2004). A majority of the streams and rivers in the project area originate in the tundra and contain higher concentrations of organic carbon. In the project area, beaded streams and small ponds contained concentrations of total organic carbon from 8.8 to 34.6 mg/L (URS 2002).

3.7.5 Marine Water

3.7.5.1 Temperature and Salinity

Marine water is defined as having a concentration of ocean derived salts greater than 0.5 parts per thousand (ppt) (Cowardian et al. 1979). Temperature and salinity in the Beaufort Sea can vary depending on location. In the project area, temperatures can range from 30°F to 37°F (Craig 1984). Sea ice can begin to form in late September and the sea can be completely frozen by October, with approximately 7.5 feet of ice by April, after which the ice starts to recede again in May (Weingartner 2009). Ice cover typically remains on the Beaufort Sea until spring breakup, which generally occurs in June in the freshwater rivers and streams. This results in sea ice melting first near the mouths of rivers and streams. Under the ice, the water column is well mixed, with temperature fluctuating around 29°F and high salinity (32.4 ppt). The currents under ice are typically slow moving (about 0.16 ft/sec) and weakly sheared and have no effect from the wind (Weingartner et al. 2005).

At the beginning of the open-water season, the water column along the coast consists of a freshwater layer resulting from sea ice melt and freshwater stream runoff, which can extend as deep as 13 feet, over a marine water layer (URS 1999). Wind stress at the water surface transfers momentum down into the water column, resulting in wind-driven currents and vertical mixing of the layers (Colonell and Niedoroda 1990). Vertical mixing is further enhanced by turbulence from wind waves. Periods of varying winds cause rapid mixing in shallow areas. As the open-water season progresses, coastal waters become colder and more saline as solar strength and freshwater input diminish (Colonell and Niedoroda 1990).

In addition to protecting the coast from sea storms, the offshore barrier islands also play a role in fresh, brackish, and marine waters mixing in the Lion Bay area. The Canning/Staines River is the major freshwater input into the bay in the project area. The barrier islands act as a natural barrier for brackish water entering the greater Lion Bay marine environment (URS 2000). The water between the shore of the mainland and the barrier islands is referred to as Lion Lagoon because of this natural barrier to the rest of Lion Bay.

The Sagavanirktok and Shaviovik Rivers are located in the western portion of the project area, approximately 40 miles from Lion Bay. The freshwater discharged from these rivers can also have an influence on the salinity of the marine environment when the wind currents originate from the west. The freshwater moves east along the surface and shoreline and thoroughly mixes with marine water at lower depths to become brackish water by the time it reaches Lion Bay (URS 1999).

3.7.5.2 Turbidity and Total Suspended Solids

During spring breakup, turbidity and total suspended solids (TSS) concentrations are usually at their highest due to runoff from watersheds and peak discharges being able to carry a high sediment load downstream and into the marine environment. Coastal erosion also has a large influence throughout the open-water season on turbidity values and TSS concentrations. Summer turbidity readings taken in 1998 ranged from 1 to 173 NTU, with the highest reading taken in an area that was just more than 3 feet deep (URS 1999). TSS concentrations averaged 43.3 mg/L in the areas sampled and the maximum concentration was 79 mg/L (URS 1999). In winter under-ice conditions, wind is not a factor in stirring up the sediments that could increase turbidity or TSS. There can be under-ice water movement that would occasionally cause bottom sediments to be introduced into the water column, but with slow-moving currents documented in the lagoon area, turbidity concentrations would be lower than values observed in the summer.

3.7.5.3 Dissolved Oxygen

During summer months when the Beaufort Sea is free of ice, the DO concentrations have been documented to range between 9.5 and 14.1 mg/L (URS 1999). In winter, BOD continues due to oxygen requirements by marine biota and for decomposition of organic materials, but the oxygen and carbon dioxide exchange between atmosphere and water cease due to thick ice conditions. Winter samples were taken in Foggy Island Bay west of Lion Bay. The concentrations found in under-ice conditions ranged from 7.4 to 13.2 mg/L (Montgomery Watson 1998). Depending on ice cover and circulation patterns, the DO concentrations could remain in a range that is conducive to overwintering for many fish species.

3.7.5.4 Hydrocarbons

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

3.7.5.5 Trace Metals

Trace metals naturally occur in the Beaufort Sea and are introduced from coastal erosion, freshwater inputs, and atmospheric deposition. The background concentrations of trace metals in Lion Bay are relatively low or below detection limits. During 1998, trace metals were analyzed in water samples from Lion Bay. Of the metals analyzed (arsenic, barium, chromium, lead, and mercury), only barium was detected. Barium concentrations ranged from 0.015 to 0.020 mg/L. There are no aquatic life water quality standards in a marine environment for barium (URS 1999).

Arsenic, barium, cadmium, chromium, lead, magnesium, nickel, and zinc were analyzed in two marine water samples collected from Lion Bay in the project area in 2002 (URS 2002). Arsenic and nickel were not detected. The other metals were detected in at least one of the samples at concentrations that were in compliance with water quality standards.

3.8 VEGETATION AND WETLANDS

The study area for vegetation and wetlands extends from near the Staines River in the east to the Endicott Spur in the west. Within this region, the study area is specifically focused on vegetation and wetlands mapping conducted for the Point Thomson and Badami projects. Mapped areas include terrestrial and marine areas in and near where infrastructure is proposed for all alternatives, including 1,000-foot transportation corridors between Point Thomson facilities and the Endicott Spur.

3.8.1 Key Information About Vegetation and Wetlands

Vegetation in the study area is dominated by sedge and dwarf shrub species that are tolerant of the soil's cold and high-moisture conditions. The vegetation cover is low and individual species do not grow taller than 6 inches.

The presence of permafrost and the area's freeze/thaw cycles influence the type of vegetation able to grow in the study area. Permafrost thaws in the active layer to shallow depths, and plants with shallow root systems are the only species that can grow.

No federally-listed threatened or endangered plants are known to occur on the ACP. Fourteen species ranked as imperiled or critically imperiled by the Alaska Natural Heritage Program (ANHP) potentially occur in the study area, but none were observed during vegetation surveys conducted in the study area.

The most common cover class types found in the study area were water bodies, wetlands, and uplands. Wetlands occupies the most land area by far (71 percent), followed by water bodies (29 percent), and uplands (less than 1 percent).

The dominant wetland cover classes in the Point Thomson study area include wet tundra (28 percent), moist tundra (22 percent), and moist/wet tundra complexes (17 percent.) Table 3.8-1 describes the cover classes common in Point Thomson study area wetlands.

Table 3.8-1: Table Wetland Cover Classes found in the Point Thomson Study Area

Class	Description
Wet tundra	Occupies wetter environments such as drained lake basins and poorly drained river terraces. Typically characterized as saturated or inundated emergent and scrub-shrub wetland. Ranges from saturated to permanently flooded.
Moist tundra	Covers broad expanses of open tundra above shallow water tables. Moist tundra is characterized as saturated wetland, dominated by scrub-shrub and emergent vegetation.
Wet/moist complex	Includes areas of tundra with a mosaic of wet and moist tundra, generally with moist ridges dominated by dwarf shrubs and wetter basins dominated sedges. Common in drier portions of drained lake basins and on poorly drained river terraces. Wet/moist tundra complexes are generally characterized as saturated or inundated emergent and scrub-shrub wetland, ranging from seasonally saturated to permanently flooded.

Wetlands serve important biological and ecological functions and support key bird, terrestrial mammal, and fish habitat within the study area. Some of the most prevalent functions served by wetlands in the study area include:

- Flood flow moderation and conveyance
- Production and export of organic matter
- Maintenance of soil thermal regime
- Waterbird support
- Resident and diadromous fish support

3.8.2 Review and Adequacy of Information Sources for Vegetation and Wetlands

Comprehensive vegetation mapping for the North Slope is available (Raynolds et al. 2006), which is at a 1:4,000,000 scale that is useful for regional assessment and comparison but higher resolution mapping is required for this NEPA assessment at the scale of the Point Thomson study area.

Higher resolution vegetation and wetlands data on the North Slope are most often collected on a project-specific basis by oil and gas companies. Vegetation and wetlands data are typically consistent among studies because all follow the northern Alaska tundra classification system developed by Walker (1983).

Four field surveys have been performed within the study area to document vegetation and wetlands (Schick and Noel 1995, Noel and Funk 1999, Noel and Funk 2001, OASIS 2010, and HDR 2011i). In addition to the field studies, OASIS (2009) and HDR (2011i) extended vegetation mapping based on aerial photograph and GIS analysis. These vegetation studies are limited to areas where gravel and ice infrastructure has been proposed. The eastern study area has the greatest portion of continuous coverage because of proposed infrastructure in this area.

Table H-8 in Appendix H discusses the publications, reports, and data available for vegetation and wetlands that are cited in this Draft EIS and their relevance to the proposed project. Full references for the studies cited in the Draft EIS are in Chapter 9, References.

3.8.3 Study Area Vegetation and Wetlands Types and Mapping

Vegetation of the ACP is dominated by species tolerant of cold and high-moisture conditions. Small topographic differences affect soil moisture which, in turn, strongly affects the vegetation of any site. Margins of thaw lakes, drained thaw lake basins, ice-wedge polygon troughs, and low-centered polygons, all features common to the study area, tend to be saturated throughout the growing season and have high-moisture tolerant species, including sedges or grasses occupying lower wetter areas, and dwarf scrub communities occupying areas with better drainage (Gallant et al. 1995).

A 64,356-acre subset of the total mapped area comprises the study area for vegetation and wetlands. An atlas of the study area vegetation mapping is included in Appendix J; because most of the study area is wetland or water body, this detailed mapping is the wetland and water body mapping as well.

Mapped vegetation types have been classified using a hierarchical tundra vegetation classification scheme designed specifically for northern Alaska (Walker 1983). This classification method categorizes map unit types by both moisture regime and dominant plant growth forms, and incorporates information on physiognomy (e.g., tundra, shrublands, barren), plant growth form (e.g., tall/low/dwarf shrub, herb, lichen), hydrologic regime (e.g., tidal, aquatic, wet, moist, dry), site chemistry (e.g., saline, alkaline), landform (e.g., pingo, high-centered polygon, river terrace, beach), microrelief (tussocks, ***strangmoor***, polygonal ground), interspersion of vegetation types and water regimes, and plant species. Land cover types were mapped and labeled according to Walker's Level C for photo interpreted maps with field-verified data. HDR expanded Walker's classification system by distinguishing among water body types (ocean, stream, lake, pond). Existing map unit types were then grouped into common cover classes, and reclassified (ExxonMobil 2009b) into National Wetland Inventory (NWI) classes (Cowardin et al. 1979) using plant and water regime descriptions (see Table J-1 in Appendix J, Mapped Land Cover and Wetland Types). Physical descriptions of the map unit types were taken from Schick and Noel 1995; Noel and Funk 1999 and 2001; OASIS 2009 and 2010; and HDR 2011i.

Twenty-eight map unit types occur in the study area; twenty-five of these are water bodies or wetlands. Water bodies include unvegetated intertidal and subtidal bays and inlets, rivers, streams, lakes, ponds, and their associated barren mud flats, gravel bars, and drained lake basins. Water bodies and their associated barrens occupy approximately 29 percent (18,354 acres) of the study area. Wetlands are defined as "areas that are inundated or saturated by surface or groundwater 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…" (51 FR 41251). Wetlands occupy approximately 71 percent (45,796 acres) of the study area. Areas not classified as water bodies or wetlands are considered uplands. Uplands occupy less than one percent (205 acres) of the study area. When a vegetation or unvegetated cover type could be wetland or upland, it is assumed to be wetland for this EIS analysis, so the listed acreages of wetlands in the study area are overestimates. The map unit types, NWI classifications, and descriptions are further described in Table J-1 in Appendix J.

3.8.3.1 Water Bodies

Water bodies constitute 29 percent of the study area. They include areas of open water (26 percent), river gravels/beaches (2 percent), wet mud (1 percent) and bare peat (less than 0.1 percent) associated with lakes, ponds, and coastal areas. For detailed information about water bodies in the study area, see Section 3.6, Hydrology.

3.8.3.2 Wetland Vegetation

This section provides a general overview of wetlands vegetation in the study area. For details on vegetation classification, correlation to the NWI classification, dominant plant species and prevalence in the study area, see Table J-1 in Appendix J. Common, scientific, and Inupiaq names for plant species are presented in Appendix B.

The dominant wetland cover classes in the study area include wet tundra (28 percent), moist tundra (22 percent), and moist/wet tundra complexes (17 percent).

Wet tundra is dominated by wet/moist sedges and dwarf shrubs, and occupies wetter environments such as drained lake basins and poorly drained river terraces. Wet sedges dominate this tundra type, but better drained rims and ridges of patterned ground features such as low centered polygons and strangmoor are dominated by moist sedges and dwarf shrubs. Small intermixed patches of aquatic sedges and grasses may occur in flooded areas. Large complexes of wet and moist tundra occur, with interspersed areas of open water. Wet tundra is generally characterized in the NWI classification system as saturated or inundated emergent and scrub-shrub wetland, with a water regime ranging from saturated to permanently flooded.

Moist tundra is dominated by moist sedges and dwarf shrubs. This type covers broad expanses of open tundra elevated above the shallow water table. Well-developed high-centered polygons with distinct troughs and flat-topped polygons with more subtle high and low-centered polygons and poorly developed troughs characterize this type. Moist polygon centers are the dominant landform, occupied by sedges and ***tussock***-forming cotton-grass. Dwarf shrubs (willows and entire leaf mountain avens) and various forbs dominate the high centers and polygon rims. Frost boils occur in some locations, resulting in barren and partially vegetated areas. Moist tundra is characterized in the NWI classification system as saturated wetland, dominated by scrub-shrub and emergent vegetation.

Large mosaics of moist/wet tundra complexes occur in areas of open tundra and are common in drier portions of drained lake basins and on poorly drained river terraces. Patterned ground is widespread and moist sedges and dwarf shrubs dominate areas with better drainage, including weakly developed strangmoor ridges. Wet sedges dominate lower areas and aquatic sedges and grasses may occur in flooded areas. Mixed high and low centered polygons with extensive thermokarst troughs are interspersed with lakes and ponds. High centered polygons may be dominated by dry, dwarf shrubs and fruticose lichens. Similar to the expanses of wet tundra, moist/wet tundra complexes are generally characterized in the NWI classification system as saturated or inundated emergent and scrub-shrub wetland, with water regimes ranging from seasonally saturated to permanently flooded.

The cover of salt marsh vegetation communities within the study area is minor (1 percent). This community type is located in coastal areas at the mouths of rivers and streams and is populated by salt-tolerant sedges, grasses, and forbs. These areas are subject to locally varying intervals of flooding by brackish water. Large patches of unvegetated intertidal sediments may be present. Also included in this community are areas slightly further inland that are subject to intermittent inundation by saltwater. In these locations, non-salt-tolerant vegetation has been killed and these areas are dominated by a sparse cover of salt-tolerant species.

Several other minor (less than 5 percent) map unit types are classified as wetlands or water bodies. While the term "dry" is used in the names of vegetation types, some of these communities are dry only relative to other communities on the ACP. General descriptions of these types are presented in Table J-1 in Appendix J.

3.8.3.3 Upland Vegetation

Less than one percent of the study area is upland (nonwetland). These areas include unvegetated gravel roads and exploratory pads and sand dunes. Vegetation or unvegetated cover types that could be wetland or upland are assumed to be wetland for this EIS analysis. In addition, vegetation types that may be a mosaic of upland and wetland are considered wetland for this analysis. For example, the vegetation types commonly associated with well drained areas such as pingos and low ridgetops are also found on the tops of well developed high center polygons; because the troughs between the high polygon centers are wetlands, the vegetation types have been included as wetlands for this analysis. Upland areas serve as well-drained components in mosaics of wetland habitat. The diversity of plant species found in naturally occurring vegetated or partially vegetated uplands is typically higher than in the surrounding wetlands. These areas are also used as denning habitat by foxes, bears, and small mammals (ground squirrels, lemmings, and voles).

3.8.4 Threatened/Endangered and Sensitive Plant Species

No federally-listed threatened or endangered plants are known to occur on the ACP (USFWS 2011a). The ANHP maintains a database of rare vascular plant species, which includes global and state species status ranks. Plants ranked as critically imperiled (S1) or imperiled (S2) in Alaska that could occur in the study area include *Cardamine microphylla* aff. *microphylla*, *Draba subcapitata, Draba micropetala, Draba pauciflora, Erigeron muirii, Erigeron ochroleucus, Mertensia drummondii, Pedicularis hirsuta, Pleuropogon sabinei, Poa hartzii* ssp. *alaskana, Puccinellia vahliana, Ranunculus sabinei, Saxifraga aizoides*, and *Symphyotrichum pygmaeum* (Carlson et al. 2006, ANHP 2008, Lipkin 2010). None of these listed species were observed during vegetation surveys conducted for the study area.

3.8.5 Wetland Functions

HDR scientists prepared a functional assessment for the study area wetlands (Appendix K, Wetland Functional Assessment) based on pertinent scientific literature and project-specific data and analyses of resources associated with wetlands. HDR scientists selected the functions to evaluate based on industry standards, consideration of natural processes that occur on the ACP, and their estimation of the wetland-related resources of most concern to NEPA and permitting agencies. They also chose and defined the functions with the objective of differentiating among wetlands; for example, if virtually all the wetlands in the study area would perform a certain function, HDR scientists redefined the function to identify just the wetlands performing the function at a higher magnitude or to identify the part of the function most dependent on the wet nature of a wetland.

The evaluated functions are listed and defined in Table 3.8-2, and the acreage estimated to perform this function (as specifically defined for this project) is also shown. The assessment method rests on assumptions that each wetland function is associated with certain landforms and geomorphic positions, flooding conditions, connections with water bodies, vegetation types, and proximity to the sea. Certain combinations of these features at a site indicate that the function likely occurs there. Note that many functions are not specific to wetlands, but may also occur in nonwetland areas; in some cases, the function occurs in a certain location, such as on a floodplain, regardless of whether the underlying ground is wet or dry. Note also that the regulatory process typically entails analysis of wetland functions, but not necessarily the equivalent processes that occur in nonwetland water bodies. For the wetland functions evaluated for this project, if a water body would perform the same function, it was also ascribed the function. However, scientists did not separately consider any functions specific to water bodies.

Some ubiquitous wetland functions are not addressed by the project assessment method. These are described in more detail in the functional assessment report. Study area wetlands absorb snowmelt and rainfall, particularly after breakup when the soil is thawed and the water table partly drawn down by evaporation and plants' transpiration of water to the atmosphere. Much of the rain that falls on the coastal plain during the summer is retained in the soils and on the surface of wetlands, never reaching streams, and this moderates stream flows. All of the study area wetlands provide habitat to communities of native plants and animals adapted to life in an arctic environment. At snowmelt, when water flows over much of the coastal plain, some of the organic matter produced in wetlands is washed overland into other aquatic ecosystems, where it provides energy and nutrients to other organisms. In many wetlands, organic matter accumulates as peat soil because the wet and cold conditions slow decomposition. Lower layers of peat may become perennially frozen. The carbon of undecomposed organisms is held in the soil until conditions warm or dry, when it may be decomposed and be released back to the atmosphere.

Maps in Appendix J show locations within the study area ascribed each of the evaluated functions. The acreage determined to perform each of the evaluated functions is presented in Table 3.8-2, along with the percentage of the study area that acreage comprises. Note that any wetland area may perform multiple functions, so the acreage performing wetland functions sums to more than the total study area size. Five percent of the study area did not perform any of the evaluated functions, or did so to a negligible degree, according to the assessment method.

Table 3.8-2: Acreages of Wetlands and Water Bodies Performing Each Evaluated Function in the Study Area

Wetland or Water Body Function	Function Definition	Acreage Performing Function in Study Area (acres)	Percent of Study Area
Flood Flow Moderation and Conveyance	A wetland's reduction of peak flows in streams by temporarily storing or slowing water passage en route to stream channels or by retaining the water without later release downstream. This function does not include the absorption of snowmelt and precipitation in soil.	18,187	28
Shoreline and Bank Stabilization	Wetland vegetation's role in binding substrates and dissipating erosive forces of moving water in the form of waves, tidal water flow, and stream bank overflow. Also, barrier islands' and coastal beaches' role in dissipation of wave force.	4,672	7
Maintenance of Natural Sediment Transport Processes	The natural processes of entrainment of particulates by flowing water, transport of particulates to downstream and coastal areas, and deposition of suspended particulates generated at natural sources. This function does not include capture or retention of airborne particulates or coastal sediment transport processes.	14,171	22
Production and Export of Organic Matter	A high-level of production of organic carbon via photosynthesis and consumption of that material by microbes, and subsequent flushing of this organic matter to downstream ecosystems where it may support various trophic pathways. This definition does not include transport of organic materials during the early snowmelt period of widespread sheetflow across the tundra.	18,558	29
Maintenance of Soil Thermal Regime	The role of wetland soil and vegetation in maintaining a stable soil thermal regime, as indicated by presence of permafrost, surface topography, and soil moisture typical of the site's plant community.	39,641	62
Waterbird Support	The capacity of a wetland or water body to provide a high or moderate level of support to waterbird species.	36,103	56

Table 3.8-2: Acreages of Wetlands and Water Bodies Performing Each Evaluated Function in the Study Area

Wetland or Water Body Function	Function Definition	Acreage Performing Function in Study Area (acres)	Percent of Study Area
Terrestrial Mammal Support	The capacity to support denning, foraging, movement, and insect escapement behavior of terrestrial mammals of cultural or subsistence interest. As noted in Appendix K, this function definition does not include wetlands' production of vegetation as a food sources because that is a ubiquitous wetland function.	4,398	7
Resident and Diadromous Fish Support	Wetlands and water bodies known or suspected to directly support freshwater or diadromous fish by providing habitat at some life stage. Diadromous fish include both amphidromous and anadromous fishes, which migrate between freshwater and saltwater environments.	24,607	38
Threatened or Endangered Species Support	Wetlands and water bodies known or suspected to provide important habitat to spectacled eider or having the potential to provide polar bear denning habitat or identified as critical habitat.	—	—
Spectacled Eider	Nests and broods have been found in basin wetland complexes, lowland wet-moist patterned tundra complex, and shallow or deep water with islands or polygonized margins, and on salt-killed tundra. At fledging, spectacled eiders move to nearshore marine waters (65 FR 6114; USFWS 2001).	33,158	52
Polar Bear	Denning habitat has been modeled by USGS (Durner et al. 2001, 2006) and this data set serves as an indicator of polar bear habitat. The barrier island critical habitat and the sea ice habitat areas mapped by the USFWS are also incorporated into this function, including the no-disturbance zone around the barrier islands.	21,942	34
Scarce and Valued Habitats	Habitats that are widely recognized as highly valuable on the ACP: brackish meadows, and ponds supporting pendent grass, *Arctophila fulva*.	1,999	3
All Functions Combined	The area performing any one or more of the functions.	62,382	97

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3.9 BIRDS

The study area used to describe bird abundance, distribution, and habitat use assessing the Point Thomson project includes the ACP and adjacent coastal waters, lagoons, and barrier islands between and including the Sagavanirktok River and the Canning River delta and extending inland approximately 9 miles from the coast.

3.9.1 Key Information About Birds

More than 70 bird species have been documented in the study area. Of these, 29 are listed as species of concern by the USFWS, ADF&G, Audubon, and/or Alaska Shorebird Group because of small population sizes, population declines, sensitivity to disturbance, or other reason. Two of these 29 species, the spectacled eider and Steller's eider, are also listed as threatened under the ESA and one of them, the yellow-billed loon, is a candidate species for ESA listing; however, these three species are considered uncommon in the study area.

Most bird species are migratory and use the study area between May and September for spring and fall migration (resting and foraging), nesting, and molting. Bird use of tundra habitats in the study area is low relative to habitats to the east and west, although the Sagavanirktok River delta provides high quality habitat for numerous species. The shoreline and coastal lagoons in the study area provide important post-nesting and molting habitat for birds, and these habitats are included in the Eastern Beaufort Sea Lagoons and Barrier Islands Important Bird Area (IBA).

3.9.2 Review and Adequacy of Information Sources for Birds

Birds on the North Slope have been studied by federal agencies and by private oil and gas companies establishing baseline information for proposed projects and monitoring bird use of areas after oil and gas projects have been constructed.

The USFWS conducts annual aerial surveys for nesting waterfowl and other birds identifiable from aircraft. Aerial surveys are conducted to monitor populations of birds across large areas, with a focus on areas known for higher densities of birds. Results of aerial surveys are presented in annual technical reports for USFWS management activities and are rarely published in peer-reviewed journals. USFWS also conducts ground-based studies within the Arctic Refuge, including the Canning River delta.

Other federal agencies also conduct or fund studies of birds on the North Slope. BLM has conducted studies within NPR-A, which is far from the study area, but information from these studies are valuable for comparison. The Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE) has also funded studies of marine birds in the Bering and Chukchi Seas to assess potential impacts from offshore oil and gas lease sales; these studies are far from the study area but are referenced in this EIS where the information is applicable.

Private oil and gas companies conduct aerial surveys and ground-based studies in discreet areas associated with proposed development or around existing facilities. Although some of these studies result only in annual reports with limited distribution, many of the surveys conducted in the Point Thomson region have resulted in peer-reviewed publications of results from multiple years of data collection. These studies provide some of the most comprehensive and detailed studies of birds available for the North Slope.

In the Point Thomson study area, bird studies have been focused around proposed Point Thomson facilities, at Badami, at Bullen Point, and in the Sagavanirktok River delta. Thus, there are areas within the study area where no studies have been conducted. USFWS aerial surveys include some transects over the entire study area and these surveys provide an overall index to bird distribution in the study area.

Based on the ground-based studies, aerial surveys, and knowledge of available habitats, the existing studies are adequate for evaluating the potential impacts of the Point Thomson project on birds.

Table H-9 in Appendix H discusses the publications, reports, and data available for birds that are cited in the EIS and their relevance to the proposed project. Full references for the studies cited in this Draft EIS are in Chapter 9, References.

3.9.3 Landscape Setting and Habitats

Alaska's ACP is part of the Arctic Plains and Mountains Bird Conservation Region (NABCI 2010), which includes low-lying coastal tundra and drier uplands of the arctic mountains across the entire northern edge of North America. Bird groups that commonly occur in the Point Thomson study area include:

- Waterbirds: waterfowl, loons, cranes, seabirds, and shorebirds
- Landbirds: raptors, owls, ptarmigan, and songbirds

Waterbirds dominate the study area because of the abundance of surface water caused by the underlying permafrost. The most abundant bird in the study area and ACP is a songbird, the Lapland longspur (Hussell and Montgomerie 2002). Most birds migrate to the study area from other areas, breed, rear young, forage, and/or molt from May through September, and then migrate to wintering grounds in the lower 48 states, Mexico, and Central America. A few landbirds overwinter on the ACP. Birds documented to occur in the study area and their habitat associations are listed in Table 3.9-1. Scientific and Inupiaq names for these bird species are listed in Appendix B. The study area includes various types of tundra, stream, river, river delta, lake, pond, Beaufort Sea shoreline, coastal lagoon, and barrier island habitats.

The shoreline, lagoons, barrier islands, and nearshore areas in the study area are located within the Eastern Beaufort Sea Lagoons and Barrier Islands IBA, which was designated for its global importance to breeding migratory waterfowl and other marine birds during the months when the waters are ice-free (Audubon 2010). These nearshore habitats provide sheltered foraging and roosting areas used by molting seaducks, especially long-tailed ducks, and these habitats also provide breeding and staging areas for seaducks, seabirds, and shorebirds. Diving ducks, such as long-tailed ducks, eiders, and scoters (which use coastal marine waters) are considered seaducks. Long-tailed ducks are the most abundant birds in the Eastern Beaufort Sea Lagoons and Barrier Islands IBA during late summer and early fall, and in some years large numbers of red phalaropes and red-necked phalaropes use this IBA during August or September (Audubon 2010). The USFWS considers the Beaufort Sea barrier islands and the lagoon habitat they create a Category II habitat for birds, meaning the habitat is of high value for bird species under evaluation by the agency and the habitat is relatively scarce or becoming scarce on a national or ecoregional basis (USFWS 2010a).

Additionally, the study area is located in between two IBAs that were designated for their continental importance (the Colville River Delta and the Northeast ACP) and just west of the proposed Canning River Delta IBA (Figure 3.9-1; Audubon 2010). These delta and coastal plain IBAs are considered important because they provide breeding and staging habitat for waterfowl, shorebirds, and raptors (Audubon 2010).

Table 3.9-1: Birds in the Point Thomson Study Area

Common Name[a]	Status[b]	Relative Abundance[c]	Habitat Associations[d]						
			Lake	Emergent Marsh	Wet Sedge	Moist Sedge-Shrub	Coastal Barrens	Coastal Wet Sedge	Coastal Water
Waterbirds									
Geese & Swans									
Brant	Breeder*	Common	H	H	H	—	H	H	M
Cackling Goose	Breeder*	Common	M	M	M	H	—	—	—
Greater White-fronted Goose	Breeder+	Common	H	H	H	M	—	M	—
Snow Goose	Breeder+	Uncommon	—	M	M	—	—	M	—
Tundra Swan	Breeder*	Common	H	H	H	H	—	M	—
Dabbling Ducks									
American Wigeon	Breeder+	Uncommon	M	M	M	—	—	M	—
Mallard	Visitor+	Rare	M	—	M	—	—	—	—
Northern Pintail	Breeder*	Common	M	H	H	H	M	M	—
Northern Shoveler	Breeder+	Uncommon	M	M	M	—	—	M	—
Diving Ducks									
Black Scoter	Visitor+	Rare	—	—	—	—	—	—	M
Common Eider	Breeder*	Uncommon	—	—	M	—	H	—	M
Greater Scaup	Breeder+	Uncommon	M	M	M	—	—	—	M
King Eider	Breeder*	Common	M	H	H	M	—	M	M
Long-tailed Duck	Breeder*	Common	H	H	H	M	M	M	H
Red-breasted Merganser	Breeder+	Uncommon	—	—	—	—	—	—	M
Spectacled Eider	Breeder*	Uncommon	H	H	H	—	—	M	M
Steller's Eider	Breeder	Casual	H	H	—	—	—	—	M
Surf Scoter	Visitor+	Rare	—	—	—	—	—	—	M
White-winged Scoter	Visitor+	Rare	M	—	—	—	—	—	H
Loons									
Pacific Loon	Breeder*	Common	H	H	H	M	—	M	M
Red-throated Loon	Breeder*	Common	H	H	H	—	—	M	M
Yellow-billed Loon	Breeder+	Uncommon	H	M	—	—	—	M	—
Cranes									
Sandhill Crane	Breeder+	Rare	—	—	—	—	—	—	—
Seabirds									
Arctic Tern	Breeder*	Common	M		M	M	H	H	M
Black Guillemot	Breeder+	Uncommon	—	—	—	—	M	—	M
Black-legged Kittiwake	Migrant+	Uncommon	—	—	—	—	M	—	M
Glaucous Gull	Breeder*	Common	H	M	M	M	H	—	H
Herring Gull	Visitor+	Casual	—	—	—	—	—	—	M
Long-tailed Jaeger	Breeder+	Uncommon	—	—	H	H	—	—	—
Parasitic Jaeger	Breeder*	Common	—	—	H	M	—	—	—
Pomarine Jaeger	Breeder*	Common	—	—	M	—	—	—	—

Table 3.9-1: Birds in the Point Thomson Study Area									
			Habitat Associations[d]						
Common Name[a]	Status[b]	Relative Abundance[c]	Lake	Emergent Marsh	Wet Sedge	Moist Sedge-Shrub	Coastal Barrens	Coastal Wet Sedge	Coastal Water
Sabine's Gull	Breeder*	Common	H	H	H	M	H	H	M
Short-tailed Shearwater	Visitor+	Uncommon	—	—	—	—	—	—	M
Shorebirds									
American Golden Plover	Breeder*	Common	—	—	H	H	—	M	—
Baird's Sandpiper	Breeder*	Common	—	—	M	H	M	H	—
Bar-tailed Godwit	Breeder+	Uncommon	—	—	H	M	H	—	—
Black-bellied Plover	Breeder*	Common	—	—	H	H	M	—	—
Buff-breasted Sandpiper	Breeder*	Uncommon	—	M	H	H	—	M	—
Dunlin	Breeder*	Common	—	—	H	H	M	M	—
Least Sandpiper	Migrant+	Casual	—	—	M	M	M	M	—
Long-billed Dowitcher	Breeder*	Common	—	M	H	H	M	M	—
Pectoral Sandpiper	Breeder*	Abundant	—	M	H	H	M	M	—
Red Knot	Migrant+	Casual	—	—	M	M	H	—	—
Red Phalarope	Breeder*	Common	M	—	H	H	M	—	—
Red-necked Phalarope	Breeder*	Abundant	H	M	H	H	—	M	—
Ruddy Turnstone	Breeder*	Uncommon	—	M	M	M	H	M	—
Sanderling	Migrant+	Rare	—	—	M	—	H	—	—
Semipalmated Plover	Breeder+	Rare	—	—	—	—	M	—	—
Semipalmated Sandpiper	Breeder*	Abundant	—	—	H	H	H	M	—
Stilt Sandpiper	Breeder*	Uncommon	—	—	H	H	—	M	—
Western Sandpiper	Breeder+	Rare	—	—	—	H	H	—	—
Whimbrel	Visitor+	Rare	—	—	—	M	—	—	—
White-rumped Sandpiper	Breeder*	Uncommon	—	—	H	H	—	M	—
Wilson's Snipe	Breeder+	Uncommon	—	M	H	M	—	M	—
Landbirds									
Raptors									
Bald Eagle	Visitor+	Casual	—	—	—	—	—	—	—
Golden Eagle	Visitor+	Uncommon	—	—	—	—	—	—	—
Northern Harrier	Visitor+	Uncommon	—	—	—	—	—	—	—
Peregrine Falcon	Visitor*	Rare	—	—	—	—	—	—	—
Rough-legged Hawk	Visitor*	Rare	—	—	—	—	—	—	—
Sharp-shinned Hawk	Visitor+	Rare	—	—	—	—	—	—	—
Owls									
Short-eared Owl	Breeder+	Uncommon	—	—	M	—	—	—	—
Snowy Owl	Breeder*	Uncommon	—	—	—	—	—	—	—
Ptarmigan									
Rock Ptarmigan	Resident*	Common	—	—	H	H	—	—	—
Willow Ptarmigan	Resident+	Uncommon	—	—	H	H	—	—	—

Table 3.9-1: Birds in the Point Thomson Study Area									
			Habitat Associations[d]						
Common Name[a]	Status[b]	Relative Abundance[c]	Lake	Emergent Marsh	Wet Sedge	Moist Sedge-Shrub	Coastal Barrens	Coastal Wet Sedge	Coastal Water
Songbirds									
Common Raven	Resident*	Uncommon	—	—	—	—	—	—	—
Common Redpoll	Breeder+	Uncommon	—	—	—	—	—	—	—
Eastern Yellow Wagtail	Breeder+	Common	—	—	—	—	—	—	—
Horned Lark	Visitor+	Casual	—	—	—	—	—	—	—
Lapland Longspur	Breeder*	Abundant	—	—	H	H	M	—	—
Savannah Sparrow	Breeder+	Common	—	—	—	H	—	—	—
Snow Bunting	Breeder*	Uncommon	—	—	H	—	H	—	—
Tree Swallow	Visitor+	Casual	—	—	—	—	—	—	—
White-crowned Sparrow	Breeder+	Rare	—	—	—	—	—	—	—

[a] Common names follow the American Ornithologists' Union Check-list of North American Birds (AOU 2009)

[b] Status word description as presented in the Point Thomson Project Environmental Report (ExxonMobil 2009b) with a few revisions following definitions in Kessel and Gibson (1978): Resident – present throughout the year; Migrant – seasonal transient between wintering and breeding ranges; Breeder – known to breed or possibly breed; Visitor – nonbreeding, not en route between breeding and wintering.

Status in Point Thomson study area; * - confirmed breeder; + - documented in Point Thomson study area, breeding not confirmed (Kendall et al. 2007; Noel et al. 2006a; Rodrigues 2002 a, b; TERA 1995; WCC and ABR 1983)

[c] Abundance on the ACP as presented in the Point Thomson Project Environmental Report(ExxonMobil 2009b) following definitions in Kessel and Gibson(1978): Abundant – occurs repeatedly in appropriate habitats, with available habitat heavily used, or the region regularly hosts great numbers of the species; Common – occurs in all or nearly all appropriate habitats, some areas of suitable habitat sparsely occupied or not at all, or region regularly hosts large numbers of the species; Uncommon – occurs regularly, but uses little of the suitable habitat or the region regularly hosts small numbers, not observed regularly; Rare – within normal range, occurs regularly but in very small numbers; Casual – beyond normal range, irregular observations are likely over multiple years in very small numbers

[d] Habitat associations: M – medium, H – high, only indices of M and H reported.

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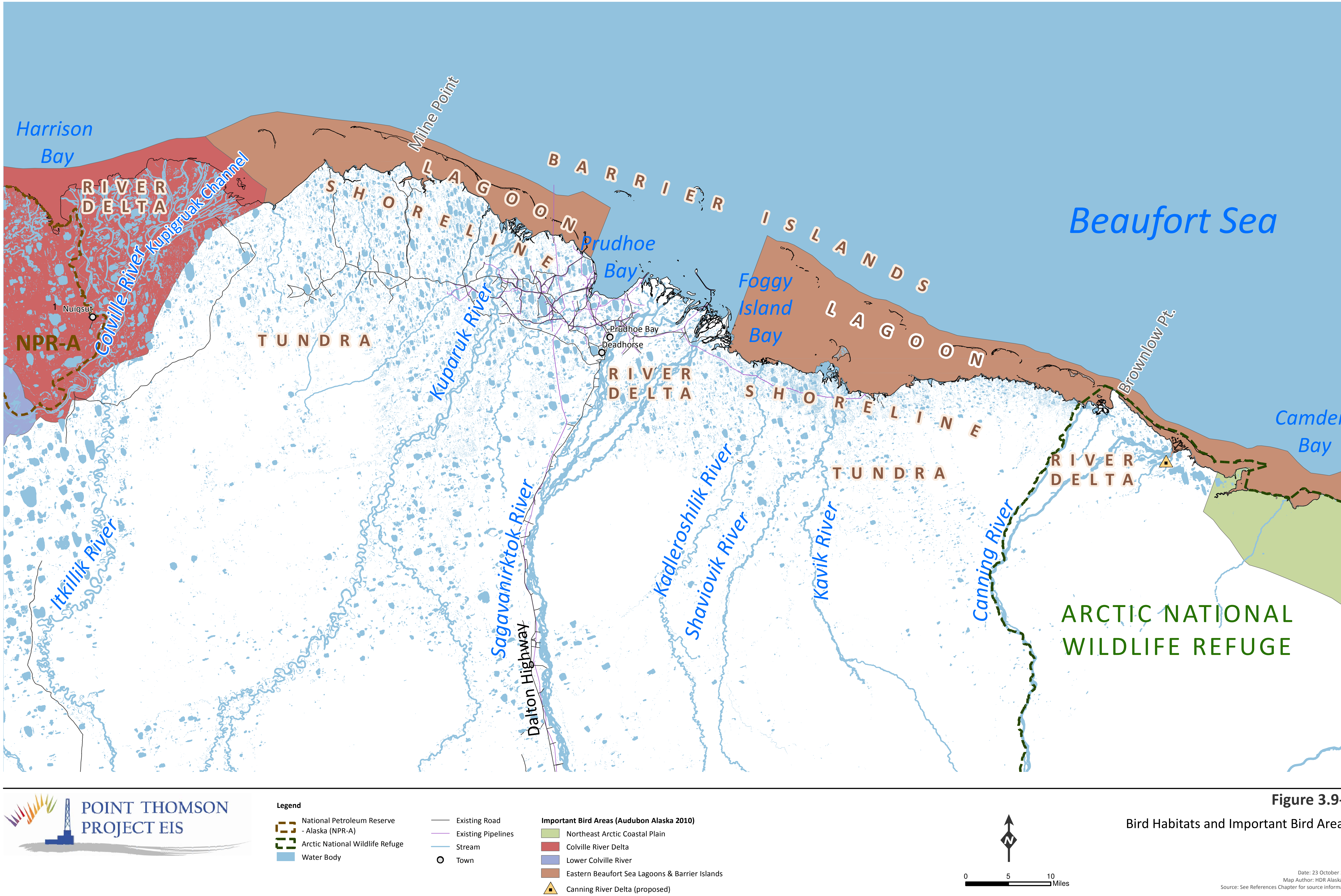

POINT THOMSON PROJECT EIS

Figure 3.9-1

Bird Habitats and Important Bird Areas

Date: 23 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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3.9.4 Migration and Seasonal Occurrence

Migration times vary between species, but most birds occupy habitats in the Point Thomson study area during May to September. Various groups and species arrive, pass through, and depart during this period. Some birds remain to forage, breed, and/or molt (shed and regrow flight feathers). Most migratory birds that nest in the study area arrive in the Beaufort Sea region by early June, and initiate nests shortly after arrival. Figure 3.9-2 shows general seasonal chronology of migration and seasonal activities for bird species and species groups that are found in the study area.

Many birds bound for nesting habitats in arctic Canada migrate through the Beaufort Sea coastal area during spring and back again, bound for wintering destinations, during late summer and fall. Some Canadian nesting, post-nesting, and/or nonnesting birds join Alaska birds to molt in Beaufort Sea lagoons, including lagoons in the study area.

3.9.5 Nesting

Birds nest on tundra, shoreline, barrier island, and artificial habitats in the study area (Frost et al. 2007, Liebezeit et al. 2009, Noel et al. 2006a). Most of the bird nests found during surveys in the study area (87 percent) were within the most abundant tundra habitat types, with the exception of water. The most abundant habitats within the vegetation survey area (wet/moist sedge, dwarf shrub tundra complex [IIId], moist sedge, dwarf shrub/wet graminoid tundra complex [Iva], and moist sedge, dwarf shrub tundra [Va]) were also the most heavily sampled for nesting birds. With proportionally fewer nests found in the wet/moist sedge (IIId) habitat, and proportionally more nests found in the moist/wet tundra (IVa) habitat. A complete list of nesting habitat types and use by species is presented in Appendix L. Overall total nest density in the Point Thomson project area (147 nests/mi^2) was about 50 nests/mi^2 lower than reported nest densities to either the west near the Badami Development (ExxonMobil 2009b) or to the east in the Canning River delta (Kendall et al. 2007). Lower nest densities near the Point Thomson project area compared to the Badami Development and Canning River delta are the result of lower densities of both nesting shorebirds and songbirds in the study area. At all three sampled tundra habitat areas the most abundant nesting birds were pectoral and semipalmated sandpipers (shorebirds) and Lapland longspurs (a song bird; see Appendix L).

The barrier islands north and west of the study area support nesting common eiders and glaucous gulls (Noel et al. 2006a). These barrier island habitats lie within the spring flood plumes of the Shaviovik and Canning Rivers and are often surrounded by river overflow during early spring, which can prevent access to the islands by arctic foxes (Johnson 2000, Noel et al. 2006a). Breeding season occurrence of birds as documented during USFWS aerial waterfowl breeding pair surveys and common eider and waterbird surveys are summarized in Appendix L.

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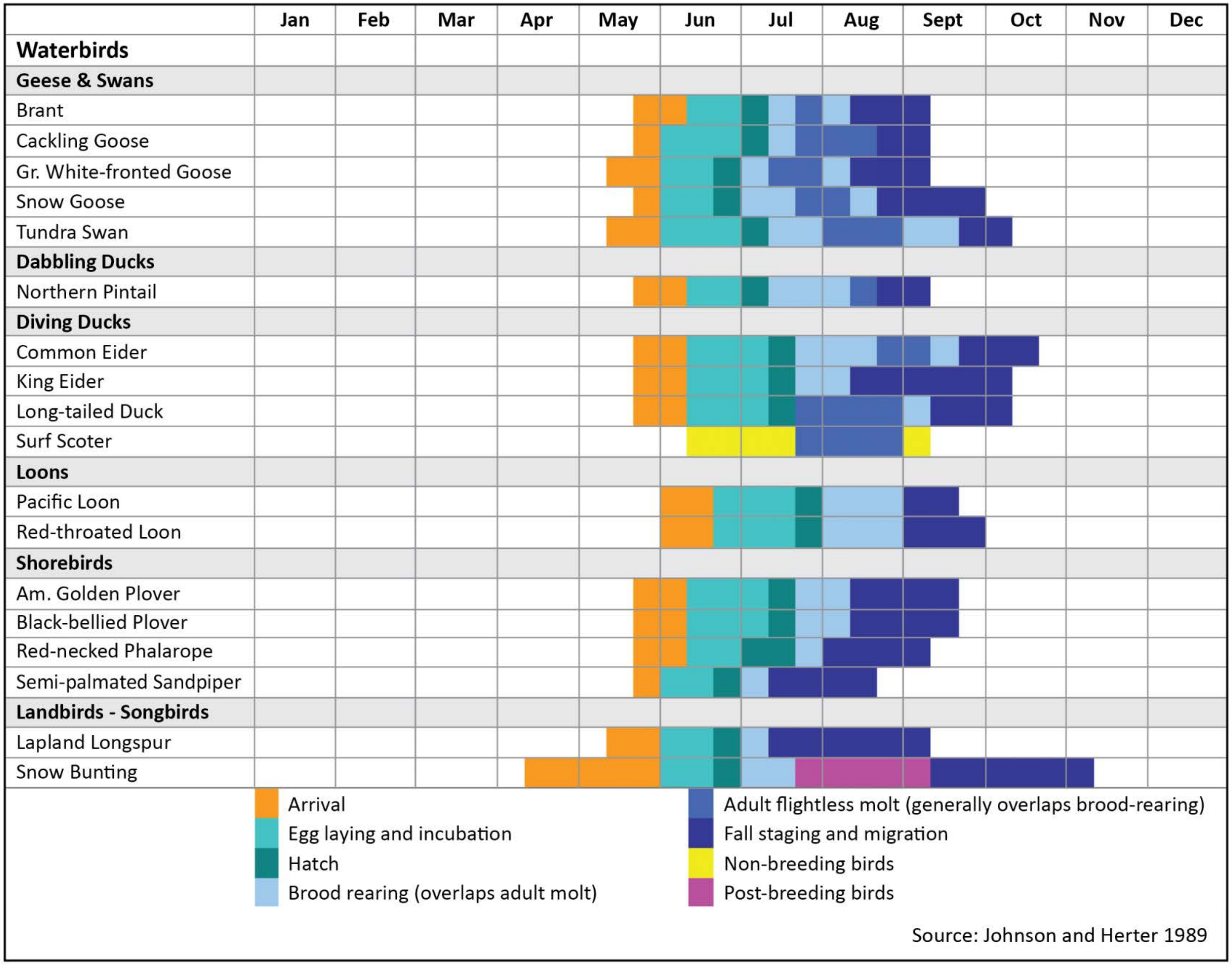

Figure 3.9-2: Seasonal Chronology for Migratory Birds Using the Point Thomson Area

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3.9.6 Brood-Rearing, Molting, and Staging

Coastal salt marshes and salt-affected habitats (wet saline graminoid tundra [IIIb], wet saline barren/wet sedge tundra [IXh], dry saline barren/forb, graminoid complex [IXi], along with river delta and coastal mudflats [Xia]) while not abundant in the study area, are important as brood-rearing and molting habitat for geese and as staging habitat for shorebirds. Coastal gravel spits and barrier islands provide important resting habitat for molting waterfowl. During the post-nesting season, molting male long-tailed ducks predominate in the barrier-island lagoon systems between the Colville River and Canning River deltas during the peak of their molt period from July 15 to August 21. The second most common waterbirds are molting male and molting and brood-rearing female eiders, likely common eiders, with a distribution centered on the Stockton Islands (Noel et al. 2005). Shallow nearshore waters (less than 33 feet deep) had a higher density of brood-rearing, molting, and staging waterbirds than deeper offshore waters between Tigvariak Island and Brownlow Point (Fischer and Larned 2004). Average densities for commonly occurring birds on the barrier island, mid-lagoon, shoreline and tundra transects for the 5 years of surveys in the study area during late-July and August 1998 to 2002 are summarized in Appendix L.

3.9.7 ACP and Point Thomson Study Area Distribution, Abundance, and Trend

The following sections provide brief descriptions of the distribution, abundance, and population trends for bird species and species groups that use the study area.

3.9.7.1 Waterbirds

Waterbirds, including waterfowl, loons, cranes, seabirds, and shorebirds, use water bodies and wetlands to varying degrees during portions of their life history. Species-specific surveys have been conducted for a variety of waterbirds in the study area as highlighted in the sections below.

All waterbirds in the study area are migratory, as aquatic habitats are frozen during the winter. Waterfowl, loons, and cranes are hunted and breeding populations are monitored by USFWS by annual aerial surveys across the ACP, including the study area. Subsistence hunting of study area waterbirds is discussed in Section 3.22. These annual surveys also document some seabirds and shorebirds as a group (Larned et al. 2009). The most abundant waterbirds recorded by these surveys on the ACP are the greater white-fronted goose, the northern pintail, and the long-tailed duck (Appendix L). Ducks greatly outnumber geese, but ducks are smaller, more cryptic, and blend into the landscape; therefore, ducks are often missed during aerial surveys and their numbers are underestimated (Larned et al. 2009).

Most waterfowl, ducks, geese, and swans, depend on aquatic habitats for foraging, breeding, molting, and escape cover. All waterfowl go through a flightless molt period, when flight feathers are shed and regrown. Molt typically occurs when one (ducks) or both (geese and swans) parents are rearing broods of flightless ducklings, goslings, or cygnets. Brood-rearing pairs of geese often aggregate with other brood-rearing pairs forming large flocks that forage and move together. Post-breeding male ducks and nonbreeding and juvenile waterfowl also aggregate into large flocks during the flightless molt period. Generalized arrival, nesting, molting, and migration staging chronologies for common waterfowl are illustrated in Figure 3.9-2.

Geese

Four goose species regularly nest in the study area, including brant, cackling goose, greater-white fronted goose, and snow goose. Brant are identified as a vulnerable species by the Audubon Alaska 2010 Watchlist (Kirchoff and Padula 2010). Brant typically nest in colonies and have a dispersed distribution often associated with braided river valleys, deltas, and inland lakes (Reed et al. 1998). Brant have been increasing in abundance over the past 10 years by nearly 14 percent per year in the study area (Appendix L). Nesting season densities in the study area ranged from very low to low with an increase in density within the Sagavanirktok River delta area. Coastal surveys indicate an average of less than 50 brant along the shoreline during the nesting period (Appendix L); while ground-based nest searches failed to document brant nests in the study area. Brant appear to be more abundant on tundra habitat between the Shaviovik and Canning Rivers during the post-breeding season (Appendix L).

Cackling geese in the study area have decreased in abundance over the past 10 years at a rate of about 2 percent per year. Ground-based nest searches have documented cackling goose nests in the Point Thomson study area. Cackling geese congregate on shoreline and tundra habitats between the Shaviovik and Canning Rivers during the post-breeding season (see Appendix L).

The most abundant goose on the ACP, the greater white-fronted goose, has been increasing in abundance over the past 10 years by nearly 8 percent per year (Larned et al. 2009). Greater white-fronted geese have not been documented nesting in the study area. During the post-breeding season, greater-white fronted geese are abundant on tundra habitat between the Shaviovik and Canning Rivers (see Appendix L).

Snow geese are colonial nesters and nesting populations in Alaska are increasing rapidly (Ritchie 2001; McKendrick et al. 2008). There are three colonies documented on the Alaska North Slope, including one on the Sagavanirktok River delta in the study area. In addition, coastal surveys indicate that snow geese nest in scattered pairs along the coast. Snow geese in the study area are common to the west, including about 1,000 nests in the Sagavanirktok River delta colony and over 100 nests along the shoreline, particularly in and near the Shaviovik River delta (see Appendix L). Snow geese have not been observed from Badami east to the Canning River delta during ground-based nest searches. A larger number of snow geese use the Shaviovik River delta area during the brood-rearing season (Noel et al. 2004; Appendix L).

Tundra Swan

Tundra swans have been increasing in abundance over the past 10 years by about 5 percent per year on the ACP (Larned et al. 2009; Appendix L). Tundra swans breed in tundra lakes, ponds, and pools, primarily in coastal delta areas (Limpert and Earnst 1994). Nesting season densities between the Sagavanirktok River and the Canning River were generally very low or low, with a center of high density in the Shaviovik River delta area and southeast of the Shaviovik delta. Coastal surveys indicate an average of less than 10 tundra swans occur along the shoreline during the nesting period (Appendix L), while ground-based nest searches failed to document tundra swan nests in the study area. Tundra swans appear to be more abundant on tundra habitat between the Shaviovik and Canning Rivers during the post-breeding season (Appendix L).

Ducks

Fourteen duck species (Appendix L) regularly occur in the study area. The most abundant duck in the study area, the northern pintail, has been declining in abundance over the past 10 years by nearly 9 percent per year (Larned et al. 2009; Appendix L). Within the study area, a small area of very high density of northern pintails during nesting occurs in the Sagavanirktok River delta with the remaining study area ranging from very low to medium nesting density (Larned et al. 2009). Some northern pintails remain within the Point Thomson study area during the post-breeding season with an average estimate of 69 ducks in tundra habitats and 59 ducks in coastal lagoon habitat (Appendix L).

The second most abundant duck in the study area, the long-tailed duck, has been declining in abundance over the past 10 years by about 2 percent per year (Appendix L; Larned et al. 2009). Small areas of very high density long-tailed duck nesting occurs in the Sagavanirktok and Shaviovik River deltas in the study area, but the largest areas of very high densities of long-tailed ducks during the nesting season occur east of the Colville River (more than 50 miles west of the study area). Ground-based nest searches documented long-tailed duck nests in the study area (Appendix L). Nesting season densities between the Sagavanirktok and Canning Rivers ranged from very low to medium for long-tailed ducks. In addition, long-tailed ducks are the most abundant waterbird remaining within the study area during the post-breeding season with an average estimate of 490 ducks in tundra habitats and 41,774 ducks in coastal lagoon habitat (Appendix L).

Four eiders occur in the study area; the most abundant are the king eider and the common eider. King eiders nest primarily in tundra habitats, while most common eiders nest on barrier island habitats. Spectacled and Steller's eiders are federally protected species under the ESA and are discussed in Section 3.9.9.

King eiders have been increasing in abundance over the past 10 years by nearly 3 percent per year (Larned et al. 2009; Appendix L). Nesting season densities in the study area range from very low to high. Coastal surveys indicate an average of about 158 king eiders occur along the shoreline in the study area during the nesting period and ground-based nest searches confirm king eider nests in the study area (Appendix L).

The barrier islands north and west of the study area supported an average of 232 common eider nests per year during 1982 to 2002 (Noel et al. 2006a). Late June or early July aerial surveys of these islands during 1999 to 2009 indicate that, of the average 328 common eiders observed in the study area, nearly 60 percent were observed on the barrier island transects (Dau and Bollinger 2009; Appendix L). Many common eiders remain within the lagoon area in the study area during the post-breeding season with an average estimate of 3,091 common eiders in coastal lagoon habitat, and the highest densities along the barrier islands (Appendix L).

Three scoters, black, surf, and white-winged, occur in the study area or along the Beaufort Sea coast (Appendix L). Black and white-winged scoters were observed during the 2008 ACP breeding pair survey (Larned et al. 2009). Black and white-winged scoters appear to have increased in abundance over the past 10 years (Appendix L). All three scoters occur along the Beaufort Sea coast and surf scoters are the most abundant on the coast near the Point Thomson Project with an average of 422 surf scoters (probably nonnesting birds) observed during late June or early July surveys (Appendix L). During July and August surveys, a few black scoters were observed in tundra habitats between the Shaviovik and Canning Rivers, but most post-breeding scoters were documented using mid-lagoon habitats with an average estimate of 503 surf scoters, 91 white-winged scoters, and 17 black scoters in lagoon habitats near the project (Appendix L).

Loons

Three loons nest on the ACP; the most abundant is the Pacific loon. Red-throated and yellow-billed loons occur less frequently, and the yellow-billed loon is a candidate for federal listing as threatened or endangered (see Section 3.9.9 for further information on yellow-billed loons). Pacific loons often nest on smaller water bodies than either red-throated or yellow-billed loons and feed their young on aquatic invertebrates rather than fish as do both red-throated and yellow-billed loons. Red-throated loons often nest near rivers and forage in rivers and nearshore waters. Pacific and red-throated loon abundance has been unchanging during the past 10 years (Larned et al. 2009; Appendix L). Very high densities of red-throated loons during nesting generally occur within coastal habitat scattered across the ACP and areas of very high and high density occur near the Sagavanirktok, Shaviovik, and Canning Rivers and deltas in and near the study area. Coastal surveys indicate that Pacific and red-throated loons occur along the shoreline in the Point Thomson study area during the nesting period (Appendix L). Ground-based nest searches documented Pacific loon nests in the Point Thomson and Canning River delta areas and red-throated loons in the Canning River delta areas (Appendix L).

During the post-breeding season, Pacific loons use nearshore habitat while red-throated loons use ponds, lakes, and nearshore habitats (Appendix L).

Sandhill Cranes

Few sandhill cranes nest on the ACP and in the study area (Appendix L). No sandhill cranes were reported along coastal areas within the study area during the breeding season; no nests were found during ground-based searches in the study area. A few sandhill cranes have been observed in tundra habitats within the study area during the post-nesting season (Appendix L).

Seabirds

Seabirds commonly occurring in the study area include terns, gulls, and jaegers. Seabirds nest on tundra habitats and on barrier islands along the Beaufort Sea coast, with arctic terns, glaucous gulls, and Sabine’s gulls often nesting in loose aggregations.

The arctic tern is the second most abundant seabird nesting in the study area, and their abundance appears to have remained relatively stable during the past 10 years (Appendix L). Areas of medium nesting density occur in the study area and in the Canning River delta. Nesting season densities between the Sagavanirktok and Canning Rivers range from very low to medium. Coastal surveys indicate an average of about 33 arctic terns occur along the shoreline in the study area during the nesting period (Appendix L), while ground-based nest searches did not document arctic tern nests in the study area. Arctic terns remain within the study area during the post-breeding season in tundra habitats with an average estimate of 13 terns in tundra habitats and 45 terns in nearshore habitats, primarily in barrier island habitats (Appendix L).

Glaucous and Sabine’s gulls are the two most common gulls in the study area (Appendix L). Glacuous gulls nest in coastal areas, tundra, offshore islands, cliffs, shorelines, and ice edges (Gilchrist 2001). Sabine’s gulls nest primarily in drained lake-basins that contain extensive wetlands intermixed with ponds, lakes, marshes, islets, and peninsulas (Day et al. 2001). Nesting season densities in the study area range from very low to high for glacous gulls and from very low to low for Sabine’s gulls. Coastal surveys indicate an average of about 266 glaucous gulls and 12 Sabine’s gulls occurs along the shoreline in the Point Thomson area during the nesting period (Appendix L); however, ground-based nest searches in the study area did not document glaucous or Sabine’s gull nests. Both glaucous and Sabine’s gulls remained within the study area during the post-breeding season in tundra and barrier island habitats (Appendix L).

Three jaegers occur in the study area: long-tailed, parasitic, and pomarine jaegers. The three species are difficult to distinguish during aerial surveys and are usually grouped. As a group, jaegers are less abundant than either gulls or arctic terns (Appendix L). Areas of very high densities of jaegers during nesting are scattered across the study area; most very high density areas are farther inland away from the coast, including a very high density area inland about 11 miles south of the area between Tigvariak Island and Bullen Point. Nesting season densities in other parts of the study area range from low to high. Ground-based nest searches documented parasitic jaeger nests in the Canning River delta area. Jaegers remain within the Point Thomson area during the post-breeding season in tundra habitats (see Appendix L).

Shorebirds

Shorebirds are an abundant and diverse group of birds that breed, stage, and migrate in the study area. Twenty-one shorebird species occur in the study area, including several species listed as birds of conservation concern due to small population size and declining populations (Appendix L). Because of their relatively small size and wide distribution, shorebirds are usually studied by using ground-based transects or plots, rather than aerial surveys. Large bodied shorebirds (including godwits, dowitchers, and whimbrel) and small bodied shorebirds (including plovers, sandpipers, dunlin, knot, phalaropes, turnstones, sanderling, and snipe) are recorded as groups during aerial breeding pair surveys (Larned et al. 2009). However, population trends are specific to the species of shorebird and are not accurately assessed using the aerial survey platform.

Based on aerial survey distributions, very high density areas (1.4 to 7.4 birds/mi^2) of large shorebirds generally occur 30 to over 50 miles inland from the Beaufort Sea Coast between the Canning River and Barrow (USFWS 2008). In the study area, large shorebird densities during nesting season range from very low (0 to 0.07 birds/mi^2) to low (0.07 to 0.25 birds/mi^2) and very few shorebirds were recorded during breeding season coastal surveys in the Point Thomson area (Appendix L). The only large shorebird nests documented in the study area during ground-based nest searches is the long-billed dowitcher, with observations in the Badami, Point Thomson, and Canning River delta areas (Appendix L). Long-billed dowitcher population trends in North America may be stable or declining (Morrison et al. 2006).

Small shorebirds occur in very high densities (6.4 to 25.5 birds/mi^2) in large areas west of Barrow (USFWS 2008a). However, within the study area, nesting season small shorebird density is primarily low (0.09 to 1.6 birds/mi^2), with a very high density area in the Sagavanirktok River delta region and a medium density (1.5 to 3.5 birds/mi^2) area in the Shaviovik River delta. Abundance and distribution of shorebirds in the neighboring Arctic Refuge shows an increase in diversity within the Canning River delta (Brown et al. 2007).

Ground-based nest searches identified pectoral sandpipers and semipalmated sandpipers as the most abundant small shorebirds. Extrapolation of nest plot densities to a 200 mi^2 tundra area between the Shaviovik and Canning Rivers indicates a total of nearly 16,000 shorebird nests (Appendix L) (nesting densities were not extrapolated for the remainder of the study area [Shaviovik River to Sagavanirktok River] because data for shorebirds are lacking for that area). Population trends for pectoral sandpipers and semipalmated sandpipers indicate that these shorebirds are likely declining in abundance in North America (Morrison et al. 2006).

Post-breeding aerial survey densities indicate approximately 300 shorebirds in tundra habitats and approximately 400 shorebirds in the nearshore lagoon (Appendix L); note that aerial densities for shorebirds were generally much lower than ground-based density estimates.

3.9.7.2 Landbirds

Landbirds occurring on the ACP include raptors, owls, ptarmigan, and songbirds (Table 3.9-1). Landbirds documented in the area between the Sagavanirktok and Canning Rivers include birds that nest on the ground, such as ptarmigan, Lapland longspur, northern harrier, short-eared owl, and snowy owl; and birds that usually nest on cliffs, bluffs, or trees, such as eagles, falcons, hawks, and common ravens.

Raptors

River bluffs in the foothills of the Brooks Range between the Sagavanirktok and Canning Rivers provide nesting habitat for raptors. Several raptors are listed as birds of conservation concern due to small population size and sensitivity to disturbance (Table 3.9-2). Northern harriers nest on the ground, although they generally nest further inland (Macwhirter and Bildstein 1996). Rough-legged hawks and peregrine falcons have been documented nesting on artificial structures at the Bullen Point radar site (Frost et al. 2007); rough-legged hawks have been documented nesting on the tundra in the Canning River delta (Kendall et al. 2007). Many raptors use the coastal plain for foraging, especially when feeding young at nests. Bald eagles, golden eagles, peregrine falcons, northern harriers, and rough-legged hawks were documented foraging in the study area (Rodrigues 2002 a, b). Golden eagles regularly occur on the coastal plain between the Sagavanirktok and Canning Rivers during mid-June (Noel and Cunningham 2003), and are suspected to take caribou calves and forage on carcasses and afterbirth. Aerial waterfowl breeding pair surveys on the ACP have documented a slight positive trend in golden eagle abundance (Appendix L); this trend is consistent with the increase in numbers of nesting pairs in the NPR-A observed between 1977 and 1999 (Ritchie et al. 2003a).

Peregrine falcons prey on ptarmigan, shorebirds, Lapland longspur, snow buntings, and ducks (White et al. 2002) during late summer and there is a general movement of immature peregrine falcons toward coastal areas along the Beaufort Sea in mid- to late August (Johnson and Herter 1989). Peregrine falcon populations are considered stable or increasing in recent decades (White et al. 2002); populations nesting within the NPR-A appear to have increased dramatically between 1977 and 1999 (Ritchie et al. 2003). Rough-legged hawks primarily forage on small mammals such as lemmings and voles, supplemented by birds and medium-sized mammals such as ground squirrels (Bechard and Swem 2002). Although the number of rough-legged hawks occupying nesting territories varies considerably year to year, twice as many pairs were located in 1999 compared to 1977 in the NPR-A (Ritchie et al. 2003).

Owls

Snowy and short-eared owls nest on the ACP and may be common in the study area during years when small mammals are abundant (Johnson and Herter 1989). Snowy owls have been documented nesting in the Canning River delta (Kendall et al. 2007) and both owls have been observed foraging in the study area (Rodrigues 2002 a, b). Both snowy and short-eared owls nest on the ground. The number of owls that nest on the ACP each year is related to the abundance of prey available during nesting. In years of high rodent abundance, more owls will nest. No noticeable trends in owl abundance tracked during the waterfowl breeding pair surveys have been observed over the last 10 years (Appendix L).

Ptarmigan

Rock and willow ptarmigan occur across the ACP and may remain on the ACP during the winter, although both species usually include populations of residents, short-distance migrants, and longer-distance migrants making seasonal southward movements and returning to the northern extents of their range on the ACP during late May (Hannon et al. 1998, Montgomerie and Holder 2008). Ptarmigan abundance can change erratically, alternating between super-abundance and virtual absence within the span of a few years; general long-term population size and trends are unknown. Ptarmigan are generally ground dwellers; they use cryptic coloration for protection, growing white feathers in late summer to early fall and brown feathers in late spring.

Passerines–Songbirds

At least nine species of passerines occur in the study area (Table 3.9-1). Of these, six are known or probable breeders; however, only three species, the eastern yellow wagtail, Savannah sparrow, and Lapland longspur are common to abundant breeders in the study area. The Lapland longspur is the single most abundant bird on the ACP. Population trends for the Lapland longspur are imprecisely known although some declines were documented during a study at Barrow during 1967 to 1973 (Hussell and Montgomerie 2002, Rich et al 2004). Lapland longspur nests are typically placed in a depression in the ground on the side of a bank or hummock (Hussell and Montgomerie 2002).

Common ravens are widely distributed in low numbers across the ACP. Common raven populations are considered to have increased in areas where human activities are concentrated on the ACP (Powell and Backensto 2009) and documented nesting sites for common ravens at the Bullen Point radar site, Prudhoe Bay, and Kuparuk oilfields have all been on artificial structures (Frost et al. 2007, Powell and Blackensto 2009). Current population trends have remained stable over the last 10 years based on the aerial waterfowl breeding pair surveys (Appendix L). Common ravens are generalists and feed on a wide variety of foods, including eggs, young birds, and garbage (Powell and Backensto 2009). Common ravens have been observed foraging in the Point Thomson study area (Rodrigues 2002 a, b).

3.9.8 Conservation Birds of Concern

Table 3.9-2 lists birds in the study area that are considered to be of concern. The list includes featured species (FS) in the ADF&G Comprehensive Wildlife Conservation Plan (ADF&G 2006), the USFWS' Birds of Conservation Concern (BCC), the Alaska Shorebird Group's Priority Shorebirds (PSB), and the Alaska Audubon's Watch List (WL).

Two federally-listed threatened birds, one bird considered a candidate for federal listing, and no state-listed threatened or endangered birds have been documented in the study area. Federally protected and candidate birds–the spectacled eider, Steller's eider, and yellow-billed loon–are discussed in Section 3.9.9.

The USFWS defines birds of conservation concern as species, subspecies, and populations that are not already federally-listed as threatened or endangered but that without additional conservation actions, are likely to become candidates for federal listing (USFWS 2008). ADF&G defines a species of special concern is any species, subspecies, or population of fish, mammal, or bird native to Alaska that has entered a long-term decline in abundance or is vulnerable to a significant decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance. ADF&G developed their featured species list based on a set of 11 criteria that included rarity, designation as at risk, sensitivity to environmental disturbance, and international importance (ADF&G 2006). The Alaska Shorebird Group's Priority Shorebirds list identifies shorebird species that are of high conservation concern in Alaska (ASG 2008). The Alaska Watchlist identifies Alaska birds that are vulnerable or declining, therefore warranting special conservation attention (Kirchoff and Padula 2010).

Table 3.9-2: Birds of Concern
Documented in the Point Thomson Study Area

Species (Migration)[a]	Status[b]	Global Rank[c]	Alaska Rank	Alaska Abundance[d]	Alaska Trend[e]	Rationale
American Golden Plover (L)	WL, PSB	G5	S5B	100,000	-	Small population, declines, vulnerable to staging habitat loss
Arctic Tern (L)	BCC, FS	G5	S4/S5B	~13,000	±	Long-term decline, sensitive to disturbance
Bald Eagle (S)	FS	G5	S5	No Estimate	+	Contaminant-affected, sensitive to changes in forests
Bar-tailed Godwit (L)	BCC, WL, PSB	G5	S3B	~100,000	-	Small population, large-scale reproductive failure, Asian overharvest
Black Scoter (S)	FS, WL	G5	S3/S4B, S3N	~100	12.10%	Apparent decline, vulnerable to oil spills and contaminants
Brant (S)	WL	G5	S4B	~12,000	14.40%	Small declining population, vulnerable to disturbance during molt
Buff-breasted Sandpiper (L)	BCC, FS, PSB, WL	G4	S2B	~7,500	-	Small population, breeds in North Slope oil fields
Common Eider (S)	FS, WL	G5	S4B, S3N	~2,500	3.00%	Long-term decline, vulnerable to oil spills
Dunlin (L)	BCC, PSB, WL	G5	S4B, S4N	~475,000	-	Declining population, vulnerable to oil spills, winter habitat loss
Golden Eagle (S)	FS	G5	S4B, S3N	~40	±	Small population, winter habitat loss
King Eider (S)	FS, WL	G5	S3B, S3N	~16,000	2.90%	Declining population, vulnerable to oil spills
Long-tailed Duck (S)	FS	G5	S5B, S4N	~62,000	± (-2.2%)	Significant long-term declines, vulnerable to oil spills and contaminants
Northern Harrier (L)	FS	G5	S4B	~900	UNK	Sensitive to disturbance, contaminants
Pacific Loon (S)	FS	G5	S5B, S4N	~21,000	±	Sensitive to disturbance, contaminants
Peregrine Falcon (L)	BCC, FS	G4T3	S3B	~1,800	+	Recently delisted, vulnerable to contaminants
Red Knot (L)	BCC, PSB, WL	G5	S2/S3B	<50,000		Small population, vulnerable to staging habitat loss, South American overharvest

Table 3.9-2: Birds of Concern Documented in the Point Thomson Study Area

Species (Migration)[a]	Status[b]	Global Rank[c]	Alaska Rank	Alaska Abundance[d]	Alaska Trend[e]	Rationale
Red-throated Loon (L)	BCC, FS, WL	G5	S4B, S4N	~2,000	±	Sensitive to disturbance, contaminants
Rough-legged Hawk (S)	FS	G5	S4B	~4,000	UNK	Sensitive to disturbance, contaminants
Sanderling (L)	PSB	G5	S2B	~30,000	-	Rangewide decline, vulnerable to oil spills
Sharp-shinned Hawk (L)	FS	G5	S4B, S3N	NE	UNK	Migrant raptor, sensitive to habitat loss or alteration
Short-eared Owl (S)	FS	G5	S4B	~90,000	UNK	Rangewide declines, vulnerable to habitat loss and predation
Snowy Owl (S)	FS	G5	S3/S4	~800	±	Small population, vulnerable to predation and disturbance
Spectacled Eider (S)	WL,T	G2	S2B, S2N	6,635	-1%	Population declines, small population, vulnerable to predation, disturbance, and oil spills
Steller's Eider (S)	WL, T	G3	S2B,S3N	168	-4.2%	Significant long-term declines, small population, vulnerable to predation, disturbance, and oil spills
Surf Scoter (S)	FS	G5	S4B, S4N	~4,000	-2%	Significant long-term declines
Whimbrel (L)	BCC, WL, PSB	G5	S3/S4B	21,000	UNK	Small population, vulnerable to winter habitat loss
White-crowned Sparrow (L)	FS	G5	S5B	21,900,000	-1.3%	Long-term Alaska declines
White-winged Scoter (S)	FS	G5	S5B, S5N	100,000	-2%	Significant long-term declines
Yellow-billed Loon (L)	BCC, WL, FS, C	G4	S2/S3B, S3	1,119	+4.6%	Small population, slow intrinsic growth rate, vulnerable to disturbance, predation, oil spills

Sources: Rosenberg 2004, ADF&G 2006, Dau and Bollinger 2009, Larned et al. 2009

[a] (R) = Resident; (S) = Short-distance migrant; (L) = Long-distance migrant.

[b] Status: BCC = Birds of Conservation Concern (USFWS 2008); FS = Featured Species (ADF&G 2006);WL = Audubon Alaska WL 2010 (Kirchoff and Padula 2010); PSB = Priority Shorebird (ASG 2008); T = Listed as Threatened under ESA; C = Candidate species for listing under ESA.

[c] Rankings: G5 = Globally secure; G4 = Globally apparently secure; T3 = Subspecies vulnerable; S5 = State secure; S4 = State apparently secure; S3 = State vulnerable; S2 = State imperiled; N = Nonbreeding; B = Breeding (ANHP 2011).

[d] Alaska abundance for Arctic Coastal Plain, Bird Conservation Region 3, or Beaufort Sea Coastal areas. Average annual long-term population trend in Alaska (Rosenberg 2004, ADF&G 2006, Dau and Bollinger 2009, Larned et al. 2009).

[e] UNK represents unknown condition, - represents declining trend of unknown magnitude; + represents increasing trend of unknown magnitude, ± represents no noted population trend.

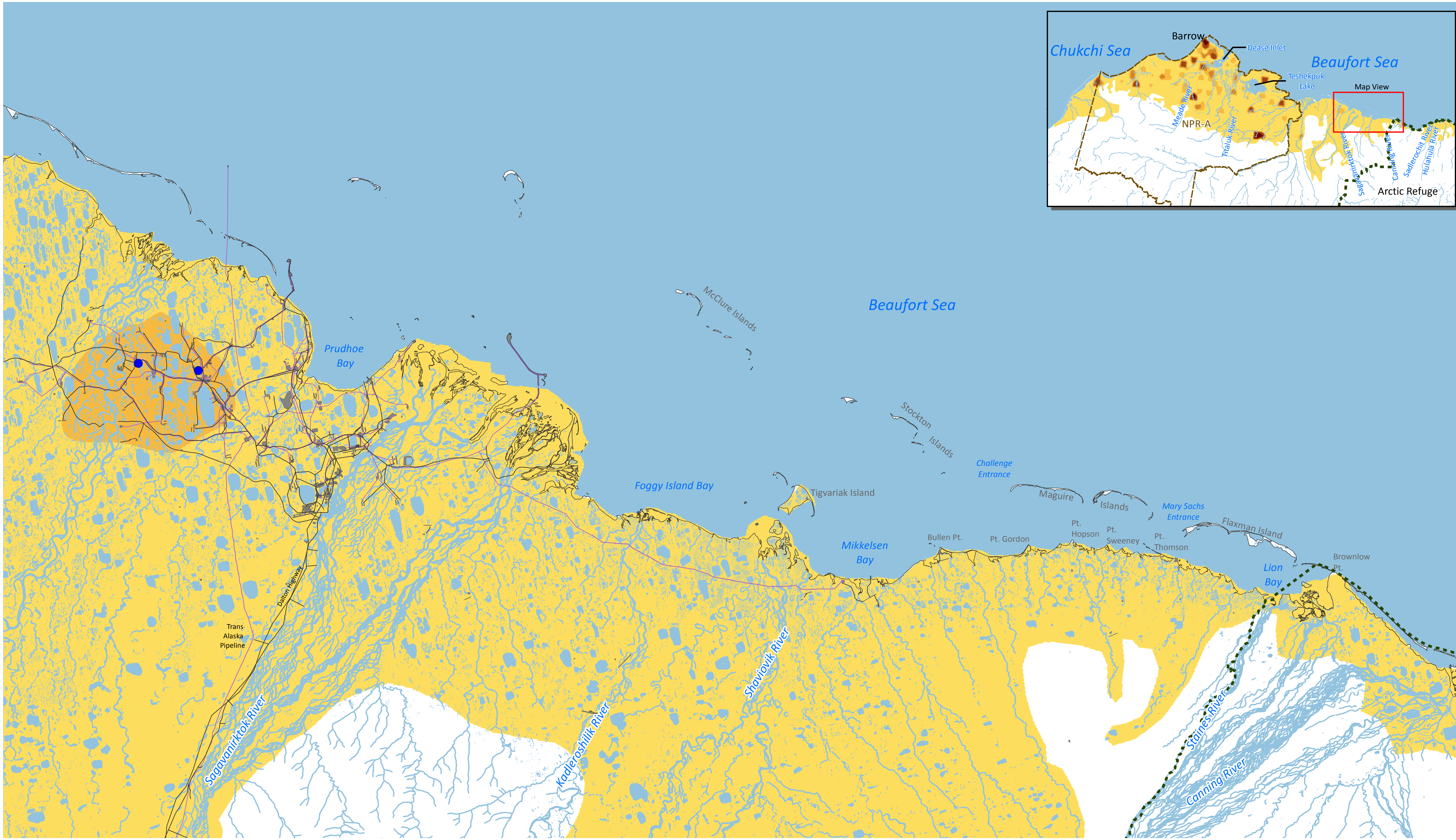
3.9.9 Threatened and Endangered Species

There are two bird species federally protected under the ESA that occur in the Point Thompson study area: the Steller's eider (threatened) and spectacled eider (threatened). In addition, the yellow-billed loon is addressed in this section because it is being evaluated for listing as a candidate species under the ESA and could be listed during project planning. Detailed descriptions of each species are provided in the Biological Assessment (Appendix M).

3.9.9.1 Steller's Eider—Threatened

The Alaska breeding population of the Steller's eider was federally listed as threatened under the ESA on June 11, 1997 (62 FR 31748). Designated critical habitat includes breeding habitat on the Yukon-Kuskokwim Delta and marine molting and overwinter habitats in the Kuskokwim Shoals in northern Kuskokwim Bay, and Seal Islands, Nelson Lagoon, and Izembek Lagoon on the north side of the Alaska Peninsula (66 FR 8850). No critical habitat for Steller's eiders has been designated on the ACP.

Steller's eiders occur at low densities across the ACP, although they are much more abundant near Barrow (USFWS 2002b; see Figure 3.9-3). Historical records document Steller's eiders nesting as far west as Wainwright. Currently, the Barrow area appears to be the center of abundance and primary nesting. Nearer to the Point Thomson study area, Steller's eiders have been observed twice west of Prudhoe Bay during aerial surveys, but nesting has not been verified east of the Colville River since the 1970s (Quakenbush et al. 2002, USFWS 2002; Figure 3.9-3). Nonbreeding and post-breeding eiders use the nearshore area of the northeastern Chukchi Sea and large lakes around Barrow for summering and molting, with a few birds occasionally occurring as far east as the U.S.-Canadian border. Neither nesting or post-nesting Steller's eiders have been recorded in the Point Thomson study area in recent years, although Steller's eiders have been observed since the 1970s in the Kadleroshilik, Shaviovik, and Canning River deltas and at Bullen Point during May to September (Quakenbush et al. 2002). The study area appears to be east of the current Steller's eider breeding range, and coastal areas between the Sagavanirktok and Canning River deltas have not been recently documented as used by post-breeding and molting Steller's eiders (Fischer et al. 2002, Fischer and Larned 2004). A 2010 aerial survey of the study area for nesting Steller's and spectacled eiders did not document Steller's eiders (Johnson et al. 2011).



POINT THOMSON PROJECT EIS

Legend

Stellers Eider Nesting Density (birds per mi²)

- 0.000 - 0.088 - Very Low
- 0.088 - 0.378 - Low
- 0.378 - 0.660 - Medium
- 0.660 - 1.059 - High
- 1.059 - 3.232 - Very High

- Steller's Eider Breeding Survey Observations (1992-2009)
- Existing Road
- Existing Pipelines
- Existing Facilities
- Arctic National Wildlife Refuge

0 3 6 Miles

N

Figure 3.9-3

Arctic Coastal Plain Steller's Eider Nesting Density

Date: 23 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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3.9.9.2 Spectacled Eider–Threatened

Spectacled eiders were federally listed as a threatened species under the ESA throughout their range on May 10, 1993 (58 FR 27474). Designated critical habitat includes breeding habitat on the Yukon-Kuskokwim Delta and marine molting and overwinter habitats in Norton Sound, Ledyard Bay, and the Bering Sea between Saint Lawrence and Saint Matthew Islands (66 FR 9146). No critical habitat for spectacled eiders has been designated on the ACP.

Spectacled eiders were listed as threatened because of a rapid population decline (96 percent decline from 1952 to 1993) in the population breeding on the Yukon-Kuskokwim Delta. Identified threats to spectacled eiders include ingestion of contaminants (especially spent lead shot), predation, hunting, ecological effects of commercial fisheries, and complex changes in fish and invertebrate populations in the Bering Sea (65 FR 6114; USFWS 1996, SDJV 2004).

Spectacled eiders arrive on the ACP in late May or early June. Observations during the prenesting period suggest that habitats containing open water with emergent vegetation early in the season are important to spectacled eiders (Derksen et al. 1981, Warnock and Troy 1992, Anderson et al. 1996). Nesting begins in mid-June and eggs begin to hatch in mid-July; males disperse from the area by late June (USFWS 1996). Large shallow productive thaw lakes with emergent vegetation and usually with convoluted shorelines or small islands appear to be important as eider nesting and brood rearing habitat on the North Slope (65 FR 6114). Critical nesting, brood-rearing, and molting habitats were not designated on Alaska's ACP because these habitats are not considered to be limiting (65 FR 6114). Important identified elements for spectacled eider habitat includes: (1) all deep water bodies, (2) all water bodies that are part of basin wetland complexes, (3) all permanently flooded wetlands and water bodies containing either water sedge, arctic pendant grass, or both, (4) all habitats immediately next to these habitat types, and (5) all marine waters out to 25 miles from shore, associated aquatic flora and fauna in the water column, and the underlying benthic community (65 FR 6114).

Spectacled eiders use a variety of nesting habitats across the ACP; at U.S. Air Force radar sites, spectacled eider nests were found within old basin wetland complex (three nests), lowland wet-moist patterned tundra complex (two nests) and shallow water with islands or polygonized margins (OASIS 2008). These observations are consistent with the habitat associations listed for spectacled eiders in Table 3.9-1 with high association for lake, emergent marsh, and wet sedge habitats (Martin et al. 2009). A failed spectacled eider nest at the Bullen Point radar site found in 2007 was in lowland wet-moist patterned tundra complex, which is equivalent to wet sedge/moist sedge, dwarf shrub tundra complex (IIId; OASIS 2008). During brood-rearing from mid-July to early September, most broods in the Colville River delta were observed using either salt-killed tundra and deep open water habitats with islands or polygonized margins (Johnson et al. 2000). Brood-rearing spectacled eiders in the Kuparuk and Milne Point oil fields use primarily water bodies with margins of emergent grasses and sedges, basin wetland complexes, and occasionally deep open lakes (Anderson and Cooper 1994). When young are capable of flight, spectacled eiders move to nearshore marine waters, and then leave the ACP when freeze-up begins, usually by early to mid September (65 FR 6114; USFWS 1996).

On Alaska's North Slope, nearly all spectacled eiders breed north of 70° latitude between Icy Cape and the Shaviovik River, within about 50 miles of the coast (65 FR 6114). Within this region, most spectacled eiders occur between Cape Simpson and the Sagavanirktok River (65 FR 6114). The current nesting population is estimated to be between 5,047 and 7,368 with an annual declining trend of 1 percent (Larned et al. 2009). In general, very high densities of nesting spectacled eiders occur west of the

Sagavanirktok River and are concentrated primarily within the NPR-A, with densities between the Shaviovik and Canning Rivers ranging from very low to medium (Larned et al. 2009; Figure 3.9-4).

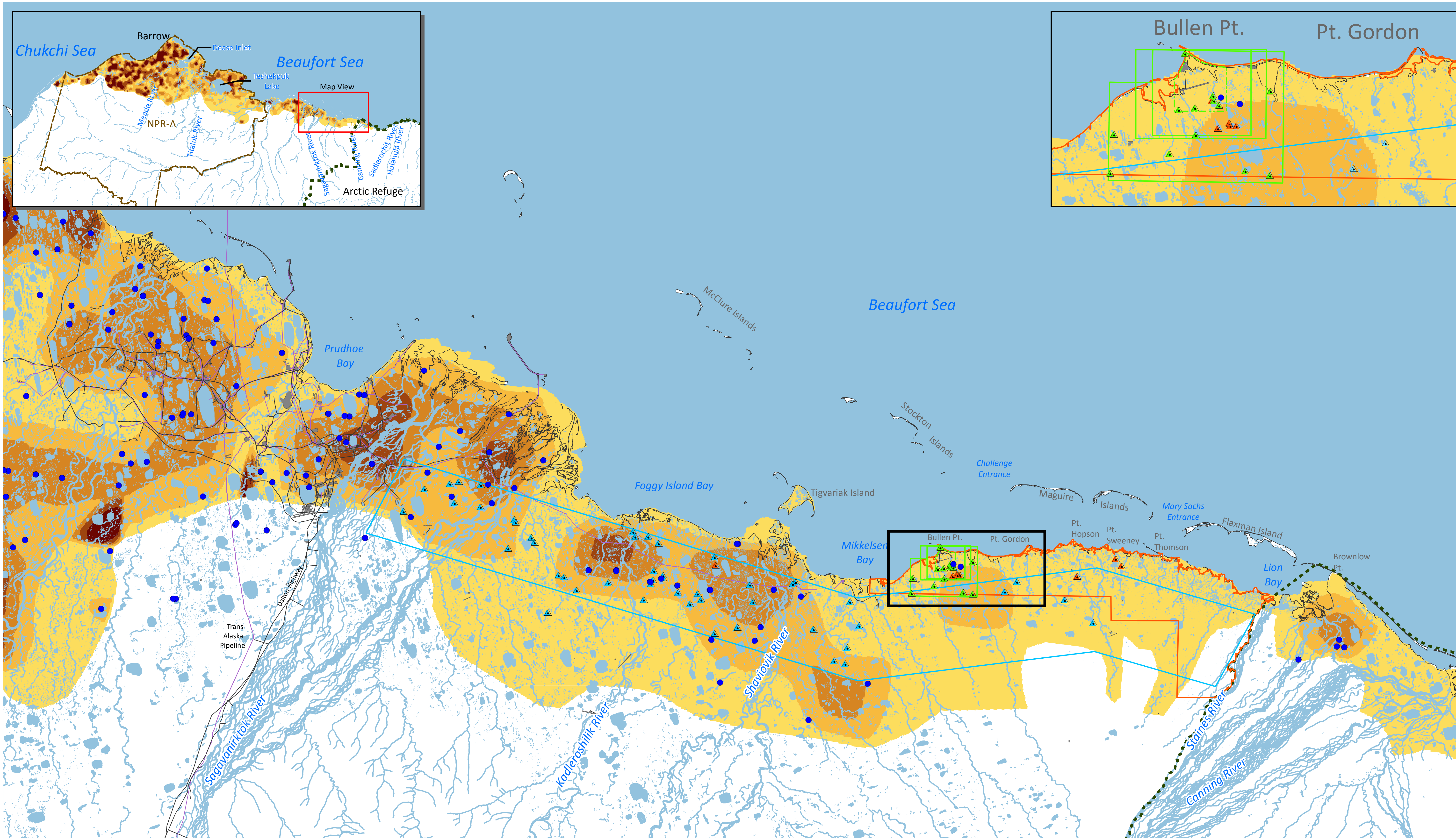
Troy Ecological Research Associates (TERA) flew 100 percent coverage surveys for eiders during June 1998 to 2001 for a portion of the Point Thomson study area (TERA 2000, 2002; Figure 3.9-4), documenting seven pairs of spectacled eiders during 4 years of surveys. Zero to three pairs of spectacled eiders occurred within the Point Thomson Unit survey area, resulting in an average annual nesting density of less than 1 pair/mi^2 within the 76.7 mi^2 survey area (TERA 2002). Although TERA did not confirm spectacled eider breeding within their survey area, breeding was confirmed by the report of a spectacled eider hen with four young south of Point Sweeney on July 31, 1998 (2002; Figure 3.9-4). Recent aerial and ground surveys for spectacled eiders have been conducted near the Bullen Point radar site in 1994, 2000, 2002, 2003, 2006, and 2007 (Day et al. 1995, Day and Rose 2000, Ritchie et al. 2003b, Schick et al. 2004, Frost et al. 2007, OASIS 2008) with 1 to 14 spectacled eiders observed each year near this facility (Figure 3.9-4). A single failed spectacled eider nest was found at the Bullen Point radar site in 2007 over the 6 years of searches (OASIS 2008). A 2010 aerial survey of the study area for nesting Steller's and spectacled eiders did not document spectacled eiders (Johnson et al. 2011)

3.9.9.3 Yellow-billed Loon – Candidate for Listing

The yellow-billed loon was designated a candidate for federal listing under the ESA throughout its range on March 25, 2009 (74 FR 12932). The yellow-billed loon is included in this section because of the high potential that it will receive protection under the ESA during the life of the Point Thomson project. Yellow-billed loons are considered vulnerable due to a combination of low population size, low reproductive rate, and very specific breeding habitat requirements (Earnst 2004). Potential identified threats to the continued survival of yellow-billed loons in Alaska include oil and gas development (especially within the NPR-A), marine pollution and overfishing, exposure to contaminants, climate change, subsistence- and commercial fishing by catch, and subsistence harvest (74 FR 12932).

The yellow-billed loon is the largest of the three loons occurring in the Point Thomson study area. Yellow-billed loons are ***piscivorous*** (fish eating) birds and are specialized for diving and swimming underwater with their streamlined shape and legs set near the rear of the body. They are unable to take flight from land.

Yellow-billed loons nest in coastal and inland low-lying tundra, in association with permanent, fish-bearing lakes on the ACP, northwestern Alaska, and on Saint Lawrence Island (74 FR 12932). Nests are typically located on lakes that have abundant fish populations, are deeper than 6 feet and at least 33 acres. The lakes have connections to streams that supply fish, convoluted, vegetated, and low-lying shorelines, clear water, and stable water levels. Nest sites are usually located on islands, hummocks, or peninsulas, along low shorelines, within 3 feet of water (74 FR 12932). One or two eggs are laid in mid- to late June, and hatch after 27 to 28 days of incubation by both sexes (74 FR 12932). Young loons leave the nest soon after hatching, and both male and female feed and care for the young (North 1994). Yellow-billed loons use nearshore and offshore marine waters close to their breeding areas for foraging in summer (74 FR 12932).



POINT THOMSON PROJECT EIS

Legend

Spectacled Eider Nesting Density (birds per mi²) (1992-2005)
- 0.000 - 0.088 - Very Low
- 0.088 - 0.378 - Low
- 0.378 - 0.660 - Medium
- 0.660 - 1.059 - High
- 1.059 - 3.232 - Very High

Spectacled Eider Aerial Survey Nest Locations
- Point Thomson
- Bullen Point
- Kuvlum

- Spectacled Eider Breeding Survey Observations (1992-2009)
- Point Thomson Aerial Survey Area 1998-2001
- Bullen Point Aerial Survey Area 1994, 2002, 2006
- Bullen Point Ground Survey Area 2006, 2007
- Kuvlum Aerial Survey Area 1993
- Existing Road
- Existing Pipelines
- Existing Facilities
- Arctic National Wildlife Refuge

N

0 3 6 Miles

Figure 3.9-4

Arctic Coastal Plain Spectacled Eider Nesting Density with Point Thomson Study Area Observations

Date: 23 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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The estimated Alaskan ACP population of yellow-billed loons was 1,200 in 2008 (74 FR 12932; Larned et al. 2009). The 10-year population trend for the ACP suggests that this breeding population has increased at a rate of nearly 5 percent per year (Larned et al. 2009; Appendix L), while previous estimates have indicated the population is stable or slightly declining (74 FR 12932).

The largest areas of very high densities of nesting yellow-billed loons occur west of the Colville River (Earnst et al. 2005, Larned et al. 2009). Yellow-billed loon density in the study area is very low (Larned et al. 2009; Figure 3.9-5). No yellow-billed loon nests have been found in the Point Thomson study area, although the breeding pair survey data and density contours indicate there may be nest habitat about 14 miles southwest of the project area (Figure 3.9-5). A study area-specific aerial survey for nesting yellow-billed loons was conducted in 2010 and no nesting birds were observed (Johnson et al. 2011).

Yellow-billed loons use coastal areas in the study area for summer foraging (Fischer et al. 2002; Rodrigues 2002 a, b; Noel et al. 2003; Fischer and Larned 2004) and for fall staging and migration (WCC and ABR 1983). An average of two yellow-billed loons were observed during late-June or early July coastal surveys during between 1999 and 2009 (Appendix L), while an estimated six yellow-billed loons use the nearshore and lagoon habitats in the study area (Appendix L). Locations of coastal yellow-billed loon observations during July surveys in 1999, 2000, and 2001 are illustrated in Figure 3.9-5.

Yellow-billed loons winter in coastal waters of southern Alaska from the Aleutian Islands to Puget Sound, the Pacific coast of Asia from the Sea of Okhotsk south to the Yellow Sea, the Barents Sea and the coast of the Kola Peninsula, coastal waters of Norway, and possibly Great Britain (74 FR 12932). Yellow-billed loons migrate by following primarily marine routes (74 FR 12932).

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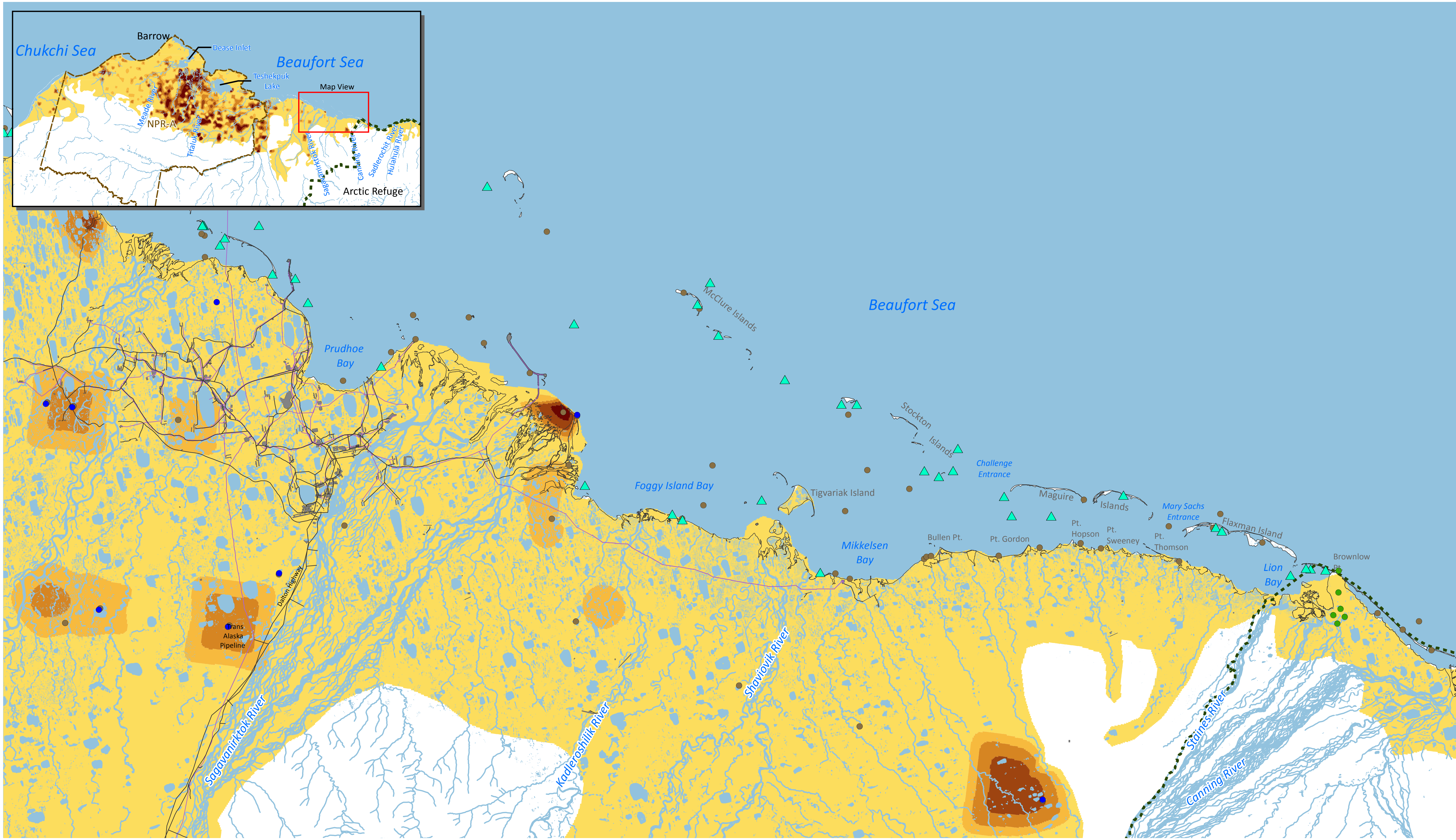

Figure 3.9-5

Arctic Coastal Plain Yellow-billed Loon Nesting Density with Post-nesting Point Thomson Study Area Coastal Observations

POINT THOMSON PROJECT EIS

Legend

Yellow-billed Loon Nesting Density (birds per mi²) (1992 - 2005)

- 0.000 - 0.065 - Very Low
- 0.065 - 0.148 - Low
- 0.148 - 0.295 - Medium
- 0.295 - 0.510 - High
- 0.510 - 1.802 - Very High

- Yellow-billed Loon Breeding Survey Observations (1992-2009)
- Yellow-Billed Loon - Kendall et al. 2003, Kendall and Brackney 2004, Kendall and Villa 2006, and Kendall et al. 2007
- Yellow-Billed Loon Registry Observations - USFWS
- Yellow-billed Loon Post-nesting Coastal Observations (1999-2001)
- Existing Road
- Existing Pipelines
- Existing Facilities
- Arctic National Wildlife Refuge

0 3 6 Miles

Date: 23 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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3.10 TERRESTRIAL MAMMALS

The study area used to describe terrestrial mammals for assessing the Point Thomson project includes the ACP between the Dalton Highway and the Staines/Canning River and inland within approximately 20 to 30 miles from the coastline .

3.10.1 Key Information About Terrestrial Mammals

The terrestrial mammals of concern for the Point Thomson project are caribou, muskoxen, brown bears, foxes, and small mammals.

Caribou use the study area for calving, summer foraging, and parasitic insect relief. During this time, caribou, potentially from several herds, are constantly on the move within and into and out of the area as they forage and seek relief from insects. Caribou calving ranges and post-calving movements vary from year to year depending on a variety of factors (e.g., weather, forage condition, insect abundance and activity, predators, disturbance). Caribou are an important subsistence resource and also are hunted recreationally.

The muskoxen population in the study area descends from a herd of muskoxen that was reintroduced to the North Slope between 1969 and 1970 following extirpation of the species in the late 1800s from overharvest. The North Slope population declined from over 500 animals to about 200 animals between the late 1990s and the mid-2000s; in recent years the population appears to have stabilized at around 200. Muskoxen use the study area year-round, using riverine and riparian habitats in the summer and windswept hilltops, slopes, and plateaus in winter.

Brown bears occur at a low to moderate density on the North Slope. Bears spend between 5 and 8 months in dens, which are commonly located in streambanks, hillsides, and terraces where snow accumulates. Within the study area, brown bear dens have been documented between the Sagavanirktok and Shaviovik Rivers. During their active period, brown bears range widely for food. Within the study area they have been observed foraging and moving through riparian habitats.

Arctic foxes spend summers on land and winters primarily along the coast and on sea ice. Red foxes tend to be most abundant in the foothills and riparian areas on the North Slope. Arctic foxes are attracted to human development and their numbers on the North Slope have been stable in recent years. Red and arctic foxes compete for resources where they occur together, and the larger red fox often displaces the smaller arctic fox.

Small mammals, such as arctic ground squirrels, collared and brown lemmings, root voles, and barren ground shrews occur in the study area. Small mammals are important because they form the prey base for many mammals and birds, and because they are an integral part of the arctic ecosystem.

3.10.2 Review and Adequacy of Information Sources for Terrestrial Mammals

Terrestrial mammals on the North Slope have been studied by the USFWS, USGS, ADF&G, and private oil and gas companies operating on the North Slope. The types of studies include annual or less regular population estimates based on airplane or ground counts and behavioral studies of terrestrial mammals in specific locations. The terrestrial mammal information provided in this Draft EIS relies on data from multiple sources collected both within and outside of the study area over a 40 year time period based on observational, telemetry, systematic, and non-systematic study designs. These data represent the best available information to describe terrestrial mammal abundance, distribution, and vulnerability to potential impacts. More recent telemetry data, including detailed caribou movements and brown bear den locations for the study area collected by ADF&G biologists, were not made available for use in this assessment.

The abundance and distribution of some large game mammals such as caribou, muskoxen, and brown bears are regularly monitored by the ADF&G in their efforts to evaluate population status and to make recommendations to the Board of Game, who set harvest regulations. Industry-sponsored aerial surveys flown during the summers of 1995 and 1997 to 2003 for the Badami and Point Thomson projects, and ADF&G and USFWS-collected survey and telemetry data when available, provide the basis for discussion and display of large mammal abundance and distribution within the generalized study area. The size of the CAH has increased substantially since systematic surveys documenting caribou use of habitats within the Point Thomson area were completed; which may underestimate the current number of animals that could be present in the area. Telemetry data from 1983 to 2001 available for the assessment from WCC and ABR (1983) and USGS (Griffith 2002) are also dated and may underestimate exposure of caribou to the potential alternative scenarios. The number of muskoxen in the region has decreased somewhat since systematic surveys were completed, which may overestimate the current number of animals that could be present in the area. The status of most small mammals is not monitored and their abundance, distribution, and population trends are relatively unknown.

Den and burrow habitat is an important factor in understanding the potential distribution and use of the study area by hibernating brown bears, reproducing arctic and red foxes, and burrowing small mammals. Because there are limited data available on den and burrow locations for these species within the study area, potential den and burrow habitat was also used to assess potential impacts. For burrowing small mammals and arctic foxes, potential burrow and den habitat was evaluated based on the availability of dry dwarf shrub-lichen tundra (map units Vc and Vd) because these habitats contain well-drained soils that are potentially suitable for construction of burrows and den sites. For brown bears potential den habitat was evaluated based on a den habitat model developed for polar bears based on topography and aerial photo interpretation for this region (Durner et al. 2001, 2006). These polar bear den habitat models were used because they are based on topographic features with elevation changes of 3 feet or more (e.g., stream, river, and lake terraces) that likely contain soils and drifted snow that could also provide suitable den sites for brown bears in the study area. Shideler and Hechtel (2000) documented brown bear den locations on the North Slope within sand dunes, hillsides, stream and river banks, pingos, low-based mounds, terraces of rivers and streams, and margins of drained and active lakes.

Naming conventions for terrestrial mammals follow MacDonald and Cook (2009).

Table H-10 in Appendix H discusses the publications, reports, and data available for terrestrial mammals that are cited in the Draft EIS and their relevance to the proposed project. Full references for the studies cited in the following text are in Chapter 9, References.

3.10.3 Distribution and Occurrence of Terrestrial Mammals

Terrestrial mammal groups represented in the study area include rodents (ground squirrels, lemmings, and voles), carnivores (shrews, foxes, bears, and weasels), and ungulates (caribou and muskoxen). Other terrestrial mammals that have been observed in the study area include moose, wolves, and wolverines; however, these mammals are not common in the Point Thomson area and potential impacts to these mammals are not evaluated. Scientific and Iñupiaq names for terrestrial mammal species that occur in the study area are listed in Appendix B. Most of these terrestrial mammals remain in the arctic year-round and use various strategies to survive the harsh winter such as living under the snow in burrows and runways, storing food, going dormant in dens, building fat reserves and using these body reserves over the winter, growing protective coats of hair or fur, and remaining active and moving for forage and cover (Table 3.10-1).

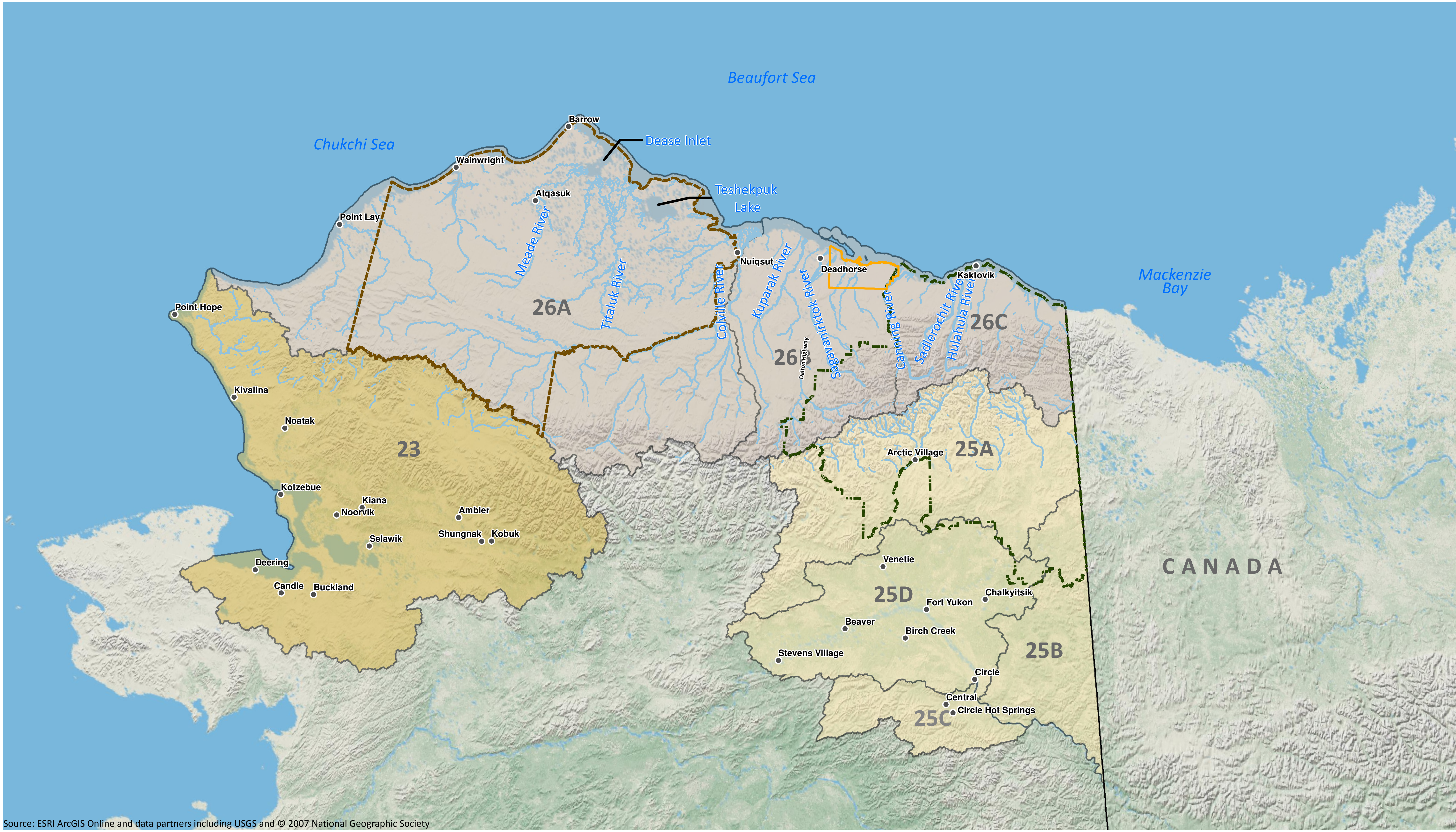
The proposed project is within the ADF&G's Game Management Unit (GMU) 26B and borders GMU 26C (Figure 3.10-1). Terrestrial mammals, especially caribou, are an important subsistence resource (see Section 3.22, Subsistence and Traditional Land Use Patterns) and brown bear, caribou, moose, wolves, foxes, arctic ground squirrels, and wolverines may be hunted during various seasons within GMU 26B (ADF&G 2009a). Wolves, wolverines, weasels, arctic ground squirrels, and foxes may also be trapped within GMU 26B (ADF&G 2009b).

Table 3.10-1: Life History Strategies and Requirements for Terrestrial Mammals Occurring in the Point Thomson Study Area					
Common Name	Grouping	Winter Strategy	Winter Requirements	Reproductive Strategy[a]	Growing Season Requirements
Arctic Ground Squirrel	Medium-size herbivore (1 - 2 pounds)	Dormant in den (hibernation), fatten before denning, use body reserves.	Winter dens, snow for insulation.	Altricial offspring, short to medium gestation, short lactation, social groups, single small to medium litters.	Abundant green forage, burrows for escape/sleep, large prewinter body reserves.
Collared Lemming Brown Lemming Root Vole	Small-size herbivores (<1 pound)	Active beneath snow, food storage.	Access to stored food, hoar frost layer, snow for insulation, natal nests.	Altricial offspring, short gestation, lactation, parental care, multiple medium to large litters.	Abundant green forage, food to store for winter, natal and post-natal nests, runways, and escape cover.
Caribou Muskoxen	Large/very large herbivores (>100 pounds)	Active, adapted to cold and reduced food, use body reserves.	Adequate winter forage, soft shallow snow.	Precocial offspring, long gestation, lactation, parental care, single birth of 1-2 offspring.	Abundant green forage, prewinter body reserves.
Barren Ground Shrew Ermine Least Weasel	Small-size carnivores (<1 pound)	Active and/or subnivean.	Invertebrate/small animal prey, natal nests, snow for insulation.	Altricial offspring, short gestation and lactation; short to medium care, single/multiple medium to large litters, delayed implantation in weasels (ermine and least weasel).	Invertebrate/small animal prey, nests.
Arctic Fox Red Fox	Medium/large-size carnivore (10 - 100 pounds)	Active, adapted to cold.	Winter prey or carcasses, natal and/or permanent dens.	Altricial offspring, short to medium gestation and lactation; short to long care, single small to large litters.	Summer prey or carcasses, dens/shelter.
Brown Bear	Vary large-size omnivore (>100 pounds)	Dormant in den, fatten before denning, use body reserves.	Natal and winter dens, adequate snow for insulation.	Altricial offspring, delayed implantation, medium gestation, very long lactation and maternal care.	Access to food, large pre-winter body reserves.

Source: Martin et al. 2009

[a] Most arctic mammals reproduce once per year; some small and medium-sized mammals may have two or more litters per year while some large/very large mammals have offspring at intervals of two or more years (Martin et al. 2009).

Altricial – blind, naked, helpless at birth, require shelter and parental care. *Precocial* – more developed at birth, with hair and able to walk and see shortly after birth. *Subnivean* – below the snow.



POINT THOMSON PROJECT EIS

Legend

Game Management Unit

- Unit 23
- Unit 25
- Unit 26
- Project Study Area
- Arctic National Wildlife Refuge
- National Petroleum Reserve - Alaska
- Water Body
- Stream

0 50 100 Miles

N

Figure 3.10-1

ADF&G Game Management Unit Boundaries

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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3.10.3.1 Small Mammals – Arctic Ground Squirrel, Lemmings, Voles, Shrews, and Weasels

The arctic ground squirrel is a featured species in the ADF&G Comprehensive Wildlife Conservation Plan because its status and abundance are considered uncertain (ADF&G 2006). Their distribution and abundance in the study area has not been investigated; but they are known to occur and burrow complexes may occur in areas with suitable burrow habitat (Vc and Vd). Habitats mapped as moist tundra, moist/wet tundra complex, dry tundra and disturbed barrens may provide suitable foraging habitat for arctic ground squirrels.

Arctic ground squirrels are colonial and can be locally abundant in suitable tundra, meadow, riverbank, and lake shore habitats with well-drained loose soils, vantage points, and adequate supplies of low, early succession vegetation (MacDonald and Cook 2009). They spend up to nine months, generally September or October to May, hibernating in their underground burrow systems and giving birth in June (Batzli and Sobaski 1980, MacDonald and Cook 2009). Large burrow systems usually have more than six entrances and reach depths greater than 1.5 feet. Arctic ground squirrels are an important food resource for brown bears, especially in spring and late fall, often occurring in the same types of habitats used for brown bear dens (See Section 3.10.3.5) and emerging from hibernation at about the same time as brown bears (Shideler and Hechtel 2000).

Based on habitat preferences and availability, and average densities reported for the nearby Arctic Refuge, brown lemmings and root voles would be expected to dominate the small mammal fauna in the study area east of Bullen Point. This is consistent with data from a study conducted just east of the Canning River (Babcock 1985). Populations of lemmings and voles vary widely in abundance from year to year. Peaks in abundance occur during years with mild winters and good snow cover, which is related to the strategy these animals use to survive the arctic winter by remaining active under the snow. The abundance of lemmings and voles, in turn, influences the abundance and reproductive success of animals that prey on them such as ermine, least weasels, foxes, raptors, owls, and jaegers.

Brown lemmings and root voles are most often associated with wet sedge meadows (and low-centered polygons where they eat primarily sedges and grasses. These habitats are relatively common in the study area east of Bullen Point. Habitats mapped as wet tundra, moist tundra, and moist/wet tundra complex likely provide suitable habitat for brown lemmings and root voles. Collared lemmings prefer drier habitats found in tussock tundra, foraging primarily on shrubs and forbs. Habitats mapped as dry and moist tundra were considered to provide suitable habitat for collared lemmings.

The distribution and abundance of shrews on the ACP is not well understood (MacDonald and Cook 2009). Shrews could periodically be relatively abundant in the study area, although Burgess (1984) captured only one barren ground shrew after 18,100 trap days over 2 summers within a 74-acre study area in the Arctic Refuge to the east of Point Thomson. Habitats mapped as moist tundra and moist/wet tundra complex were considered to provide suitable habitat for shrews.

Ermine and least weasels are likely to occur in low numbers in the study area. Based on findings by Babcock (1985), they may occur in densities as high as 1.2 per acre during peaks in lemming and vole abundance. All tundra habitats were considered suitable habitat for ermine and least weasels.

3.10.3.2 Caribou

Caribou are an important resource because of their subsistence and cultural value for indigenous Alaskans, recreational hunting and nonconsumptive use for the general public, and as an integral component for function of the arctic ecosystem. They are the most conspicuous terrestrial mammal on the arctic Alaska landscape, with more than 600,000 animals in four recognized arctic Alaska herds: the Western Arctic Herd (WAH;

approximately 377,000 caribou), the Teshekpuk Herd (TH; approximately 64,000 caribou), the Central Arctic Herd (CAH; approximately 67,000 caribou), and the Porcupine Herd (PH; approximately 100,000 caribou; Dau 2007, Caikoski 2009a, Lenart 2009a, Parrett 2009). Herds are defined as "any group of caribou that uses one calving area repeatedly over a period of years, distinct from the calving area of any other group" (Skoog 1968). Herd size and estimated birth rates (based on the number of radio-collared cows with calves compared to the number of radio-collared cows without calves observed by ADF&G) for the four arctic caribou herds are illustrated in Figure 3.10-2 through Figure 3.10-5. The WAH and PH have declined during the last decades, while the TH and CAH have increased (Figure 3.10-2 through Figure 3.10-5).

Caribou are nomadic and their seasonal distributions are generally centered on their calving ranges (Skoog 1968). Range extent and generalized calving ranges for the four arctic caribou herds are illustrated in Figure 3.10-6. Caribou groups from the various herds mix with each other to varying degrees during post-calving, breeding, and winter. As illustrated in Figure 3.10-6, the CAH is the predominant herd in the study area. Range extents for the smaller herds (CAH and TH) are generally more compact than those for the larger herds. With increasing densities, caribou movements may become more extensive, leading to shifts in seasonal habitat use, immigration and emigration between populations, and in some cases shifts in calving ranges (Skoog 1968, Hinkes et al. 2005, Dau 2007, Caikoski 2009a, Lenart 2009a, Parrett 2009).

Caribou cows are the least mobile just before and shortly after giving birth (Griffith et al. 2002). Calving grounds are considered the areas used during the calving period, which is just prior to birth through the peak lactation period. For the CAH, the calving period is generally late May to mid-June. Calving generally occurs inland from the Beaufort Sea coast; although this distance may vary annually and is likely affected by the timing of snow melt and vegetation green-up (Curatolo and Reges 1985, Kelleyhouse 2001, Noel et al. 2002a). The peak of calving in this region generally occurs during the first week of June, but also varies with snowmelt conditions (Arthur and Del Vecchio 2009, Lenart 2009a). After calving and before the onset of the peak mosquito abundance, cows continue to increase movement rates and begin to coalesce into groups, which gradually increase in size and are joined by male caribou. Forage plants continue to increase on the ACP during this period.

Mosquitoes play a role in caribou movement and aggregation. Mosquito abundance usually peaks during the first half of July and, in response to these biting insects, caribou move toward the coast and may aggregate into very large groups, up to tens of thousands, sometimes containing mixtures of animals from more than one herd. In late July to early August, growth of forage plants peaks, mosquitoes wane, and bot and warble flies (parasitic flies) increase in abundance, although mosquito and fly activity periods overlap. Weather usually moderates and caribou groups begin to split apart during this period. Caribou often respond to flies by running erratically or standing motionless in a head-down position (Dau 1986). By mid August to October, forage plants mature**,** forage quality declines, and caribou move to breeding areas in the foothills and mountains where rut begins in October to November. After breeding, caribou move to winter ranges and, again, caribou from various herds may mix together on winter ranges. Spring migration begins in April or May.

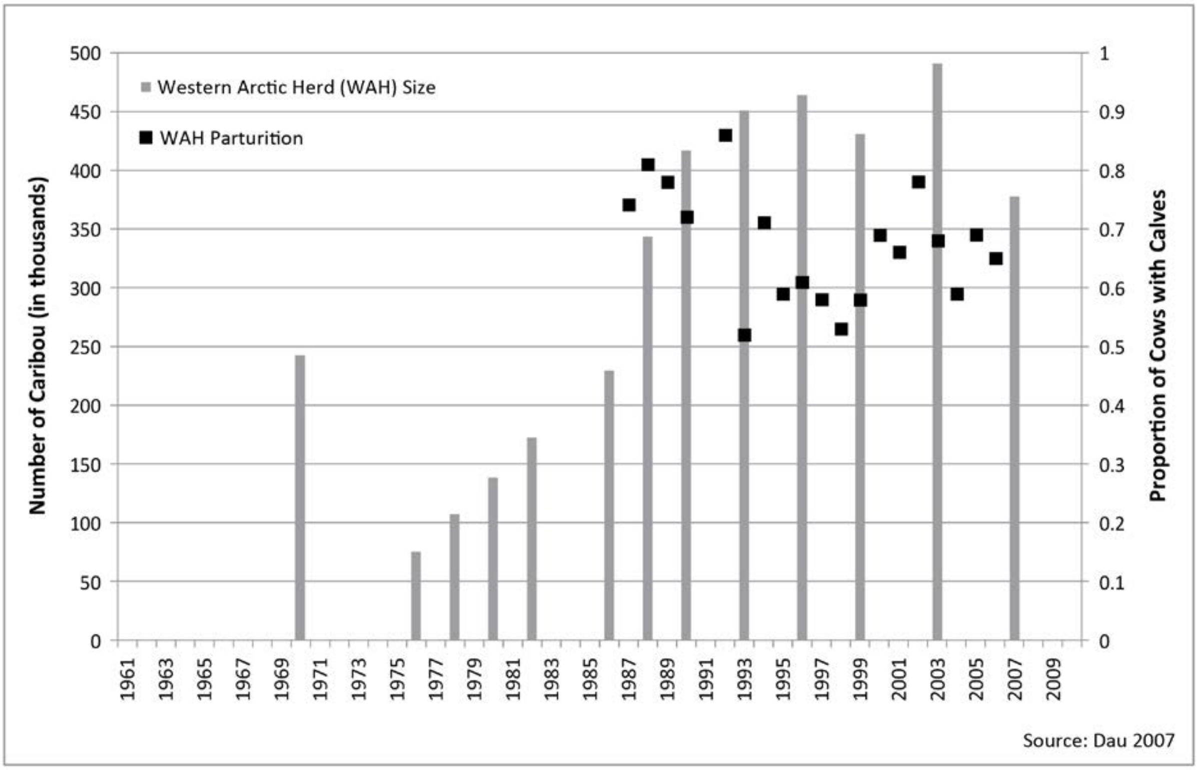


Figure 3.10-2: Western Arctic Caribou Herd Sizes and Estimated Birth Rates

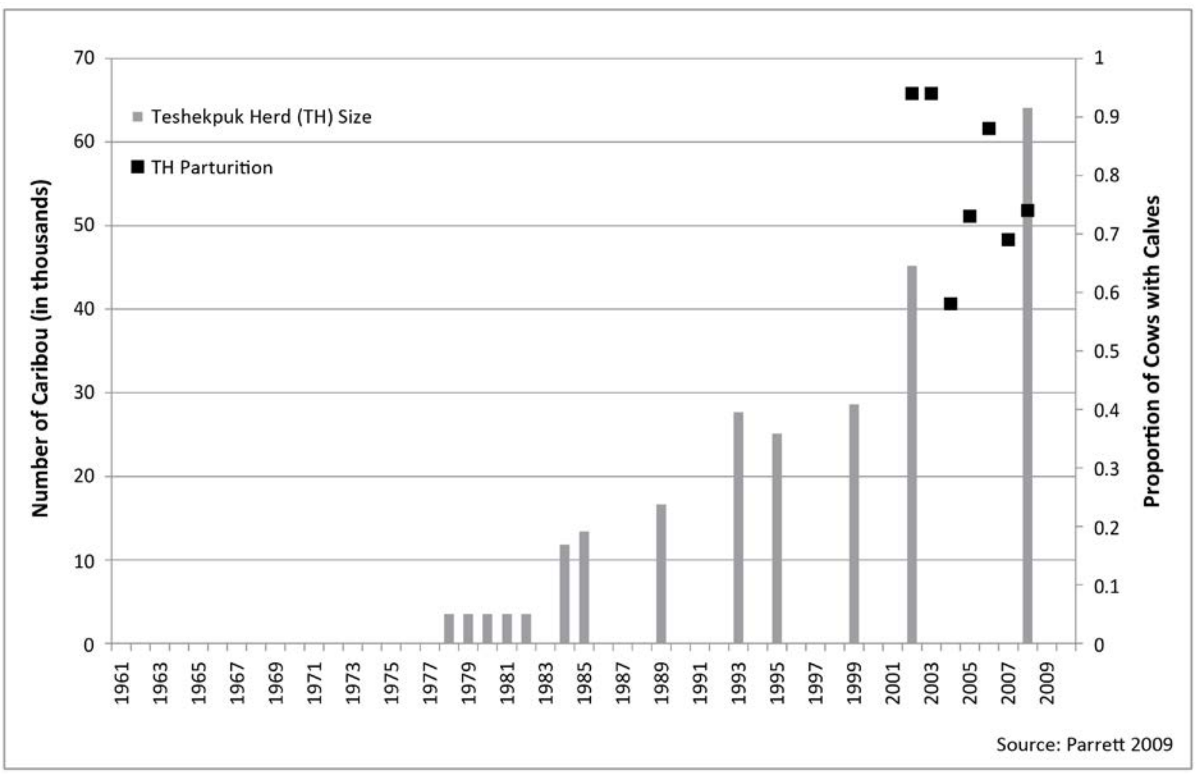


Figure 3.10-3: Teshekpuk Caribou Herd Sizes and Estimated Birth Rates

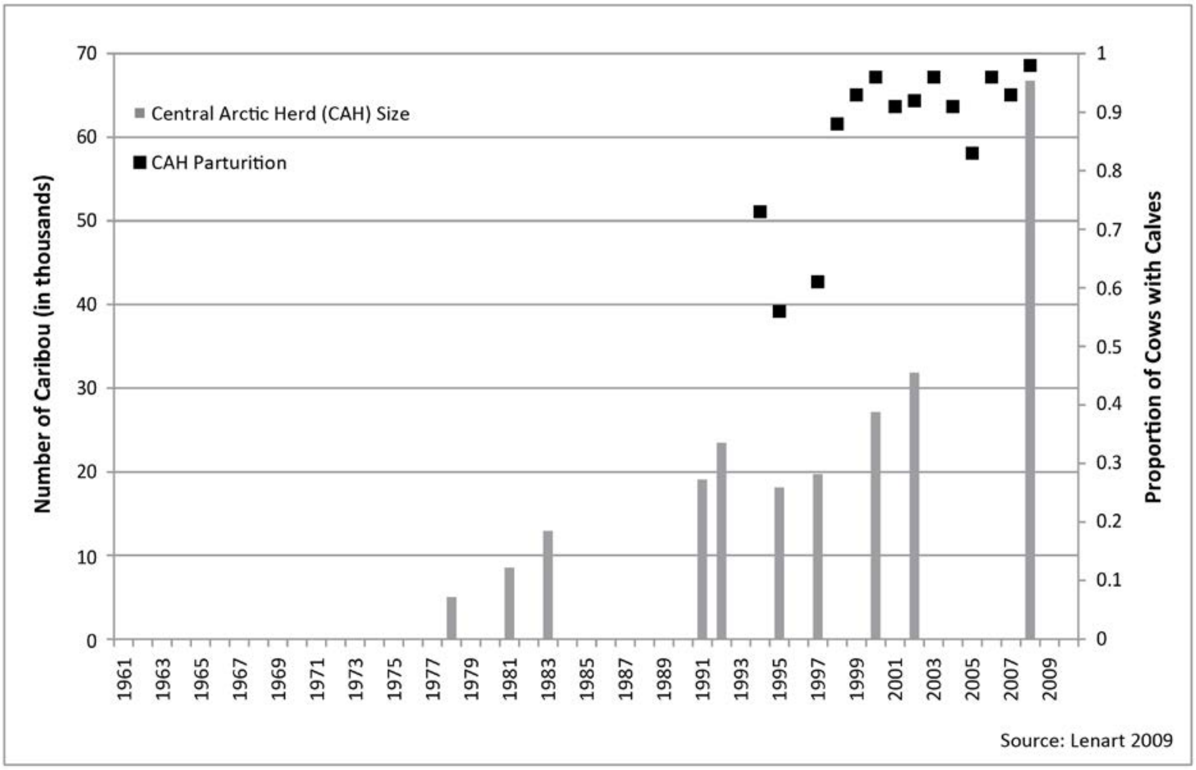


Figure 3.10-4: Central Arctic Caribou Herd Sizes and Estimated Birth Rates

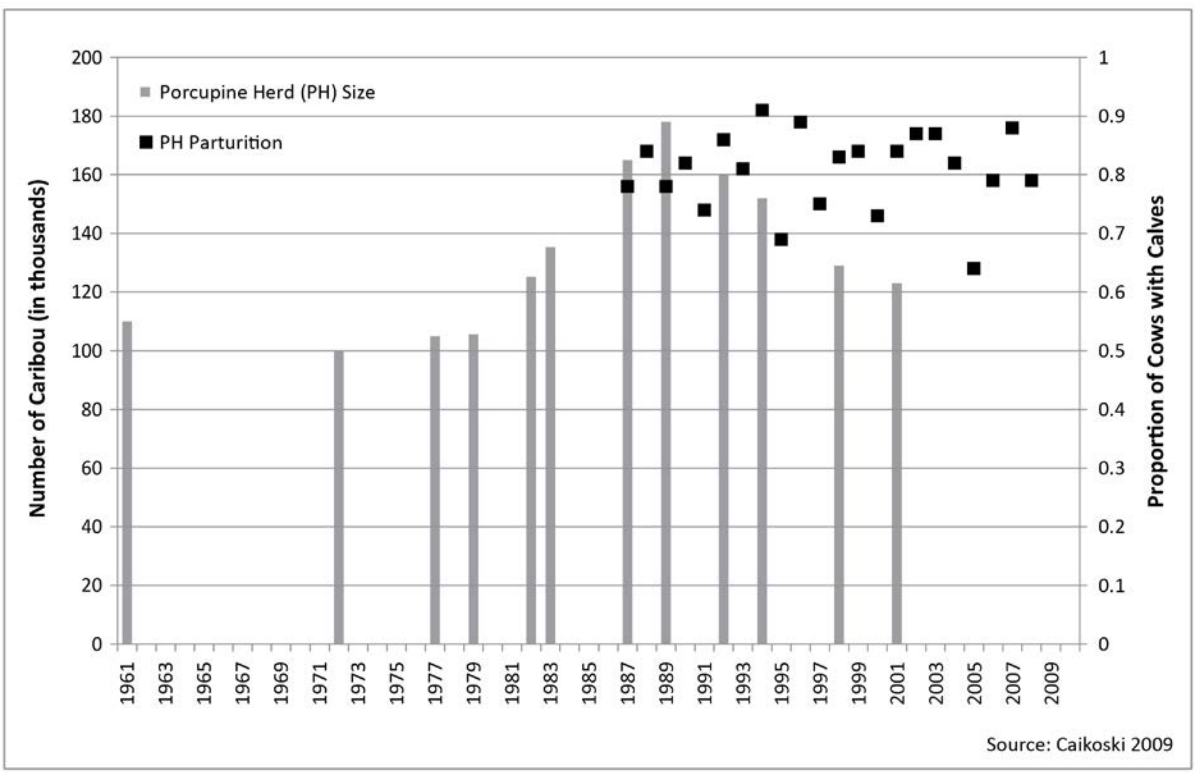
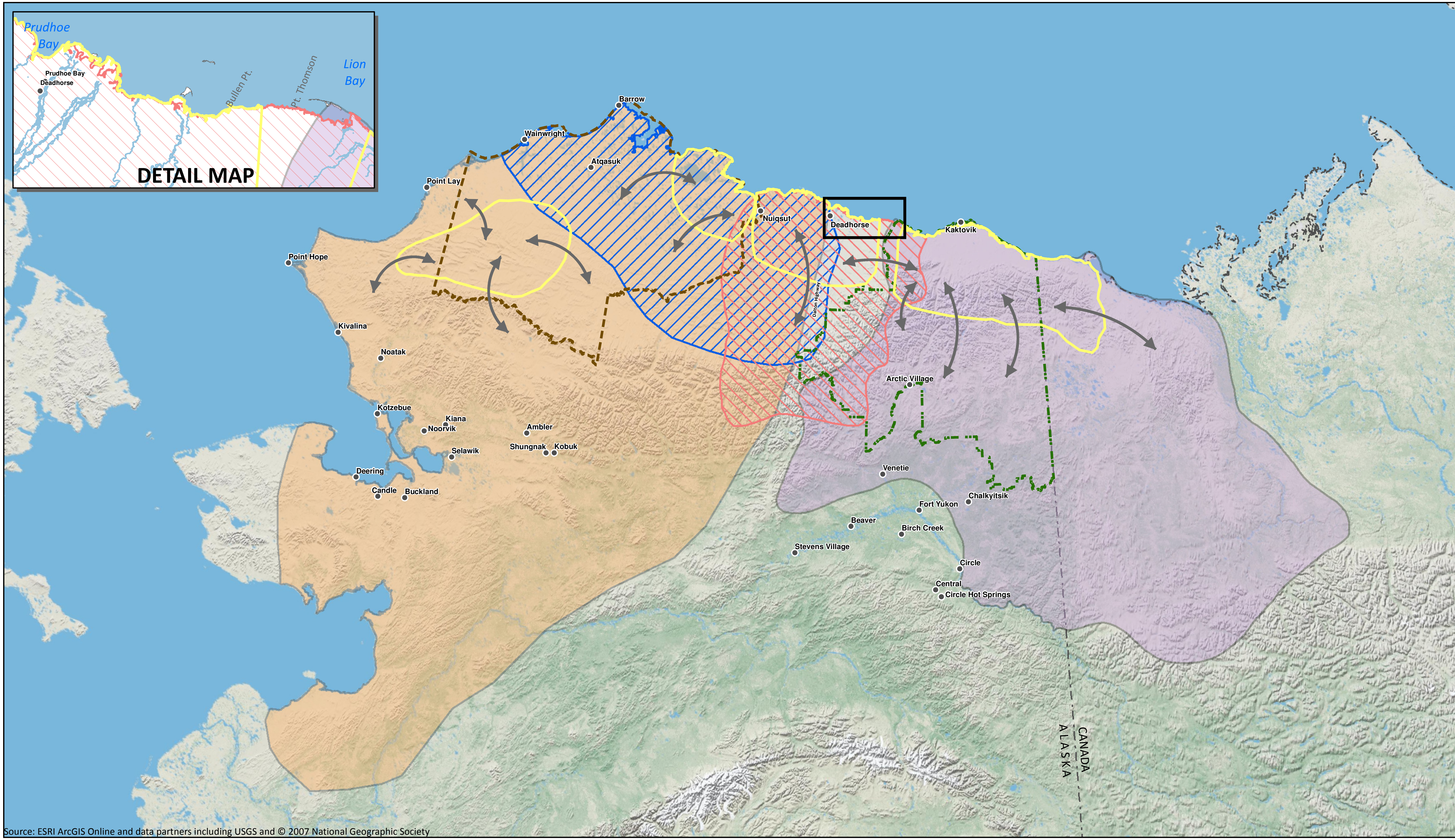


Figure 3.10-5: Porcupine Caribou Herd Sizes and Estimated Birth Rates



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Legend

Caribou Seasonal Movements

Area

- Caribou Calving Ground
- Porcupine Herd Range
- Central Artic Herd Range
- Western Arctic Herd Range
- Teshekpuk Herd Range
- National Petrolium Reserve - Alaska
- Arctic National Wildlife Refuge

Miles 0 50 100

N

Figure 3.10-6

Arctic Alaska Caribou Herd Ranges, Calving Areas, and Seasonal Movements (WAH, TCH, CAH, PCH)

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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The area between the Sagavanirktok and Canning Rivers contains the eastern portion of the calving range for the CAH (Lenart 2009a). Caribou calving west of the Canning River are defined as CAH caribou; while cows calving east of the Canning River are defined as PH caribou (Figure 3.10-6). Caribou present in the study area at any point in time may belong to CAH, PH, or TH; although based on available satellite and radio-collar studies most caribou within the study area are considered to belong to the CAH.

Systematic caribou surveys were conducted during June 1 to June 20 in this region from 1997 to 2003, a period in which the CAH population grew from 20,000 to 32,000. Based on these surveys, average caribou density within 1 mi^2 grid cells were calculated[1] and are illustrated in Figure 3.10-7. Calving locations for radio-collared CAH caribou are illustrated with calculated densities from systematic surveys in Figure 3.10-7. Caribou density during calving within specific areas is variable year to year, shifting both north to south and east to west (Wolfe 2000, Government 2010). After giving birth, caribou cows and calves begin to coalesce into progressively larger groups, which then move together and are often later joined by male caribou.

Caribou use habitats between the Sagavanirktok River and the Canning River during July and August for foraging and insect relief. They move into and out of this region during the summer and distribution and abundance may change dramatically within the course of several days (Pollard and Noel 1995; Noel 1998a, b; Noel and Olson 1999a, b, 2001a, b; Noel and King 2000a, b; Jensen and Noel 2002, Jensen , et al. 2003; Noel and Cunningham 2003). Average caribou density between the Sagavanirktok and Canning rivers during late-June, July, and early August 1997 through 2003[2] is illustrated in Figure 3.10-8. Highest caribou densities occurred in coastal and riparian habitats as large groups of caribou used these areas to escape from mosquitoes. Caribou groups that were photographed and counted by ADF&G's herd census are illustrated with calculated densities from systematic surveys in Figure 3.10-8.

Caribou movements within the study area during June, July, and August were estimated based on available telemetry data for 34 animals in 1983 and 49 animals (15 identified as CAH and 34 identified as PH) from 1987 to 1990 (WCC and ABR 1983, Griffith 2002; Figure 3.10-9). Each time a caribou crossed a 1 mi^2 grid cell, a movement was counted. The number of movements ranged from 0 to 39 times for the 83 caribou over the 3 summer months (Figure 3.10-9). Based on these data, Figure 3.10-9 shows that most caribou movement during the summer months occurred near the coast. Some caribou may continue to use this area for foraging into late summer, depending on weather conditions. However, most caribou have usually moved away from this region by late July or early August on their way to breeding areas and winter ranges. Caribou may also move through this region during fall migrations on their way to wintering areas, as occurred when TH caribou moved through this region to overwinter near Barter Island, east of the study area (Person et al. 2007).

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[1] These average densities were calculated from observations of caribou collected during one or two annual 100 percent coverage systematic strip-transect surveys over the seven year period. Numbers of caribou totaled for each grid cell were then divided by the number of times the specific grid cell was sampled which was then divided by the total area of the grid cell that was sampled. Most grid cells were sampled during every survey, however changes in survey extent and grid cells that cover areas outside of survey coverage were adjusted for the area sampled during each survey.

[2] Average caribou densities were calculated from observations of caribou collected during three to five annual 100 percent coverage systematic strip-transect surveys over the seven year period. Densities were calculated as described above for the 1-20 June 1997-2003 period.

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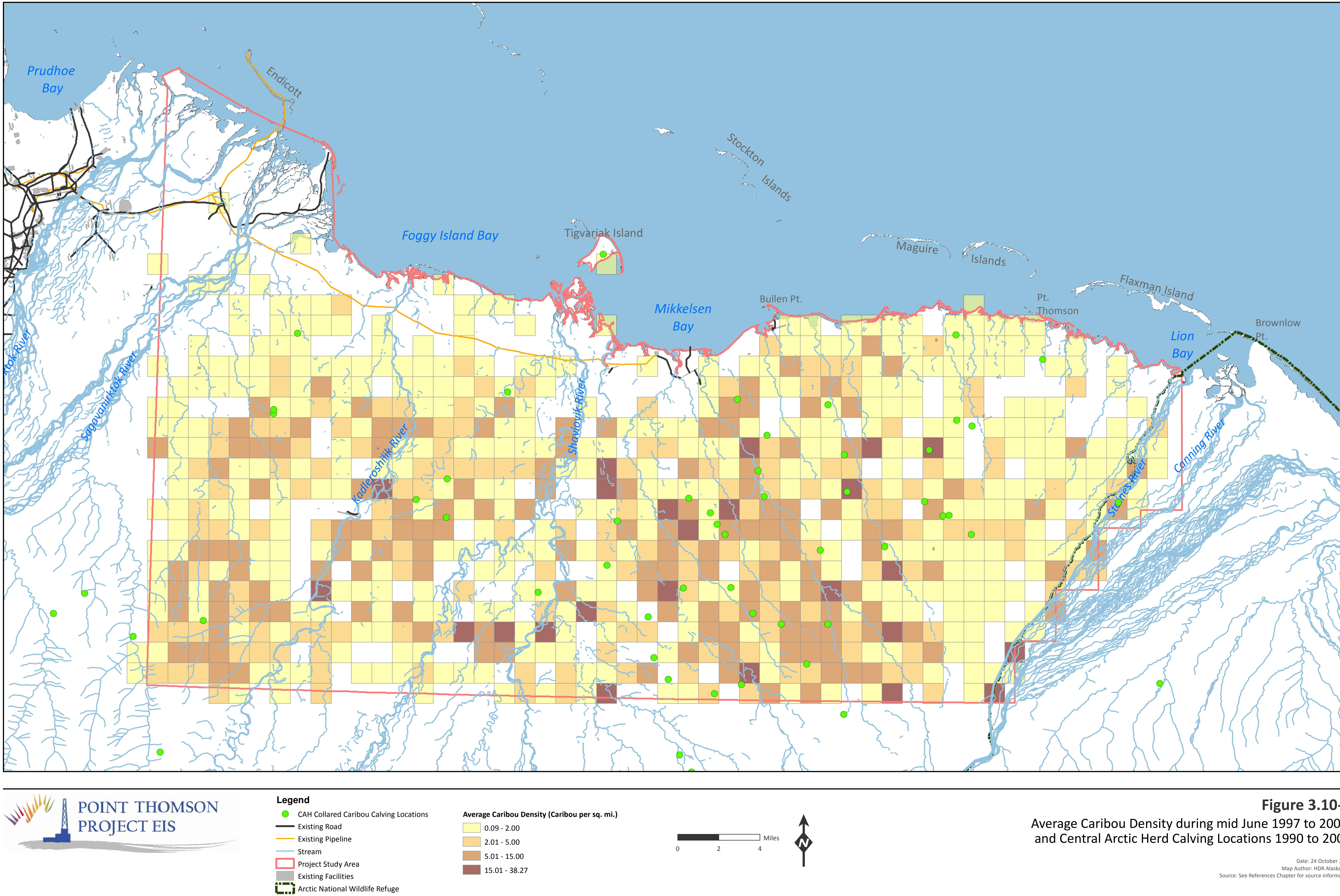

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Figure 3.10-7

Average Caribou Density during mid June 1997 to 2003 and Central Arctic Herd Calving Locations 1990 to 2002

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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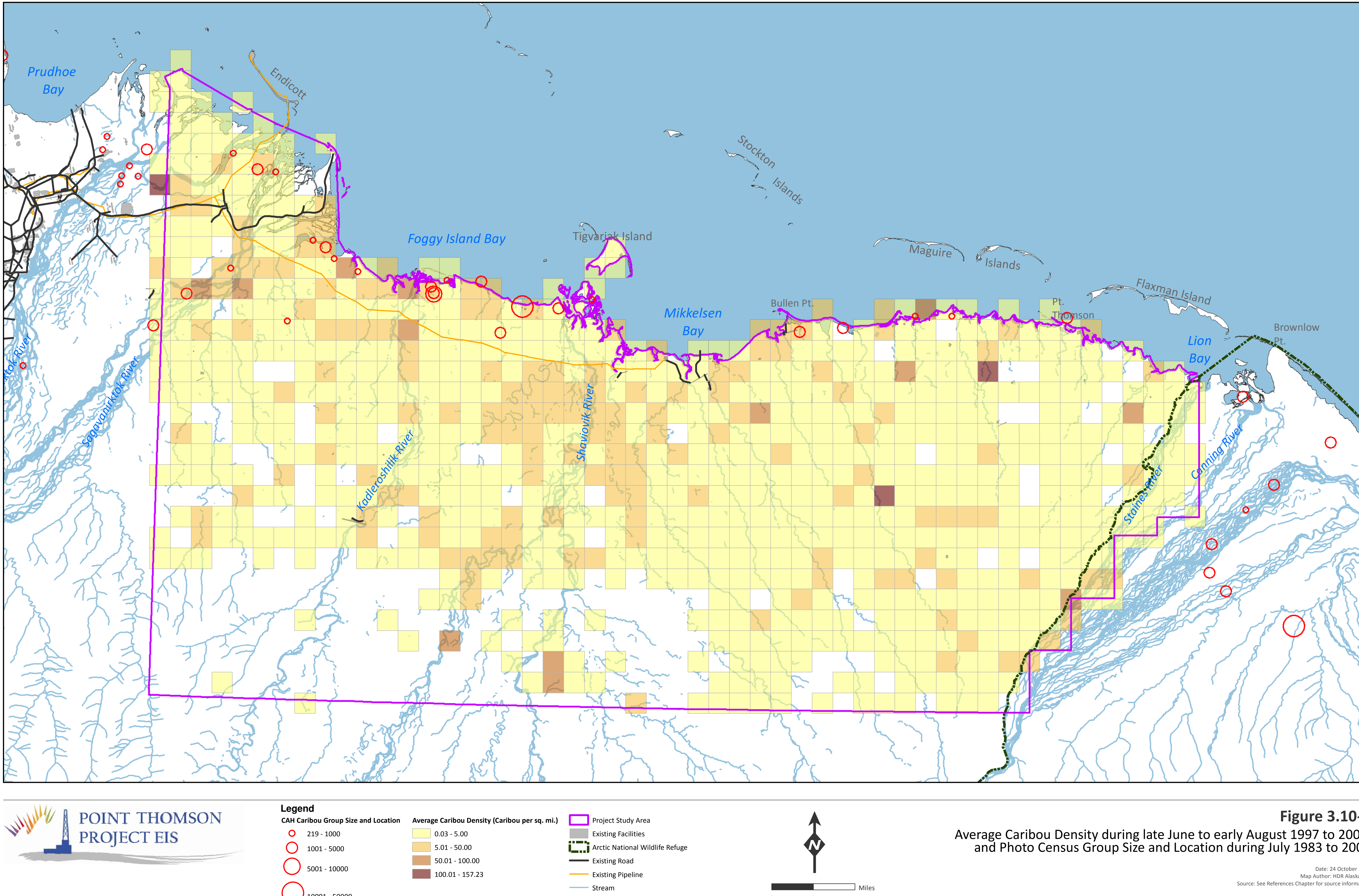

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Figure 3.10-8

Average Caribou Density during late June to early August 1997 to 2003 and Photo Census Group Size and Location during July 1983 to 2008

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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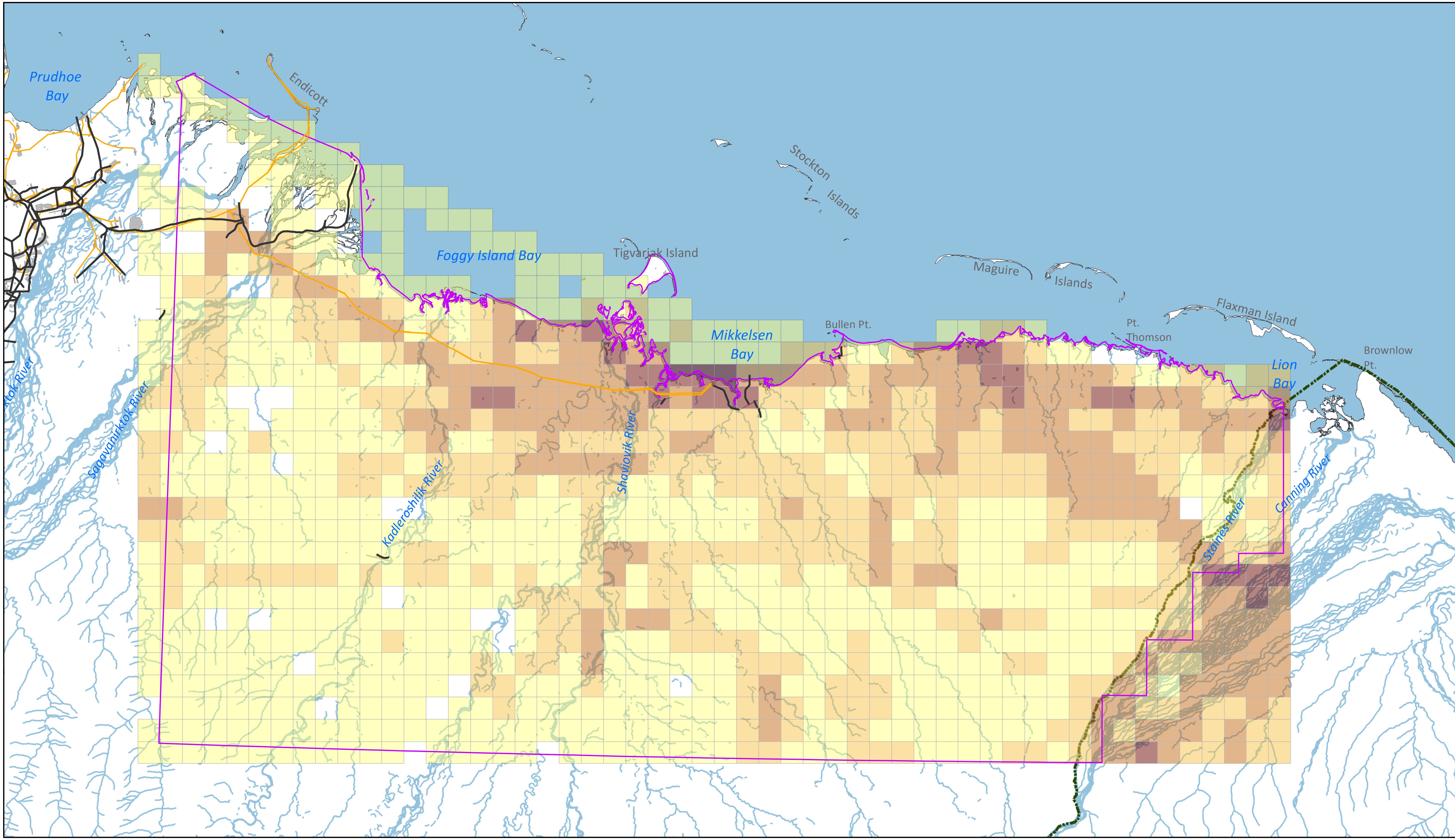

POINT THOMSON PROJECT EIS

Legend

Density of Caribou Crossings (Crossings per sq. mi.)

- 1 - 5
- 6 - 10
- 11 - 20
- 21 - 40

- Project Study Area
- Existing Facilities
- Arctic National Wildlife Refuge
- Existing Road
- Existing Pipeline
- Stream

0 2 4 Miles

N

Figure 3.10-9

Caribou Summer (June, July, August) Movement Density

Date:24 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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3.10.3.3 Muskoxen

Following their disappearance from Alaska in the late 1800s or early 1900s because of overhunting, muskoxen were reintroduced to the ACP at Barter Island in GMU 26C and on the Kavik River in GMU 26B during 1969 and 1970 (Lenart 2009b). The reintroduced muskoxen population increased steadily within GMU 26C during the 1970s and 1980s, and expanded their range to the east into Yukon, Canada and to the west into GMU 26B and eastern GMU 26A during the late 1980s and early 1990s (Lenart 2009b). Since the late 1990s, however, muskoxen within GMU 26C declined substantially in abundance likely due to low calf production, low yearling recruitment, increased adult mortality, disease, and emigration. By 2008, less than 50 muskoxen remained in GMU 26C (Lenart 2009b; Figure 3.10-10). During the mid 2000s the muskoxen population in GMU 26B and eastern 26A declined, but likely remained stable during the late 2000s with recruitment rates closely mirroring mortality rates (Lenart 2009b). While the total number of muskoxen across GMU 26 declined steadily from 651 to 331 muskoxen during 1995 to 2003, the number of muskoxen west of the Dalton Highway in western GMU 26B increased from 92 to 115 during 1997 to 2003 (Lenart 2009b; Figure 3.10-10).

Muskoxen generally associate in groups and use riparian and moist tundra habitats in summer and wind-swept hilltops, slopes, and plateaus in winter (Reynolds et al. 2002). Muskoxen make seasonal movements between habitats, forming larger more sedentary groups during winter than during summer when movements are more frequent (Reynolds et al. 2002, Lenart 2009b). Movement rates in summer average 1.6 miles per day, with rates increasing in June with spring green-up (highest in July), and decreasing in August with plant maturity and ***rut*** (Reynolds 1998). Movement rates during other seasons range from 0.7 to 0.9 miles per day (Reynolds 1998). Calves are born during late April to mid May before the spring green-up, so female muskoxen must use remaining body reserves gained during the short summer growing season to support their developing fetus and themselves, and to produce milk for their calves after birth (Reynolds et al. 2002).

Within the study area, muskoxen were counted within two survey areas, one extending from about the Sagavanirktok River to Bullen Point and the other extending from Bullen Point to the Canning River; the aerial surveys were systematic (transects with complete coverage of the survey area) and were conducted during June, July, and August from 1995 to 2003 (Pollard and Noel 1995; Noel 1998a, b; Noel and Olson 1999a, b, 2001a, b; Noel and King 2000a, b; Jensen and Noel 2002, Jensen, et al. 2003; Noel and Cunningham 2003). Results of these surveys indicate the following:

- Most muskoxen were observed in riparian habitats (see Figure 3.10-11)
- An overall average of 11 muskoxen were observed per survey.
- Between 0 and 36 muskoxen were observed during surveys in the Sagavanirktok River to Bullen Point area
- Between 0 and 19 muskoxen were observed during surveys in the Bullen Point to the Canning River area

The estimated population of muskoxen in GMU 26B during this survey period (1995 to 2003) averaged 271. In contrast, the 2004 to 2008 average for GMU 26B was 198 muskoxen (Lenart 2009b).

USFWS recorded seven muskoxen groups during winter (March and October) 1995 and 1996 between the Sagavanirktok River and the northwest corner of the Arctic Refuge. Most muskoxen groups were in the Arctic Refuge near the Canning River delta in winter, although one group was near the confluence of the Shaviovik and Kavik Rivers (Reynolds 1998). USFWS also observed muskoxen during the calving period in April and May in the Arctic Refuge near the Canning River and tributaries to the southeast.

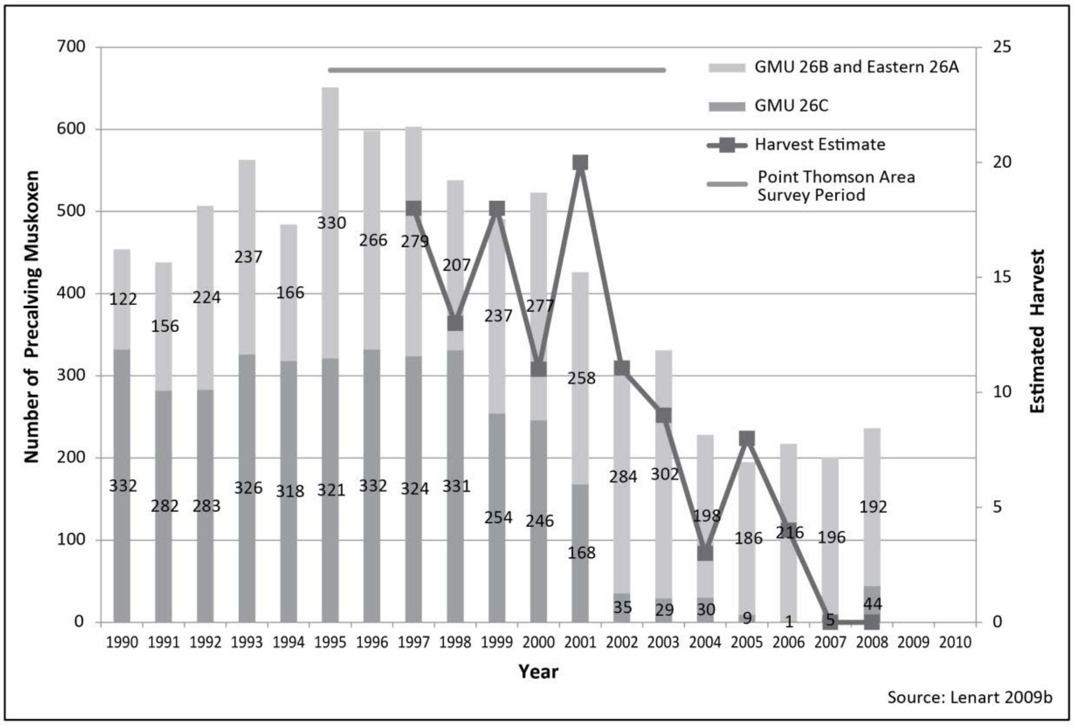
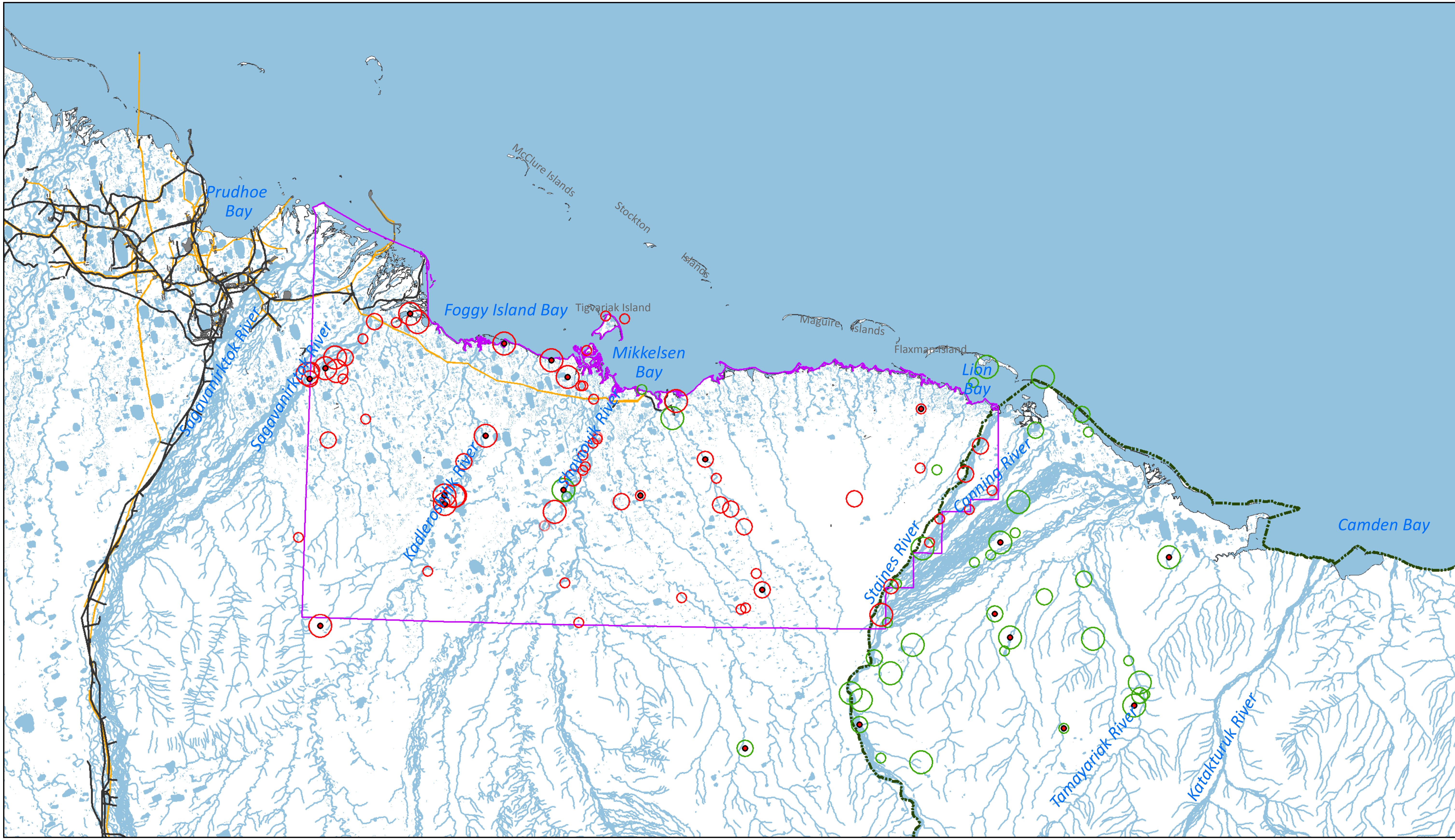


Figure 3.10-10: Game Management Unit 26B and 26C Precalving Muskoxen Population and Harvest Estimates with Point Thomson Systematic Survey Period



POINT THOMSON PROJECT EIS

Legend

Muskox Group Size, 1995-2002
- 1 - 5
- 6 - 12
- 13 - 32

- Badami and Point Thomson Surveys
- USFWS Surveys
- Muskox Groups with Calves
- Project Study Area
- Existing Facilities
- Water Body
- Arctic National Wildlife Refuge
- Existing Road
- Existing Pipeline
- Stream

0 2.5 5 Miles

N

Figure 3.10-11

Muskoxen Observations (1995-2003)

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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3.10.3.4 Foxes – Arctic and Red

Arctic foxes occur naturally along the arctic coast as far south as the northwestern shore of Bristol Bay (MacDonald and Cook 2009). They are well adapted to the harsh arctic environment and are found in tundra, rocky beaches, and on the frozen pack ice where they scavenge on remaining kill left by polar bears. Arctic foxes also associate with people when they are allowed access to food waste, garbage, and artificial den sites (USFWS 2003). They den in light, sandy soil along riverbanks, and on low mounds, sometimes enlarging ground squirrel burrows for dens.

Mating occurs during March or April; pups are born between May and early July, and pups emerge from dens when about 3 weeks old. Litter sizes vary among years depending on food resources. Pups disperse around August. Family groups break up during September and October; during midwinter, arctic foxes are primarily solitary except when congregating at carcasses of marine mammals or caribou (Stephenson and Hocker 2008). Arctic foxes are sexually mature at 9 to 10 months, but survival to age of first reproduction may be low. Populations fluctuate widely in abundance seasonally and year-to-year.

Arctic foxes may make long-distance seasonal movements toward the coast and onto the sea ice in fall and back onshore in late winter to early spring (Pamperin et al. 2008). Individual foxes may move up to 1,700 miles, with average travel rates for individual foxes ranging from 5 to 11 miles per day on ice (Pamperin et al. 2008). Maximum movement rates of arctic foxes reached 38 miles per day on ice and 32 miles per day on land (Pamperin et al. 2008).

Red foxes occur throughout Alaska. In the northern portion of the state, red fox abundance is generally considered highest in the mountains and foothills and along riparian habitats; abundance is considered lowest on the coastal plain and along the coast (MacDonald and Cook 2009). Red foxes occur year-round and reproduce in the Prudhoe Bay region, where they compete with arctic foxes for dens and food (Pamperin et al. 2006, Sanzone et al. 2009). The number of dens occupied by red foxes with pups increased from 2 in 2005 to 8 in 2008 within the Prudhoe Bay oil field (Sanzone et al. 2009) and trappers indicated that red foxes were abundant and increasing in abundance in the arctic (GMU 23 and 26) Where these two foxes co-exist, the larger red fox generally wins the competition for food and other resources (Pamperin et al. 2006).

Fox den density varies across the ACP, ranging from about 1 per 4.5 mi^2 to 1 per 6 mi^2 in the developed areas of the Prudhoe Bay oil field to about 1 per 11 mi^2 to 1 per 13 mi^2 in areas outside of the developed Prudhoe Bay oil field (generally further inland) and on the Colville River delta (Eberhardt et al. 1983, Ballard et al. 2000). Study estimates of fox den density may vary due to multiple factors including: the size of the study area considered, the history of previous den searches in the study area, survey methodology, and the level of search effort expended (Ballard et al. 2000).

Arctic foxes prefer large, older dens, which are usually located on mounds, low hills, or ridges with thin snow accumulations, a deep active thaw layer, stable surface, and sandy soils (Burgess 2000). Older, complex fox dens may have more than 50 burrow entrances and vegetation is often modified by years of use. Foxes may also use smaller temporary dens during the summer. Den sites are usually more abundant than reproducing foxes and the proportion of dens that are occupied each year is a reflection of both food availability and the abundance of breeding foxes (Burgess 2000). The rate of occupation of known den sites is often useful as an indicator of arctic fox abundance (Burgess 2000).

The distribution of identified fox den sites and habitat potentially suitable for excavation of fox dens within the study area is shown in Figure 3.10-12. Biologists searched for new fox dens and determined occupancy for new and previously documented fox dens in the study area during 1999 and 2000 (Perham 2000, 2001). An additional 14 den observations that appear to represent dens not previously documented during fox den searches are also illustrated on Figure 3.10-12 as unnumbered aerial observations (Noel and Olson 1999a, b, 2001a, b; Noel and King 2000a, b, Jensen and Noel 2000, Jensen et al. 2003). These dens were identified because foxes were spotted at den openings by survey observers during aerial large mammal surveys; fox den observations during large mammal surveys were limited to areas close to the survey transects. Based on the compiled data and survey areas described by Perham (2001), fox den density in the study area ranged from 1 den per 12.8 mi^2 between the Sagavanirktok River to about Bullen Point to 1 den per 20.6 mi^2 between Bullen Point and the Canning River. The apparently lower fox den density east of Bullen Point may coincide with a reduced abundance of potentially suitable den habitats because of the reduced topographic relief in the region of the Canning River alluvial fan. However, additional undiscovered fox dens likely occur in the study area.

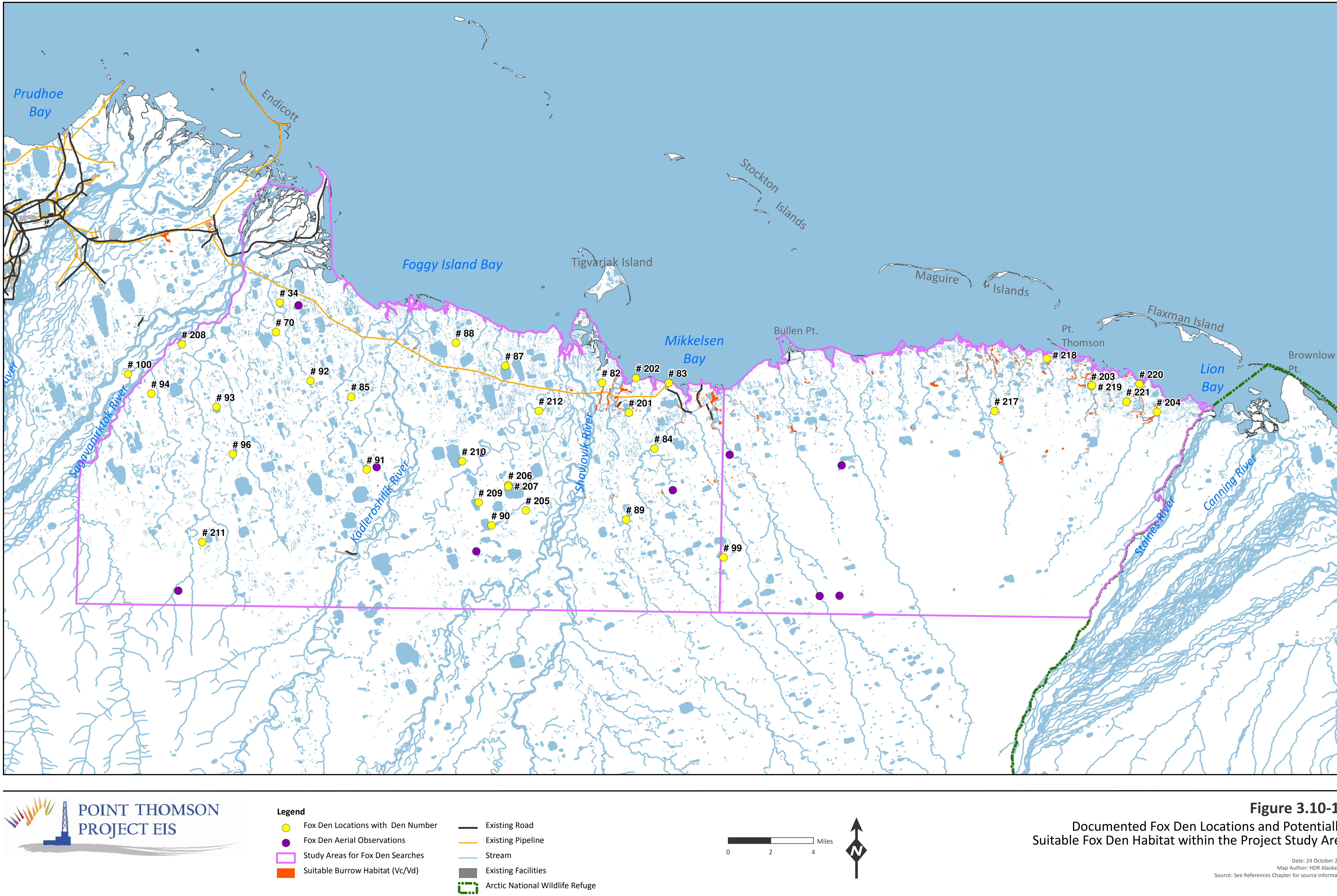

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Figure 3.10-12

Documented Fox Den Locations and Potentially Suitable Fox Den Habitat within the Project Study Area

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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3.10.3.5 Brown Bears

Brown bear populations in northeastern Alaska declined during the 1960s primarily because of guided, aircraft-supported hunting (Lenart 2007). GMU 26B and 26C were closed to brown bear hunting in spring 1971 to fall 1972, with limited harvest in subsequent years to allow for the brown bear population to recover Lenart 2007). The population recovered in the 1980s and early 1990s, and then hunting regulations became less stringent. High harvest rates occurred through 1996 and 1997 which subsequently led to more stringent regulations (Lenart 2007). The current brown bear population estimate, based on surveys completed during 1999 to 2003, is considered a low to moderate density for the arctic, with a sustainable harvest goal of 5 percent or 13 brown bears for GMU 26B (Lenart 2007; Figure 3.10-13).

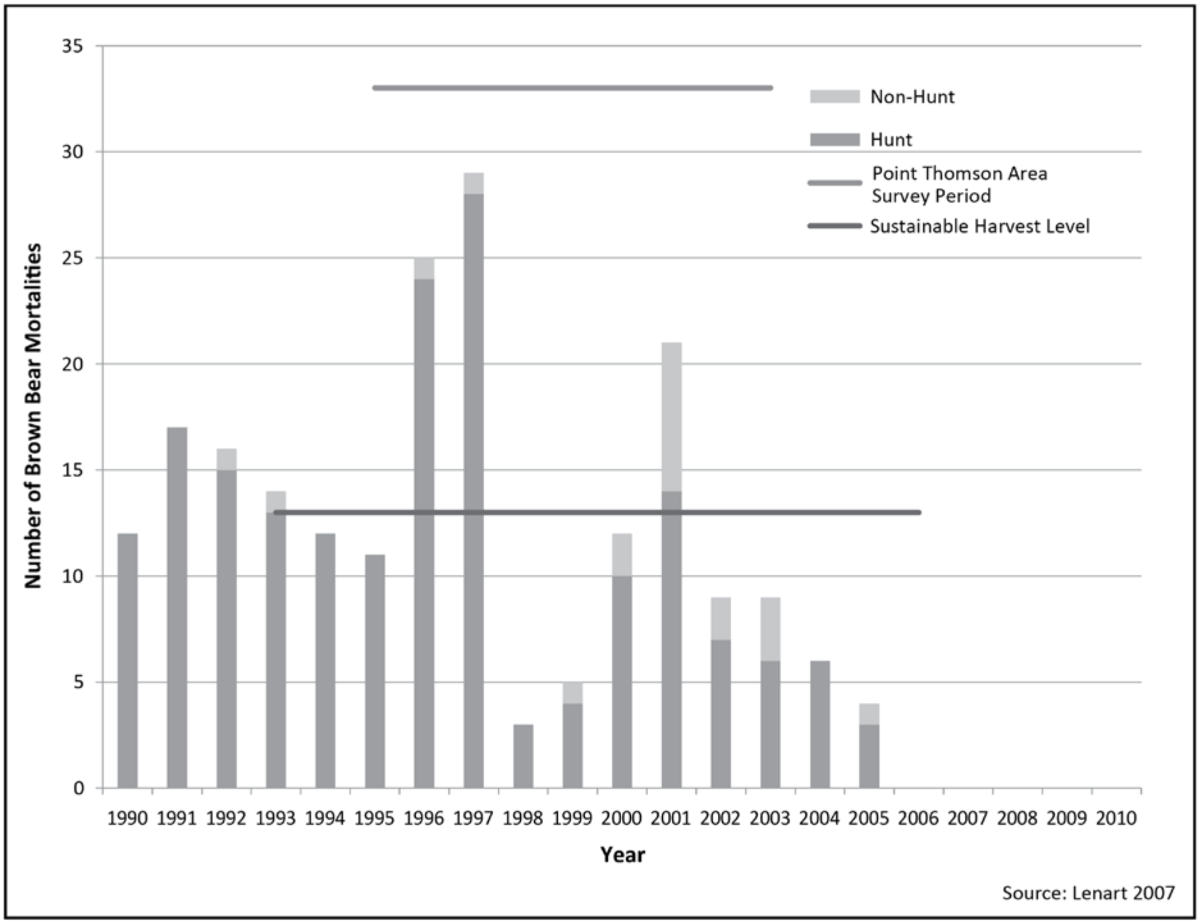

Figure 3.10-13: Brown Bear Mortality, Point Thomson Survey Period, and Sustainable Harvest Levels in GMU 26B 1990 to 2005

Arctic brown bears forage on vegetation—digging roots in early spring, grazing on vegetation during summer and foraging on berries in late summer and fall, which is supplemented with animal foods whenever possible . Animal foods include bird eggs and nestlings, ground squirrels, lemming and voles, caribou calves, and muskoxen (Shideler and Hechtel 2000).

Both male and female brown bears hibernate during the winter, entering dens between late September and mid-November, with pregnant females entering earliest and adult males entering latest. Dens are excavated during late fall in well-drained sand or silt permafrost soils; commonly used den habitats include streambanks, hillsides, and terraces. Brown bears emerge from their dens between March and May; adult males emerge first and females with new cubs emerge last (Shideler and Hechtel 2000). Brown bear dens have been documented in the study area west of the Shaviovik River, and habitat suitable for denning is found in this region primarily around the Sagavanirktok, Kadleroshilik, Shaviovik, and Kavik Rivers as well as the few large pingos in the region (Figure 3.10-14). ADF&G collaring and tracking effort was lower for brown bears east of the Kavik River; and while this area may have been under-sampled for brown bear dens, it also appears to contain a smaller area of potentially suitable den habitat than the region east of the Kavik River (Figure 3.10-14).

Most brown bears were observed within or near riparian habitats between the Sagavanirktok and Canning Rivers during June and July; survey observers documented brown bears within this region on 34 percent of surveys in 1995 and 1997 to 2003 (Figure 3.10-14). An average of 1.4 brown bears was observed during systematic surveys of this region; with an average of 2.1 bears per survey during June and 0.9 bears per survey during July. No brown bears were observed during the few August surveys. Brown bears range widely and in many different habitats in search of food during their active period; female brown bears in the vicinity of Prudhoe Bay range about three times as far (1,190 mi^2) as bears either to the west (in the western Brooks Range; 383 mi^2) or to the east (in the Canadian Northwest Territories; 386 mi^2; Shideler and Hechtel 2000).

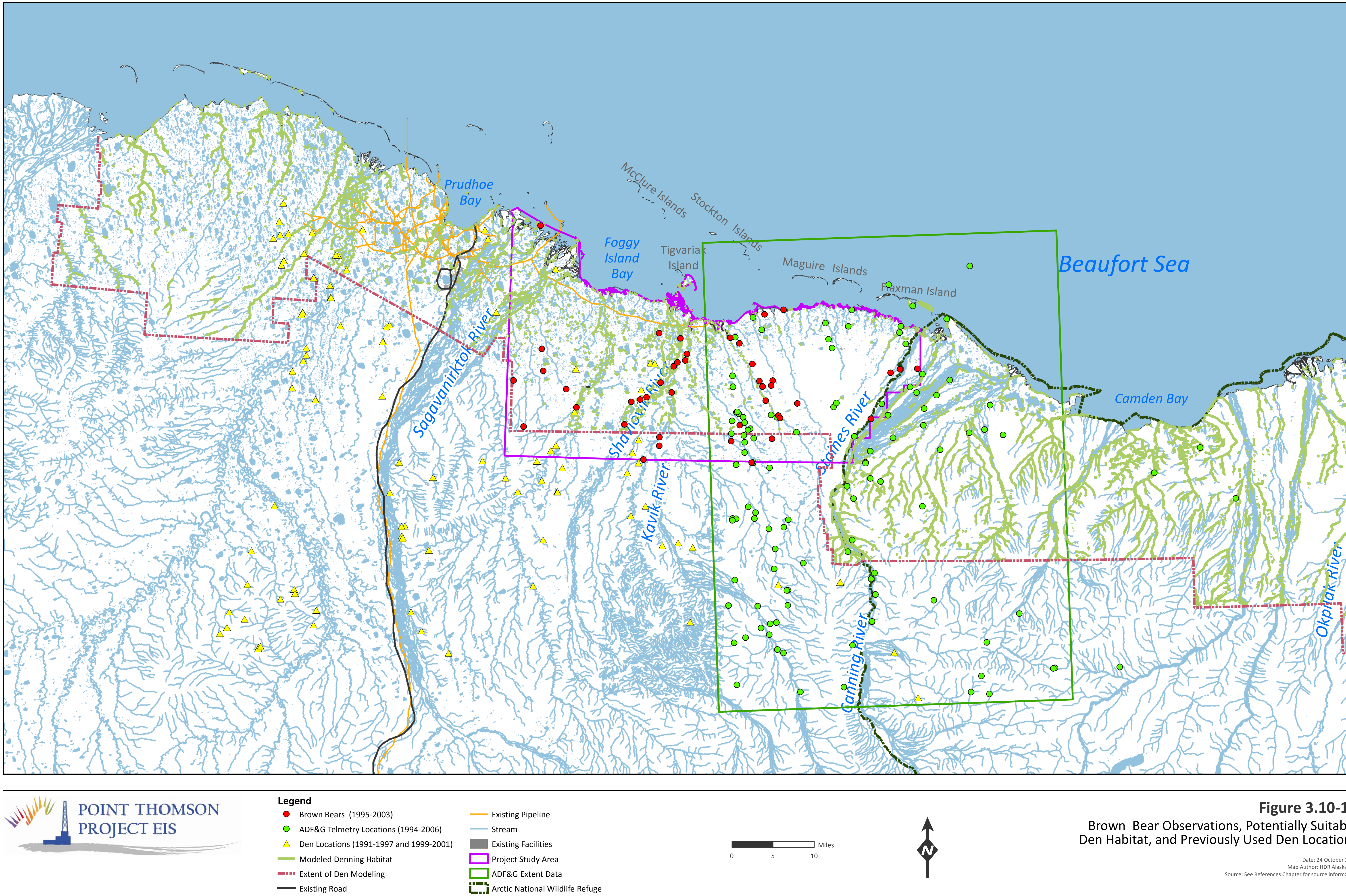

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Figure 3.10-14
Brown Bear Observations, Potentially Suitable Den Habitat, and Previously Used Den Locations

Date: 24 October 2010
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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3.11 MARINE MAMMALS

Marine mammal occurrence in the Beaufort Sea is strongly influenced by changes in seasonal ice cover. The greatest diversity of species occurs during the open-water season (late June through September), while during the remainder of the year, the most frequently encountered species are limited to the bearded seal, ringed seal, and polar bear. The study area includes the ACP and marine waters from Prudhoe Bay to the Canning River delta, extending 25 miles seaward and up to 20 miles inland. Specifically, the study area includes coastal waters between the Canning/Staines and Sagavanirktok Rivers; Lion Bay, Mikkelson Bay, Foggy Island Bay, and portions of the Canning/Staines and Sagavanirktok River deltas; the offshore barrier islands, including Flaxman, Maguire, Stockton, Tigvariak, and McClure Islands; and terrestrial habitat. The study area, particularly the nearshore and terrestrial environments (including the barrier islands) are used for foraging and as a platform for breeding (e.g., polar bear). Deeper waters seaward of the barrier islands are used for foraging and breeding in the winter when sea ice is prevalent (e.g., ringed and bearded seals), and for migration in the warmer seasons (e.g., multiple whale species).

3.11.1 Key Information About Marine Mammals and Marine Mammal Critical Habitat

There is documented occurrence of 16 marine mammal species within or adjacent to the study area: five baleen whale species, four toothed whale species, six pinniped species, and the polar bear. Seven species have an expected occurrence, while the other nine do not regularly occur in the Beaufort Sea. These species are considered to be extralimital to the region, and not likely to occur in the Point Thomson study area. Due to anticipated timing of construction schedules, location of project activities, and the known distributional ranges of the marine mammal species, the bearded seal, beluga whale, bowhead whale, polar bear, and ringed seal are of greatest concern for the Point Thomson study area (see Table 3.11-1).

Table 3.11-1: Marine Mammal Species of Most Concern for the Point Thomson Project

Species	Reason for Concern
Bearded Seal	Protected by MMPA; proposed Threatened under ESA; occurs in coastal waters, both inside and seaward of the barrier islands, during the summer/fall open-water season.
Beluga Whale	Protected by MMPA; occurs commonly seaward of the barrier islands during spring and fall migration and infrequently observed along or near the coast.
Bowhead Whale	Protected by MMPA; Endangered under the ESA; occurs commonly seaward of the barrier islands during spring and fall migration.
Polar Bear	Protected by the MMPA; Threatened under the ESA; Critical Habitat designated; maternal dens commonly observed in and near the study area from November through April, and studies have shown a landward and eastward shift in denning toward the area between the Sagavanirktok and Canning Rivers (including the study area). Nondenning foraging bears are also anticipated to occasionally roam through the study area during the same months, although preferred hunting habitat is farther seaward in winter and spring.
Ringed Seal	Protected by MMPA; proposed Threatened under ESA; occurs in coastal waters, both inside and seaward of the barrier islands, during the summer/fall open-water season.

Source: LGL & Greenridge 1996, MMS 2008, Funk et al. 2010, Amstrup 2002, Fischbach et al. 2007

Marine mammals that use the study area are sensitive to:

- Habitat loss or alteration due to physical habitat changes, species' displacement from or to altered habitat, disturbances from noise or activity, or fragmentation
- Land/ice vehicle or sea vessel collision injury or mortality

- Altered survival or productivity related to changes in predator and prey abundance, distribution, feeding strategies, or predation risk, or from increased exposure to garbage, and spills and leaks of toxic materials

The occurrence and distribution of marine mammals in the Beaufort Sea and the study area are closely tied to and/or influenced by sea ice. Recently, changes in duration and extent of sea ice have affected the distribution, occurrence, and abundance of marine mammals in the arctic, and in the vicinity of the study area.

3.11.2 Review and Adequacy of Information Sources for Marine Mammals

There are considerable data available on the occurrence and distribution of marine mammals (particularly for the bowhead whale and the polar bear) in the central Beaufort Sea where the study area is located.

The bowhead whale, because of its ESA status and importance for subsistence whaling, has been a large driver for marine mammal monitoring efforts in waters of the region. Not only are data for bowhead whales collected during these surveys, but data are also captured for other marine mammal species encountered. Extensive aerial surveys for bowhead whales have been conducted nearly annually, mainly during late summer/early fall, in the Beaufort and Chukchi seas by the Minerals Management Service (MMS; now known as Bureau of Ocean Energy Management, Regulation and Enforcement [BOEMRE]), the NMFS, and other groups (e.g., consultants) funded by oil and gas companies since the late 1970s (reviewed by Smultea et al. 2011). BOEMRE has funded the Bowhead Whale Aerial Survey Program (BWASP) during each year from 1979 to the present to monitor bowhead whale fall migration through the Beaufort Sea. BWASP is now part of the NMFS' Aerial Surveys of Arctic Marine Mammals (ASAMM) project, which is funded in part by BOEMRE. Extensive vessel-based surveys for bowheads and other marine mammals associated with seismic monitoring; activities associated with the Northstar oil production island; and baseline studies, have occurred for many years in the region (e.g., Funk et al. 2010, Richardson 2011, Smultea et al. 2011). Passive acoustic monitoring for vocalizing bowhead whales also have been conducted in the central Beaufort Sea (e.g., Blackwell et al. 2007, 2009; Richardson 2011).

Polar bears on the Southern Beaufort Sea coastline have been monitored since 1967 (Durner et al. 2010). Research was initiated to address management issues, including recreational and subsistence hunting, and the establishment and expected growth of the petroleum industry in Alaska and neighboring Canada (Durner et al. 2010). Research efforts pertinent to polar bears in this region are conducted by the USFWS, U.S. Geological Survey, and consultants (in relation to oil and gas activities on the North Slope), all which are summarized by Perham (2005). Research has focused on developing indices of population size and trends, and on identifying major aspects of life history that are strong determinants of those trends (Durner et al. 2010). For example, since 2000, the USFWS has conducted fall season coastal aerial surveys to monitor polar bear distribution and numbers along the Beaufort Sea coastline and barrier islands between Barrow and the Canadian border to determine polar bear density during the peak use of terrestrial habitat by bears (e.g., Schliebe et al. 2001, Kalxdorff et al. 2002). BWASP surveys also have provided important data on polar bear occurrence in the region (e.g., Monnett and Gleason 2006). The oil and gas industry conducts many activities during the winter season on the North Slope of Alaska and monitoring the location of denning polar bears is critical for management of potential impacts. The oil and gas industry cooperates with the Federal government, including efforts towards den detection (e.g., Amstrup et al. 2004, Schliebe et al. 2006a). Durner et al. (2010) provides a good review of the history of maternal polar bear denning research for the North Slope.

For pinnipeds (seals), occurrence information is collected opportunistically during surveys for bowhead whales and the polar bear. Data on pinnipeds, as noted earlier, also results from industry-sponsored monitoring efforts.

Table H-11 in Appendix H includes the publications, reports, and data available for marine mammals that are cited in the Draft EIS and their relevance to the proposed project. Full references for the studies cited in the Draft EIS are in Chapter 9, References.

3.11.3 Marine Mammal Species in Study Area

All species of marine mammals in U.S. waters are federally protected by the MMPA of 1972. Table 3.11-2 provides an alphabetical list of the 16 marine mammal species that have been observed in the study area historically. Inupiaq names for these species can be found in Appendix B. Marine mammal records for the study area range from observations of species that commonly or occasionally occur in the area and whose home ranges are inclusive of or adjacent to the study area, to rarer sightings of species whose ranges are external or "extralimital" to the study area, making the potential for interaction during the proposed project time line minimal.

Eight species of marine mammals with ESA status (listed or candidates for listing) are identified as having potential presence in the study area (Table 3.11-2). These include three endangered species (bowhead, humpback, and fin whales), two threatened species (polar bear and Steller sea lion), and three species that the NMFS and the USFWS identified as candidates for listing (ringed and bearded seals, and Pacific walrus). All of these species are managed by the NMFS, except the Pacific walrus and polar bear, which are both managed by the USFWS. The relative and seasonal occurrence by each species and type of use of the study area and/or vicinity are also identified in Table 3.11-2.

Table 3.11-2: Marine Mammal Species with Occurrence in or Near the Point Thomson Study Area

Species	Occurrence in Study Area[a]	Preferred Marine Habitat	Primary Prey	Season Present	ESA Status
Bearded Seal	Regular	Shelf waters; ice-associated	Crustaceans/ fish	May—September (some year-round)	Proposed Threatened
Beluga Whale	Regular	Shelf/offshore waters	Fish	April—May and August-September	None
Bowhead Whale	Regular	Shelf waters	Zooplankton/ crustaceans	May—October	Endangered
Fin Whale	Extralimital	Shelf/offshore waters	Fish/ zooplankton	July—September in waters with no or little ice	Endangered
Gray Whale	Rare	Shelf waters	Crustaceans	July—September	None
Harbor Porpoise	Extralimital	Shelf waters	Fish/squid	July—September	None
Hooded Seal	Extralimital	Pack ice edge, deep offshore waters	Squid/fish	July—December	None
Humpback Whale	Extralimital	Shelf waters	Fish/ zooplankton	July—September in waters with no or little ice	Endangered
Killer Whale	Extralimital	Shelf/offshore waters	Marine mammals/ fish	July—September	None

Table 3.11-2: Marine Mammal Species with Occurrence in or Near the Point Thomson Study Area

Minke Whale	Extralimital	Shelf waters	Fish/squid	July—September	None
Narwhal	Extralimital	Slope, offshore waters, pack ice	Fish/ crustaceans	July—September	None
Pacific Walrus	Extralimital	Shelf waters	Mollusks	July—September	Candidate
Polar Bear	Regular	Sea and terrestrial ice habitat	Seals/ whales	Year-round	Threatened; Critical Habitat designated
Ringed Seal	Regular	Shelf waters; ice-associated	Fish/ zooplankton	Year-round, mostly winter and spring	Proposed Threatened
Spotted Seal	Rare	Shelf waters; ice-associated	Pelagic fish/octopus/ crustaceans	July—September	None
Steller Sea Lion	Extralimital	Shelf/slope waters	Fish/ cephalopods/ mollusks	late May—early July, in waters with little or no ice	Threatened [b]

Sources: Jefferson et al. 2008, Perrin et al. 2008, Allen and Angliss 2010

[a] Regular = occurs as a regular or normal part of the fauna; Rare = only occurs in the area sporadically; Extralimital = not likely to normally occur in the area and considered beyond the normal range of the species, but one or more records have been documented in the area.

[b] The species as a whole is listed as threatened; the eastern population is listed as threatened, while the western population is listed as endangered. Origin of vagrant individuals is not known.

The occurrence and distribution of marine mammals in the Beaufort Sea and the study area are closely tied to and/or influenced by sea ice (Moore and Huntington 2008). The Beaufort Sea can be divided into three separate dynamic conditions based on seasonal variations: (1) summer (open-water) usually beginning in late June and reaching fullest extent in August/September, though the extent of open water along the coast varies from year to year depending on climatic factors; (2) broken ice (time when there is a transition from open water to ice-covered and vice versa) usually in June and October; and (3) winter (ice-covered) from November through May, ice covers nearly all of the Beaufort Sea (USFWS 2011b).

Sea ice comes in many shapes and forms, and many marine mammal species prefer certain types of sea ice, such as landfast ice and pack ice (see Table 3.11-3 for definitions). Both the extent and duration of sea ice in the Arctic, including the Beaufort Sea and study area, are decreasing (Serreze et al. 2007, Moore and Huntington 2008, Walsh 2008). These changes have affected the distribution, occurrence, and abundance of marine mammals, some adversely, some perhaps beneficially, and some to an unknown extent (Moore and Huntington 2008, Ragen et al. 2008).

Table 3.11-3: Definitions of Ice Types Referred to in Marine Mammal Sections	
Landfast Ice	Sea ice that is either frozen to land or to the benthos (bottom of the sea) and is relatively immobile throughout the winter. The composition of landfast ice is uniform.
Shorefast Ice	A type of landfast sea ice also known as "fast ice;" defined by the *Arctic Climate Impact Assessment* (ACIA 2000) as ice that grows seaward from a coast, remains stationary throughout the winter, and is typically stabilized by grounded pressure ridges at its outer edge.
Pack Ice	Annual and heavier multiyear sea ice that is in constant motion due to winds and currents. It is located in pelagic (open ocean) areas and, unlike landfast ice, can be highly dynamic. Regions of pack ice can consist of various ages and thicknesses, from new ice only days old that may be several inches thick, to multiyear ice that has survived several years and may be more than 6 feet thick.
Lead	Linear openings or cracks in the sea ice caused by the actions of winds, currents, and temperature.
Polynya	Areas of open sea surrounded by sea ice.

Source: 75 FR 76086

Most of the ice-dependent pinniped species (seals and walrus) are closely tied to ice for portions or all of their lives as a platform for breeding, feeding, birthing, predator avoidance, and migration (Moore and Huntington 2008, Ragen et al. 2008). With the documented retreat of the ice edge to locations farther offshore and often in deeper water (particularly during summer and fall) the distribution of these animals is also affected (Moore and Huntington 2008, Ragen et al. 2008). Some pinnipeds are predicted to follow the receding ice edge while others may not (Moore and Huntington 2008). A retreating ice edge in deeper offshore waters may make prey less accessible, particularly for those pinnipeds that are benthic feeders (i.e., feed at the ocean bottom). Some species, such as the polar bear and walrus, are experiencing increased stress due to reductions in ice habitat and prey, and may be more vulnerable to other potential environmental stressors (Moore and Huntington 2008).

In contrast, some cetacean species (baleen and toothed whales) appear to be expanding their distribution farther north and east into the Chukchi and Beaufort seas as the ice recedes and allows for access to waters that have historically been inaccessible due to ice cover (Moore and Huntington 2008).

Marine mammals also play an important cultural and subsistence role in the economies and communities that border the Beaufort Sea, including Kaktovik, Nuiqsut, and Barrow. Both Kaktovik and Nuiqsut conduct subsistence hunts for marine mammals within the study area. The primary marine mammal subsistence species in the study area is the bowhead whale, while bearded, ringed, and spotted seals and polar bear play secondary roles, often harvested more opportunistically. Section 3.22, Subsistence and Traditional Land Use Patterns, describes the ongoing connection between Native communities and marine mammals.

Abundance, distribution, habitat preferences, and limited natural history of marine mammals that could occur in the study area are presented in the following subsections. Those species with expected occurrence in the study area are discussed in Section 3.11.4; this section is further subdivided by discussion of ESA-listed species (including polar bear critical habitat; Section 3.11.4.1) and nonthreatened/nonendangered species (Section 3.11.4.2). Section 3.11.5 provides a brief synopsis of species with historical record(s) in and/or near the study area, but with traditional home ranges extralimital to the study area.

3.11.4 Marine Mammal Species with Expected Occurrence in or Near the Study Area

Seven marine mammal species have expected occurrence in the study area: five are sighted on a regular basis (bearded seal, beluga whale, bowhead whale, polar bear, and ringed seal) while the other two are sighted less frequently (gray whale and spotted seal). All of these species have distributional ranges inclusive of the study area and spend at least a portion of a calendar year in the Beaufort Sea, in and around the study area. The polar bear and ringed seal are found here year-round, while the remaining six only occur in the area between April and October, when warmer weather causes the ice to thin and recede, also known as the open-water season. Species appearance, beginning with ESA-listed and candidate marine mammal species, are discussed in Section 3.11.4.1, while the nonthreatened and nonendangered species follow in alphabetical order in Section 3.11.4.2.

3.11.4.1 Marine Mammal Species With ESA Status

Two marine mammal species with expected occurrence in the study area are listed as threatened or endangered under the ESA of 1973: the bowhead whale and the polar bear. The bearded seal and the ringed seal have been proposed threatened under the ESA by the NMFS and are also expected to occur regularly in or near the study area. Because of the timing of many of the project alternatives' construction windows and location of construction footprints, the species with the highest potential for impact during project activities are the polar bear and the ringed seal, with a more conservative potential for impact to the bowhead whale during migration through the area in the summer months. Detailed descriptions of ESA-listed species are provided in the Biological Assessments (Appendix M).

Bowhead Whale

Status

The NMFS listed the bowhead whale as an endangered species in 1970 (35 FR 18319). No critical habitat is designated for this species.

Of the four NMFS-recognized stocks of bowhead whales, only the Western Arctic stock (also known as the Bering-Chukchi-Beaufort Sea stock) occurs in U.S. waters (Allen and Angliss 2010). Based on distributional data (MMS 2008, Rugh 2008, Rugh et al. 2010), a small number of individuals from this stock are most likely to occur in or near waters of the study area during August – October during its westward migration.

The Western Arctic stock is currently estimated to be at least 10,545 individuals based on the last systematic census that was conducted in 2001 (Allen and Angliss 2010). All indications are that the stock is increasing and may have reached the lower limit of the estimate of the population that existed prior to intensive commercial whaling (MMS 2006).

The bowhead whale is an important subsistence species for Alaska Native communities, and both Kaktovik and Nuiqsut hunt bowhead whales in the study area (see Section 3.22, Subsistence and Traditional Land Use Patterns).

Distribution and Use of the Study Area

The Western Arctic stock overwinters in the central and western Bering Sea (Moore and Reeves 1993, Rugh et al. 2003). In April, whales begin migrating north through the Bering Strait into the Chukchi Sea as the ice begins to break up. From there, most individuals continue migrating around Point Barrow from April to mid-June into the Beaufort Sea (Moore and Reeves 1993, Rugh et al. 2003). After passing Point

Barrow, whales travel easterly through or near offshore leads in the ice, remaining seaward of the barrier islands (and thus the study area) in the central Alaskan Beaufort Sea (Moore and Reeves 1993, Rugh et al. 2003). Bowheads reach their summer feeding grounds in the Canadian Beaufort Sea and Amundsen Gulf from mid-May through June and July; most animals stay there until late August or early September when they begin their return westward migration (Moore and Reeves 1993). Recent tagging efforts, however, suggest that some whales leave Canadian waters as late as early October (Quakenbush et al. 2010). Bowhead whales typically reach the Point Barrow area in mid-September to late October during their westward migration from the feeding grounds in the Canadian Beaufort Sea. However, recent studies have documented bowheads feeding offshore from Point Barrow to beyond Smith Bay during late August to mid-September (e.g., Goetz et al. 2009). Consistent with this, Nuiqsut whalers have observed that a small number of the earliest arriving bowheads have apparently reached the Cross Island area earlier (late August) than in past years (Haley et al. 2010).

Habitat Use

Bowhead whales generally prefer shallow, continental shelf waters and are associated with relatively heavy ice cover for much of the year. However, the extent, nature, and location of ice cover in the Beaufort Sea appear to influence the timing, duration, and location of the bowhead whale migration. During fall in the Beaufort Sea, most individuals migrate west in waters ranging from about 50 to 650 feet in bottom depth (Miller et al. 1999). Some individuals enter shallower water, particularly in light ice years, but very few whales occur shoreward of the barrier islands. Moore (2000) determined that bowhead whales used shallow inner-shelf waters during light to moderate ice conditions, but used deeper slope waters in heavy ice conditions based on 1982 to 1991 aerial survey data. In summer, during moderate ice conditions, bowheads used primarily continental slope waters (Moore 2000). Similarly, Miller et al. (1996) reported that bowhead whales within the Northstar Island region in the Alaskan Beaufort Sea (147° to 150° W) migrated farther offshore in heavy ice years (median distances were 37 to 43 miles offshore) vs. light-moderate ice years when the whales traveled closer to shore (19 to 25 miles offshore). Treacy et al. (2006) also found that bowhead whales tended to migrate west in deeper water (farther offshore) during years with higher-than-average ice coverage than in years with less ice. In addition, the sighting rate tended to be lower in heavy ice years and more widespread in light ice years (Treacy et al. 2006).

Life History

The Western Arctic stock is believed to breed during late winter or early spring in the Bering Sea (Rugh and Shelden 2008). After a gestation period of 13 to 14 months, calves are usually born during spring in the Bering Sea, but also during the northward spring migration (Rugh and Shelden 2008).

Examination of stomach contents from whales taken in the Iñupiat subsistence harvest indicates that bowhead whales feed on a variety of invertebrates and small fish (Lowry 1993). More recent analysis of stomachs collected from whales revealed mainly ***copepods*** from those harvested off Kaktovik and ***euphausiid***-like (krill) prey from those harvested off Barrow (George and Sheffield 2009).

Summary

In May and June, most bowhead whales migrate eastward along the Beaufort Sea coast seaward of the barrier islands, though some remain to feed off Barrow. This spring migration tends to occur far offshore, outside of the study area. The return westward migration, starting in August and lasting through October, also occurs primarily seaward of the barrier islands. During the westward movement bowhead whales migrate closer to shore and a large proportion of the population would transit through the study area, however, few would pass landward of the barrier islands.

Polar Bear

Status

The USFWS listed the polar bear as a threatened species in May 2008 (73 FR 28212). Listing of this species was mainly due to concerns over the threat to polar bear habitat posed by the trend of rapidly diminishing sea ice cover and thickness in the Arctic Ocean, primarily during the summer.

Critical habitat for the polar bear was designated in December 2010 (Figure 3.11-1; 75 FR 76086). Approximately 187,150 square miles (mi^2) fall within the boundaries of the critical habitat (75 FR 76086). There are three critical habitat units designated: (1) sea ice habitat over the continental shelf (approximately 179,500 mi^2); (2) terrestrial denning habitat (topographic features such as coastal bluffs and river banks with suitable macrohabitat characteristics, approximately 5,600 mi^2); and (3) barrier island habitat (all barrier islands and their associated spits along the Alaska coast within the range of the polar bear in the U.S., including a "no-disturbance zone" extending one mile around all designated barrier island habitat; approximately 4,100 mi^2). All three of the aforementioned units of critical habitat are in the Point Thomson study area.

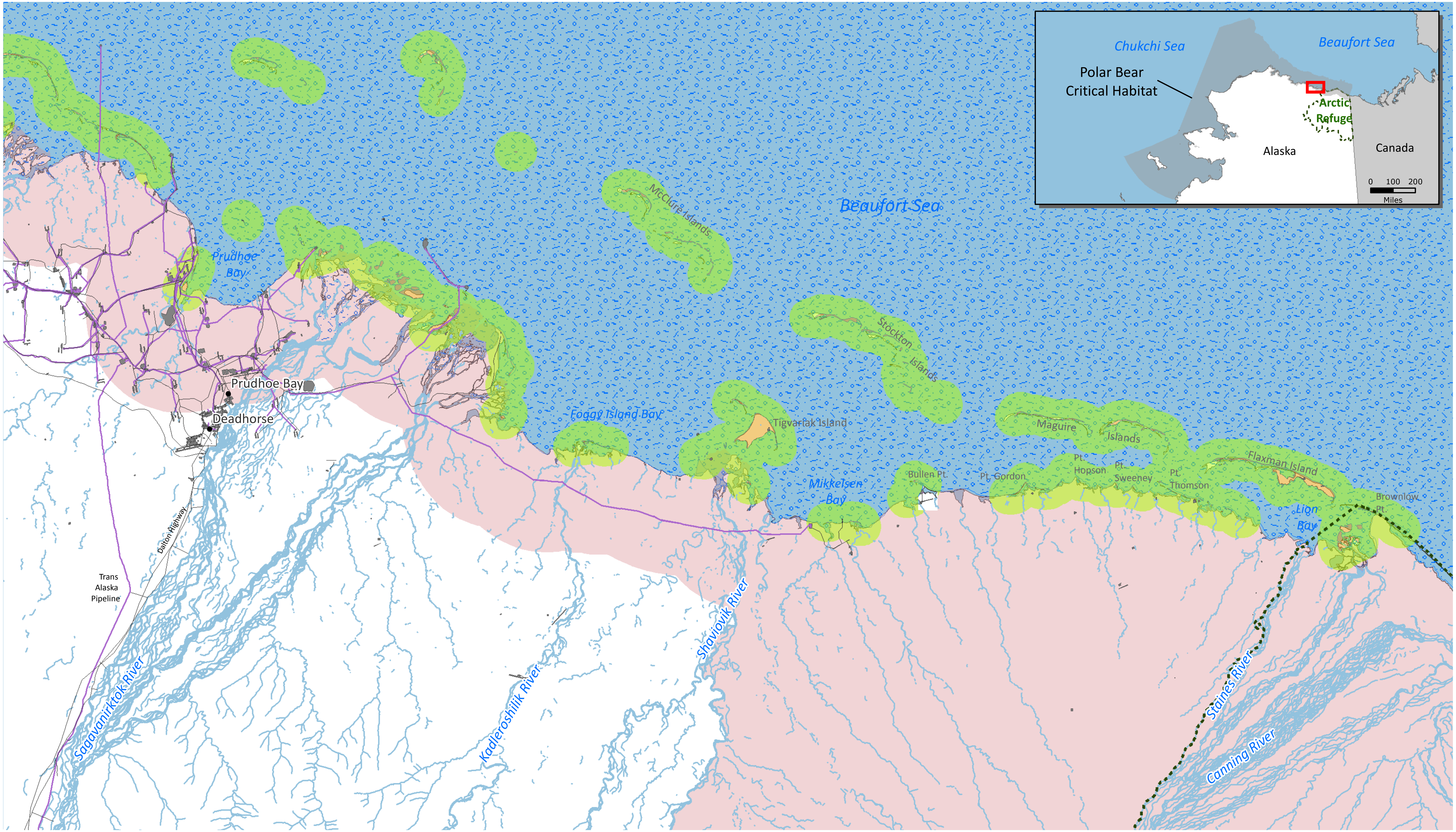
Three stocks of polar bears occur in the Alaskan Beaufort Sea: (1) the Southern Beaufort Sea (SBS), the Chukchi/Bering Seas (CBS), and the Northern Beaufort Sea (NBS; Schliebe et al. 2006a). Only the SBS stock occurs in the study area (see Figure 1 in 73 FR 28216). The SBS stock was estimated at approximately 1,526 animals in 2006 (Regehr et al. 2010) and this is still considered the most current and valid population estimate (USFWS 2010). The best information currently available suggests that the SBS population is declining. There are also indications that the range of the SBS stock has contracted in recent years (Gleason and Rode 2009). Annual survival rates of cubs of the year and recruitment of yearlings have decreased, and body sizes of subadults of both sexes, and adult females have declined from earlier periods (Regehr et al. 2010, Rode et al. 2010). The latter factors suggest reduced nutritional status and a declining population (Rode et al. 2010).

Distribution and Use of the Study Area

The range boundaries of the SBS stock extend from the vicinity of Cape Bathurst, Northwest Territories, on the east, to Icy Cape and Point Hope on the Chukchi Sea coast in Alaska on the west, and seaward about 185 miles from the coast (Amstrup et al. 2000, USFWS 2010b). The core activity area of the SBS stock encompasses a considerably smaller region from Herschel Island, Yukon, to Point Barrow, Alaska, and seaward about 85 miles (Amstrup et al. 2000) (Figure 3.11-2). The Point Thomson study area occurs within the core activity area of the SBS stock.

The Beaufort Sea is an area of widespread, low-density denning for the species (Amstrup 2003). The main area of terrestrial denning for the SBS stock is on the coast between Point Barrow (approximately 250 miles west of study area) and Barter Island (approximately 70 miles east of the study area, following the coastline), including the barrier islands and a coastal strip extending up to 25 miles inland (Durner et al. 2001, 2006) (Figure 3.11-2). The Point Thomson study area occurs within the main area of terrestrial denning for the SBS stock.

Female polar bears do not appear to exhibit fidelity to specific locations for denning; however, they do tend to den on the same type of substrate (pack ice or land) from year to year and may return to the same general area to den (Amstrup and Gardner 1994, Amstrup 2003, Fischbach et al. 2007).



POINT THOMSON PROJECT EIS

Legend

Critical Habitat Designation

- Barrier Islands Critical Habitat
- No Disturbance Zone
- Denning Critical Habitat
- Sea Ice Critical Habitat
- Existing Road
- Existing Pipelines
- Existing Facilities
- Arctic National Wildlife Refuge

0 2.5 5 Miles

N

Figure 3.11-1

Designated Critical Habitat for the Polar Bear

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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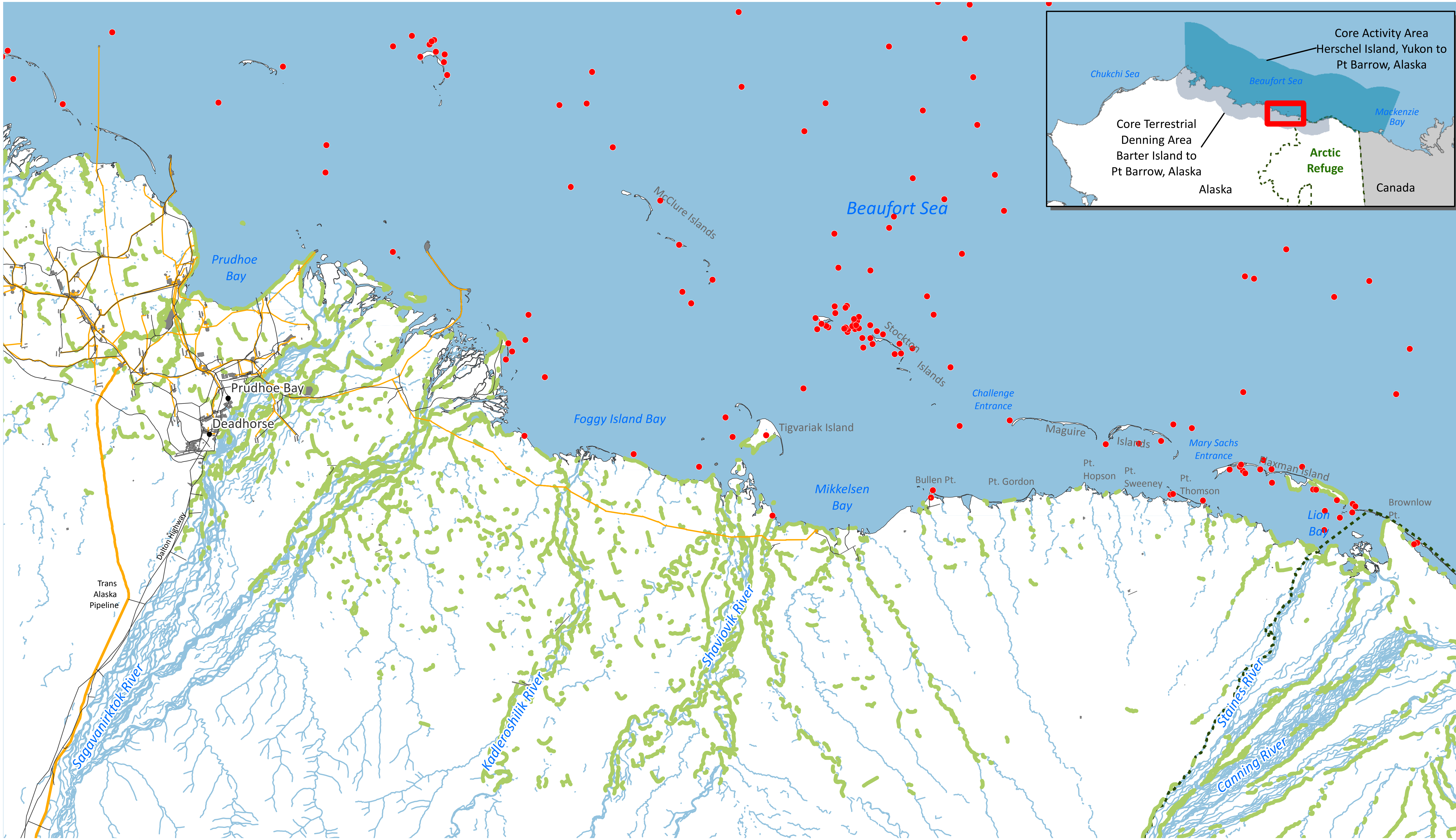

POINT THOMSON PROJECT EIS

Legend

- Polar Bear - Incidental Observations - MMS Bowhead Observation Project 1987-2007
- Polar Bear Maternal Den Habitat (USGS)
- Existing Road
- Existing Pipelines
- Existing Facilities
- Arctic National Wildlife Refuge

0 2.5 5 Miles

N

Figure 3.11-2
Polar Bear Core Use Area,
Denning Habitat, and Incidental Sightings

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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Only a portion (the proportion is unknown) of the SBS stock appears to move onto the mainland in the fall. Besides denning females, other females with cubs and subadult males occasionally come ashore, but, in contrast, adult males usually remain with offshore ice and rarely come ashore (Amstrup and DeMaster 1988). The sex/age composition of bears sighted during 2000-2004 coastal aerial surveys in coastal areas and over barrier islands was: adult females 20 percent; adult male 2 percent; subadult 2 percent; yearling cub 11 percent; cub-of-the-year 17 percent; unknown age dependents <1 percent; adult unknown sex 15 percent; and unknown sex/age 33 percent (Schliebe et al. 2006b).

Beginning in approximately mid-August, polar bear abundance increases on the mainland and barrier islands coincident with the fall, open-water whaling season (Schliebe et al. 2006a). During August through October, aerial surveys for bowhead whales along the Beaufort Sea coast and offshore have provided numerous incidental sightings of polar bears (Monnett and Gleason 2006; Figure 3.11-2). Since 2000, these surveys normally detect about 50 to 100 polar bears per survey (maximal count is approximately 125) between Point Barrow and the Canadian border; 82 percent of the total sightings have occurred on barrier islands, 11 percent on the mainland, and 6 percent on landfast ice (ExxonMobil 2009b). Polar bear sightings generally peak in late September to early October (Schliebe et al. 2001, 2008; Kalxdorff et al. 2002). In fall and winter, polar bears appear to congregate on the barrier islands of the Beaufort Sea (Figure 3.11-2) because of available food (such as bowhead whale carcasses) and favorable environmental conditions (Miller et al. 2006, Schliebe et al. 2008). Usually by late October, bears start leaving the coast to forage on the developing sea ice, except for pregnant females that remain for overwinter denning (Schliebe et al. 2001, Kalxdorff et al. 2002). In winter, nondenning bears remain closer to shore compared with late summer and fall when ice is farthest from shore (Amstrup et al. 2000).

Occasionally, polar bears make relatively long excursions inland. For example, hunters from Kaktovik reported a den near Sadlerochit Spring, about 45 miles inland from the coast (Bee and Hall 1956). During September 2002, a lone bear traveled inland along the Sagavanirktok River and was seen repeatedly as it wandered close to the Dalton Highway; by late September, the bear was about 120 miles inland from Prudhoe Bay. It began moving north again in October and was last seen near Sagwon Bluff (DeMarban 2010). To date, the longest inland movement by a polar bear was documented in March 2008, when a subadult male was killed at Fort Yukon, 250 miles from the Beaufort Sea coast (DeMarban 2010).

Although polar bears could occur in the study area at any time of year, the lowest probability of presence is May through July or early August. From late November through early April, some pregnant females and females with cubs den in the study area, most commonly on or close to the barrier islands (Amstrup 2002). Nondenning, foraging bears are expected to sometimes roam through the study area during those same months; however, their preferred hunting habitat in winter and spring is farther seaward, in areas of more active ice. The majority of polar bear movement and use of the coastline as a travel corridor, including the developed areas, occurs during the fall and spring (Perham 2005). As noted by Schliebe et al. (2008), long-term reductions in sea ice could result in an increasing proportion of the SBS stock coming on land during the fall open-water period and an increase in the amount of time individual bears spend on land.

The study area is located on a section of coastline with the least amount of historical denning habitat in the entire area mapped by the USGS (Durner et al. 2010). The actual number of denning polar bears varies from year to year and cannot be estimated with confidence. Furthermore, as noted earlier (see *Distribution*) polar bears do not use the same dens across years. Thus, the number of identified dens cannot be used to accurately estimate the number of bears using the study area. However, the number of polar bears is likely to be relatively low, judging from existing data on known den locations and other available data. The occurrence of dens in the area may increase in future years given continuing shifts in denning from drifting sea ice to land by the SBS stock.

The greatest polar bear concentrations now occur at Barter Island, Cross Island, and Point Barrow, where bears are attracted to bowhead whale carcasses taken during the fall subsistence hunt (Miller et al. 2006; Section 5.22, Subsistence and Traditional Land Use Patterns). The study area is located between Cross and Barter islands, but there is little indication of bear movement between those sites (Miller et al. 2006).

Habitat Use

Polar bears rely principally on the availability of sea ice habitats (landfast ice and pack ice) to provide a substrate on which to roam, hunt, breed, den, and rest. Preferred habitats are located in the active seasonal ice zone that overlies the continental shelf and associated islands, and in areas of heavy offshore pack ice (Stirling 1988; Durner et al. 2004, 2009). The availability and abundance of prey associated with seasonal sea ice is considered the primary factor influencing habitat use (Smith 1980).

Habitat use changes seasonally with the formation, advance, movement, retreat, and melt of sea ice (Ferguson et al. 2000). During 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; greatest densities occur in the latter two categories, presumably because those habitats offer bears greater access to seals (Schliebe et al. 2006a). Use of shallow water areas is highest in winter, in areas of active ice with shear zones and leads (Durner et al. 2004). The use of landfast ice increases in spring during the pupping season of ringed seals. Multiyear ice is selected in late summer and early autumn as the pack ice retreats to its minimal extent (Ferguson et al. 2000, Durner et al. 2004). Prey availability may not be the only factor affecting habitat selection: females with young may retreat to the safety of areas with less prey but greater stability in ice cover (Mauritzen et al. 2003). Beaufort Sea coastal habitat is most important to polar bears during maternal denning (October to April; Perham 2005).

Terrestrial coastal areas are experiencing increased use by polar bears for longer durations during the fall open-water period, the season when there is a minimum amount of ice present (Schliebe et al. 2008). Recent reports from aerial surveys suggest an increase in polar bear use of land in the fall since around 1997 (Monnett and Gleason 2006, Gleason and Rode 2009). In addition, polar bear sightings in the vicinity of onshore oil and gas facilities and observations by Native villagers suggest that bears have been increasing their use of land (Amstrup 2000, Schliebe et al. 2006a). These changes have occurred over the same time period as documented reductions in the summer extent of sea ice.

Polar bears from SBS stock have historically denned on both the sea ice and land (USFWS 2010b). Amstrup and Gardner (1994) reported that the majority of denning in the Beaufort Sea occurred on sea ice. Recent declines in the number of polar bears denning on ice strongly suggests that females in the SBS stock have exhibited a shift to denning more on land and less on the sea ice in recent years (Fischbach et al. 2007). In addition to the landward shift, there has been a trend in an eastward shift in maternal den distribution (Fischbach et al. 2007).

USGS biologists characterized and mapped potential denning habitat along the Alaska Beaufort Sea coast between the Colville River (at Prudhoe Bay) and the Canadian border (Durner et al. 2001, 2003). Areas, such as barrier islands, river bank drainages, much of the North Slope coastal plain, and coastal bluffs that occur at the interface of mainland and marine habitat, receive proportionally greater use for denning than other areas (Durner et al. 2003, 2006). Snow cover, both on land and on sea ice, is an important component of polar bear habitat as it provides insulation and cover for polar bear dens (Durner et al. 2003).

The five types of habitat occurring in the Point Thomson study area that are considered most suitable to polar bear are: (1) the nearshore Beaufort Sea seaward of the barrier islands, (2) the linear series of protective barrier islands, (3) an extensive shallow coastal lagoon, (4) two relatively wide and three narrow entrances to the lagoon, and (5) the mainland coast (ExxonMobil 2009b).

Life History

Polar bears are long-lived, reach reproductive maturity relatively late in life, have relatively few young, have an extended period of maternal care, and have relatively high survival rates, especially after attaining maturity (Amstrup 2003). Mating occurs primarily from March to late May or early June, when both sexes are active on the sea ice. Generally, only pregnant polar bears routinely enter dens in the fall for extended periods. Pregnant polar bears establish maternal dens in October and November (Amstrup and Gardner 1994). Births occur typically in late December or early January, and mothers and cubs emerge from natal dens in late March or early April (Lentfer and Hensel 1980, Amstrup and Gardner 1994). Following emergence from these maternal dens, female polar bears denning in terrestrial habitat will return to the sea ice as soon as their cubs are able (Schliebe et al. 2006a).

Cubs usually stay with their mothers until they are 1.5 to 2.5 years old, although some may remain into their third or fourth year (Amstrup 2003). Females breed again at about the same time they separate from their young; thus, the breeding interval of females that successfully wean cubs is three years or longer (Schliebe et al. 2006a).

The primary prey of polar bears in the Beaufort Sea is the ringed seal and to a lesser extent, bearded seals, walruses, and beluga whales, as well as carcasses found along the coast (Amstrup 2003, Bentzen et al. 2007). They may also occasionally eat small mammals, bird eggs, and vegetation when other food is not available (Smith et al. 2010). Bowhead whale carcasses can be particularly important food sources for subadults and sows with cubs (Miller et al. 2006). Polar bears may approach human developments in search of food.

There are three critical habitat areas or units designated: (1) barrier islands, sea ice habitat over the continental shelf (approximately 179,500 mi^2); (2) terrestrial denning habitat (topographic features such as coastal bluffs and river banks with suitable macrohabitat characteristics, approximately 5,600 mi^2); and (3) barrier island habitat (all barrier islands and their associated spits along the Alaska coast within the range of the polar bear in the U.S., including a "no-disturbance zone" extending 1 mile around all designated barrier island habitat; approximately 4,100 mi^2). All three of the aforementioned habitats are in the Point Thomson study area.

Summary

Although polar bears may be encountered year-round in nearshore and coastal areas of the Beaufort Sea (Schliebe et al. 2006a), individuals are usually absent from the study area during early summer (June-July) based on available data. Numbers begin to increase in August and peak in September (based primarily on aerial survey data); these bears are believed to be moving through the area to reach newly-forming pack ice to forage. The barrier islands in the study area, especially Flaxman Island, are consistently used by denning females from fall through winter (Durner et al. 2006, Smith et al. 2007), although the number of denning bears is relatively small compared to other known denning areas.

Ringed Seal

Status

On December 10, 2010, the NMFS proposed listing five subspecies of ringed seals as threatened (including the arctic subspecies that occur in the Point Thomson study area; 75 FR 77476). Declining ice due to climate change is considered a serious threat to ringed seals as they are closely associated with ice (Kelly et al. 2010).

The ringed seal is the most abundant marine mammal in the Beaufort, Chukchi, and Bering seas (Frost et al. 1988, Funk et al. 2010, Kelly et al. 2010). Ringed seals that occur year-round in the Beaufort Sea and the study area belong to the Alaska Stock (Allen and Angliss 2010). However, there is currently no reliable information on population abundance or trends of ringed seals for the Alaska stock (Allen and Angliss 2010). There is a minimum population estimate of 249,000 ringed seals for the Beaufort and Chukchi seas combined (Allen and Angliss 2010). In addition, aerial surveys conducted from Barrow to Kaktovik between 1996 and 1999 indicate that from May to June, ringed seal densities are higher to the east of Flaxman Island (three seals per square mile) than to the west (two seals per square mile; Frost et al. 2002, 2004). This distribution trend is likely similar during winter (Burns 1970, Allen and Angliss 2010).

Distribution and Use of the Study Area

Besides the abundance of the species, the ringed seal is also one of the most widely distributed marine mammals in the Beaufort Sea (Funk et al. 2010, Kelly et al. 2010). In general, distribution is strongly correlated with ice-covered waters (Moulton and Lawson 2002, Kelly et al. 2010) and density varies between nearshore and offshore waters by season and ice coverage. During winter and spring, seals occupy landfast and offshore pack ice yet, during summer and fall, ringed seals are widely distributed in open water between Barrow and Kaktovik (Funk et al 2010, Kelly et al. 2010); there are no indications of any preferred or concentrated geographic areas.

Habitat Use

In winter, few ringed seals inhabit shallow water (less than 16 feet) as water typically freezes to or near this bottom depth and any available water supports few food resources (Link et al. 1999, Moulton et al. 2002, Frost et al. 2004). During winter and spring more than 75 percent of the water in the study area is considered marginal or unsuitable seal habitat as it is less than 10 feet deep and is predominantly frozen and grounded to the sea bottom (as defined by bathymetric contours).

Life History

In late March and April ringed seal pups are born on the pack ice in lairs that have been excavated in snowdrifts and pressure ridges. Seals build these lairs in waters more than 10 feet in bottom depth and where sufficient open water under the ice is available (Burns 1970, 1981a). During the 4- to 6-week nursing period, pups usually remain in the birth lair, but by late April through June, they generally move northward with the receding southern ice edge (Burns 1970, 1981a).

Ringed seals are considered opportunistic feeders (Hammil 2008). They feed throughout the water column and bottom, and eat a wide variety of small prey. Predominant prey includes arctic cod, saffron cod, shrimps, amphipods, and euphausiids (Kelly 1988a).

Summary

Ringed seals are expected to occur commonly in and near the study area in coastal waters during the summer/fall open-water season. Yet, during winter and spring, the proportion of ringed seals in the study area is anticipated to be small relative to the estimated size of the Beaufort Sea population given existing records and the limited availability of suitable water depths.

Bearded Seal

Status

On December 10, 2010, the NMFS proposed listing one subspecies (two distinct population segments [DPS]) of the bearded seal as threatened, including the Beringia DPS, which occurs in the Beaufort Sea waters of the study area (75 FR 77496). Declining sea ice due to climate change is considered a serious threat to bearded seals as they are closely associated with sea ice (Cameron et al. 2010).

Bearded seals that occur in the Beaufort Sea, and possibly the study area, belong to the Alaska Stock (Allen and Angliss 2010). The bearded seal is the second most common seal species in the Beaufort Sea after the ringed seal (Laidre et al. 2008). No reliable population estimates or trends are currently available for the Alaska Stock (Allen and Angliss 2010, Cameron et al. 2010). However, density data are available for a portion of the stock occurring in the eastern Chukchi Sea based on surveys conducted in 1991 and 2000 between Barrow and Shishmaref (Bengston et al. 2005). The average estimated density in that area was 0.03 to 0.05 seals per square mile. These are considered minimum estimates because only hauled-out seals were counted; thus, seals in the water or under ice were not accounted for. Given those limitations, Bengston et al. (2005) suggested that actual densities could be up to about 12 times higher, which would result in approximately 0.34 to 0.68 seals per square mile.

Distribution and Use of the Study Area

The Alaska stock of bearded seals inhabits continental shelf waters of the Bering, Chukchi, and Beaufort seas (Cameron et al. 2010). Distribution is affected by ice cover and movement related to seasonal changes (Kovacs 2008, Cameron et al. 2010). Individuals overwinter in the Bering Sea; in April and May, they migrate north through the Bering Strait as the ice edge recedes (Burns 1981b, Burns and Harbo 1972, Moulton and Lawson 2002). By July through September, they have followed the receding ice edge to the Chukchi and Beaufort seas (Moulton and Lawson 2002). During this period, bearded seals inhabit primarily the widely fragmented edge of multiyear ice (Moulton and Lawson 2002).

Habitat Use

Bearded seals prefer drifting pack ice over waters less than 650 feet in bottom depth (Harwood et al. 2005, Kovacs 2008). The species rarely uses landfast ice (Burns and Harbo 1972, Burns 1981b, Moulton and Outlaw 2002). Spring surveys along the Alaska coast indicate that bearded seals are typically most abundant about 50 to 300 miles from shore (Bengston et al. 2000). Suitable habitat for the bearded seal is more limited in the Beaufort Sea versus the Bering and Chukchi seas, as the continental shelf is narrower and the pack ice edge frequently occurs seaward of the shelf and over water too deep for feeding (Brueggeman et al. 2009).

Life History

Pupping occurs in late March through May, primarily in the Bering and Chukchi seas, although some pupping also occurs in the Beaufort Sea (Cameron et al. 2010). Pups are born on the ice within a few feet of open water. Molting occurs mainly in June and bearded seals prefer to stay out of the water during this time (Kovacs 2008).

Bearded seals are predominantly benthic (on or in the bottom of a sea or lake) feeders (Burns 1981b, Kovacs 2008). They consume a variety of benthic prey, including crabs, shrimp, mollusks such as clams, as well as arctic cod, saffron cod, flounder, sculpins, and octopuses (Kelly 1988b).

Summary

Because bearded seals are normally found in broken ice that is unstable and typically inhabit the Beaufort Sea only during summer, this species is unlikely to be encountered in the study area in winter or early spring.

3.11.4.2 NonESA-listed Marine Mammals

Of the three nonthreatened/nonendangered marine mammal species with occurrence in the study area, only the beluga whale is anticipated to actually occur here, and only in relatively low numbers (Table 3.11-2). The two other species (gray whale and spotted seal) have a rare occurrence (i.e., sporadically occurring in the study area).

Beluga Whale

Beluga whales in the Beaufort Sea belong to the Beaufort Sea and the Eastern Chukchi Sea stocks (Allen and Angliss 2010). The NMFS estimates that approximately 39,258 belugas comprise the Beaufort Sea stock, while the Eastern Chukchi Sea stock is estimated to be 3,710 individuals (Allen and Angliss 2010). Any occurrences of beluga whales in the study area are most likely individuals from the Beaufort Sea stock. Satellite-tagging data, however, demonstrates that summer distribution of the Eastern Chukchi Sea stock includes the Beaufort Sea, with some individuals moving into Canadian waters (Suydam et al. 2001, 2005). The distribution of the two stocks, therefore, overlaps during the summer in the study area.

The general distribution pattern for beluga whales shows major seasonal changes (Allen and Angliss 2010). During the winter, they occur in offshore waters associated with pack ice. In the spring, beluga whales migrate to warmer coastal estuaries, bays, and rivers where they may molt, give birth, and care for their calves.

Beluga whales of the Beaufort Sea stock winter in the Bering Sea, and migrate north and west into the eastern Beaufort Sea where they spend their summers (Angliss and Allen 2010). The eastward spring migration in the Beaufort Sea occurs through ice leads far offshore (Richardson et al. 1995). During summer, this stock primarily inhabits offshore waters of the eastern Beaufort Sea and Amundsen Gulf; however, during July-August, many of the whales use the Mackenzie River estuary for molting (Harwood et al. 1996, Richard et al. 2001). By late summer and fall, most of the population has moved to far offshore waters at the front of the pack ice (Frost et al. 1986, Hazard 1988). While the Beaufort Sea stock of beluga whale is expected to occur offshore, a few migrating belugas have been observed in nearshore waters of the central Alaskan Beaufort Sea during the July/August time period (e.g., LGL and Greeneridge 1996, Aerts et al. 2008, Christie et al. 2010).

In summary, small numbers of beluga whales of the Beaufort Sea stock may occur in the study area seaward of the barrier islands, most likely during the fall westward migration from late August through mid-September. It is possible, though highly unlikely, that a few belugas from the Eastern Chukchi Sea stock could occur in the study area, also during the fall westward migration from late August to mid-September. No belugas are expected in the region during winter and spring.

Gray Whale

Any occurrence of the gray whale in the central Beaufort Sea would be from the Eastern North Pacific stock, most recently estimated as 18,813 individuals (Allen and Angliss 2010). The Eastern North Pacific Stock of the gray whale was listed as threatened under the ESA until 1994 when it was delisted (Allen and Angliss 2010). The abundance of this stock has been roughly stable since the mid-1980s; it is currently believed to be at or near carrying capacity (Rugh et al. 2005, Allen and Angliss 2010).

Most of the stock forages during summer in the northern and western Bering and Chukchi seas (Rice and Wolman 1971) and, less frequently, in the Beaufort Sea (Allen and Angliss 2010). The closest traditional feeding area to the study area occurs in the northeastern Chukchi Sea southwest and west of Point Barrow (Clarke et al. 1989, Brueggeman et al. 1992), 250 miles west of the study area.

Sightings of small groups or individuals have been reported in the central Alaskan Beaufort Sea (Hashagen et al. 2009, Funk et al. 2010), including Harrison Bay (Miller et al. 1999, Treacy 2000); near the Northstar production island (Williams and Coltrane 2002); and near Camden Bay (Christie et al. 2010). Sightings have also been reported in the Canadian Beaufort Sea (to 130° W; Rugh and Fraker 1981). The recent increase in gray whale sightings east of Barrow has been associated with decreased ice coverage, which may facilitate increased gray whale access to this region (Moore and Huntington 2008).

Given the limited sightings of gray whales in the vicinity of the Point Thomson study area, it is possible, though unlikely, that this species would be encountered. No gray whales would occur during winter and spring. Any occurrences would most likely be limited to fall or summer when gray whales are on their feeding grounds in the northern and western Bering and Chukchi seas approximately 250 miles west of the study area and might wander into the study area. Given the species' rare occurrence in the central and eastern Beaufort Sea, no more than a few could be expected during the summer and fall. As with other species, the frequency of gray whales reported in the Beaufort Sea has been increasing as ice cover has diminished and sea temperatures have warmed. Thus, the likelihood of encountering a gray whale here may increase in the future, particularly during light ice years.

Spotted Seal

The spotted seal is the least common seal species in the Beaufort Sea (compared to the more abundant ringed and bearded seals; Laidre et al. 2008). Spotted seals that occur in the Beaufort Sea belong to the Alaska stock (Allen and Angliss 2010). Although spotted seals occur regularly in the Beaufort Sea, they are unlikely to occur in the study area based on known distribution and habitat preferences (Table 3.11-2). A reliable estimate of the Alaska stock is currently unavailable (Allen and Angliss 2010). Aerial surveys from 1992 and 1993 observed 4,145 and 2,591 seals, respectively (Rugh et al. 1993). However, satellite tagging data revealed that a small percentage of animals were hauled out during those surveys (Lowry et al. 1994). Correcting for missed seals, the minimum population estimate for spotted seals is 59,214 (Allen and Angliss 2010). This is considered a minimum estimate, as a large portion of the species' range was not included in the survey. In October 2009, the NMFS determined that the Alaska stock did not warrant listing under the ESA (74 FR 53683).

The Alaska stock of spotted seal is distributed over the outer continental shelf of the Bering, Chukchi, and Beaufort seas (Boveng et al. 2009). More spotted seals inhabit the coast of the Chukchi Sea than the

Beaufort Sea (Frost et al. 1993). During summer, spotted seals inhabit primarily the Bering and Chukchi seas, although some individuals also occur in the western Beaufort Sea from July through September (Rugh et al. 1997, Lowry et al. 1998). During summer, spotted seals alternate between hauling out on land and spending extended periods at sea; they rarely use pack ice unless it is very close to shore (Boveng et al. 2009). They migrate out and south of the Chukchi and Beaufort seas when the ice cover thickens in fall and move into the Bering Sea to overwinter (Lowry et al. 1998).

In summary, the spotted seal is unlikely to occur in the study area as the majority of the population inhabits the Chukchi and Bering seas with relatively few individuals occurring in the Beaufort Sea during July through September.

3.11.5 Marine Mammal Species That are Extralimital to the Study Area

Nine species are considered "extralimital" (i.e., they are unlikely to normally occur in the area and the region is considered beyond the normal range of the species, but there are one or more historical observation records) to the Beaufort Sea and thus the study area: the fin whale, harbor porpoise, hooded seal, humpback whale, killer whale, minke whale, narwhal, Pacific walrus, and Steller sea lion. Given their rarity in the study area, these species are not further addressed in this document beyond a brief summarization of occurrence records to the area. It should be noted, however, that occurrences of these species might increase in the future in the Beaufort Sea (and therefore, the study area) based on predicted climate change trends and associated diminishing ice coverage in arctic waters (Higdon and Ferguson 2009).

Fin Whale

While fin whales have not been seen in the Beaufort Sea, individuals have been seen and acoustically detected in the Chukchi Sea (Brueggeman et al. 2009, Ireland et al. 2009). Those sightings are only during the open-water seasons of summer and fall. These individuals likely belong to the Northeast Pacific stock. Recent fin whale sightings beyond their typical northern range in Alaska, including in the eastern Chukchi Sea, may be associated with a rise in sea surface temperatures, as was suggested by Hashagen et al. (2009) for humpback whales.

Harbor Porpoise

In Alaska, the harbor porpoise occurs primarily in the Bering Sea and typically does not occur east of Point Barrow (Suydam and George 1992, Allen and Angliss 2010). During summer, however, a small number of harbor porpoises from the Bering Sea stock do regularly move north into the Chukchi Sea and have occasionally been observed as far east as the Beaufort Sea (Allen and Angliss 2010). During extensive aerial surveys monitoring marine mammals relative to seismic activities in 2006, 2007, and 2008, though, only one harbor porpoise was documented in the Beaufort Sea; this sighting occurred in September 2007 between the villages of Barrow and Kaktovik (Funk et al. 2010).

Hooded Seal

Records of the hooded seal in the Beaufort Sea are few and scattered (Burns and Gavin 1980). The normal distribution of the hooded seal is throughout much of the North Atlantic and Arctic Oceans where they prefer deep and offshore waters in heavy pack ice (Kovacs 2008). Hooded seals are highly migratory, particularly juveniles, and occasionally wander outside their typical range by long distances (Burns and Gavin 1980). Between 1970 and 1975, three hooded seals were reported in the western

Beaufort Sea: one in September 1972 in Prudhoe Bay, one in December 1975 in Prudhoe Bay, and one west of Prudhoe Bay at Beechey Point in the summer of 1970 (Burns and Gavin 1980).

Humpback Whale

Humpback whales that occasionally occur in the Beaufort Sea during the open-water seasons of summer and fall are considered to have wandered from the more southern waters of Alaska. Stock origin of these individuals is not known; some propose the individuals may belong to the Central North Pacific stock (Funk et al. 2010, Allen and Angliss 2010), while others have suggested that could belong to the Western North Pacific stock (Hashagen et al. 2009). In August 2007, two individuals were sighted in Smith Bay (Funk et al. 2010), approximately 55 miles east of Point Barrow (about 130 miles west of the study area). During the same month, a humpback whale mother and calf pair was also photographed east of Point Barrow (Green et al. 2007). These extralimital sightings could suggest that rising sea surface temperatures may contribute to the extension of this species' typical range into more northern, usually ice-laden waters, including the Chukchi and Beaufort seas (Hashagen et al. 2009).

Killer Whale

Killer whales have not been documented in the Beaufort Sea since the 1980s (Lowry et al. 1987) other than a single record from near Point Barrow (i.e., at the furthest reach of the Beaufort Sea where the transition to the Chukchi Sea occurs) in the early 1990s (George et al. 1994). Historically, though, Native Alaskan beluga whale hunters have reported seeing killer whales on rare occasions in the Beaufort Sea while conducting nearshore hunts for beluga (Baird 2001, Harwood and Smith 2002).

Minke Whale

The minke whale has only been seen occasionally in the Beaufort Sea, as its normal range in Alaska is limited to the Gulf of Alaska north to the Bering and Chukchi seas, where it is considered relatively common (Mizroch 1991, Allen and Angliss 2010). During extensive summer/fall aerial and vessel surveys for marine mammals in the Beaufort Sea between 2006 and 2008, which were limited to seaward of the barrier islands, there were only four sightings over the continental shelf and shelf break: one whale in 2006, one in 2007, and two in 2008 (Funk et al. 2010).

Narwhal

The narwhal is considered extremely unusual in the Beaufort Sea. Its normal distribution is the Atlantic sector of the Arctic Ocean (Heide-Jørgensen 2008) and there are no recent sightings from the Beaufort Sea (Harwood and Smith 2002). The last known record in October 1991 was of the tip of a narwhal tusk found embedded in the melon (head) of a beluga whale hunted off Tuktoyaktuk, Canada (Orr and Harwood 1998).

Pacific Walrus

The Pacific walrus occurs primarily in shallow, continental shelf waters of the Bering and Chukchi seas, with small numbers occurring in the Beaufort Sea, and only during the summer (Garlich-Miller et al. 2011). The Beaufort Sea is beyond the normal range of the Pacific walrus and the likelihood of encountering walruses in the study area appears to be low (USFWS 2011b). From 1994-2004, industry monitoring programs recorded a total of 9 walrus sightings involving 10 animals; 2 of these sightings were of individual animals that hauled-out onto the Northstar production island (Garlich-Miller et al. 2011).

Steller Sea Lion

The Steller sea lion normally occurs along the North Pacific Rim from northern Japan to California, with abundance and distribution centered in the Gulf of Alaska and Aleutian Islands (Loughlin et al. 1984, Allen and Angliss 2010). Individuals seen in the Beaufort Sea are considered vagrants (Rice 1998) and would likely belong to the Western Pacific stock (Allen and Angliss 2010). Extralimital records include Herschel Island in the Canadian Beaufort Sea, approximately 180 miles east of the Point Thomson study area (Rice 1998).

3.11.6 Marine Mammal Hearing

To consider the influence of various kinds of noise on marine mammals, it is necessary to understand the hearing abilities and sensitivities of the species of interest, and the frequencies and source levels produced by the relevant noise sources.

Southall et al. (2007) delineated five functional groups of marine mammals (representing only cetaceans and pinnipeds) based on similarities in their hearing (see Table 3.11-4). Marine mammal species with expected occurrence in the study area and addressed in this Draft EIS (except the polar bear) are identified by these groups. In general, data on the hearing abilities of cetaceans are sparse, particularly for the larger cetaceans such as the baleen whales; thus, most information on hearing is derived from data on known frequency ranges of vocalizations. Structurally, though, it is recognized that ears of small toothed whales are optimized for receiving high-frequency sound, while baleen whale inner ears are best optimized for low to infrasonic frequencies (Ketten 1992, 1997). Four of the five functional hearing groups identified by Southall et al. (2007) are relevant to the impact assessment for this study area: low-frequency hearing cetaceans, mid-frequency hearing cetaceans, pinnipeds hearing in water, and pinnipeds hearing in air (see Table 3.11-4).

Table 3.11-4: Hearing Capabilities of Marine Mammal Species Expected in the Point Thomson Study Area

Functional Hearing Group	Estimated Auditory Bandwidth	Study Area Species	Frequency-Weighting Network
Low Frequency Cetaceans	7 Hz—22 kHz	Bowhead whale, gray whale	M_{lf}(lf: low-frequency cetacean)
Mid-frequency Cetaceans	150 Hz—160 kHz	Beluga whale	M_{mf} (mf: mid-frequency cetaceans)
High Frequency Cetaceans	200 Hz—180 kHz	None	M_{hf} (hf: high-frequency cetaceans)
Pinnipeds in Water	75 Hz—75 kHz	Ringed seal, bearded seal, spotted seal	M_{pw} (pw: pinnipeds in water)
Pinnipeds in Air	75 Hz—30 kHz	Ringed seal, bearded seal, spotted seal	μPa (pa: pinnipeds in air)

Source: Southall et al. 2007

Little research has been conducted on the effects of noise on the polar bear (Perham 2005). Results of behavioral audiograms of five polar bears showed best hearing sensitivity between 8 and 14 kHz, with a sharp roll-off between 14 and 20 kHz (Owen et al. 2010). In another study, auditory-evoked potentials of three individuals revealed the best sensitivity to be between 11.2 and 22.5 kHz (Nachtigall et al. 2007).

3.12 FISH, ESSENTIAL FISH HABITAT, AND INVERTEBRATES

The study area for fish, essential fish habitat, and invertebrates includes the area from the Staines/Canning River to the Sagavanirktok River. The southern boundary begins on the east side (Staines River) approximately 9 miles south of the coast and extends west to the Shaviovik River where the boundary gradually shifts north until it meets the Sagavanirktok River approximately 4 miles from the coast. The northern boundary extends approximately 5 miles offshore.

3.12.1 Key Information about Fish, Fish Habitat, and Invertebrates

Fifty-eight fish species have been found in the Alaskan Beaufort Sea and nearshore environment near the study area. Thirteen fish species have been documented in freshwater habitats of the study area. A comprehensive list of fish species in the study is included, with both English and Iñupiaq names, in Appendix B. The fish species of most concern for the Point Thomson project are listed in Table 3.12-1. Species were included if they met one or more of the following criteria:

- Target of a subsistence, sport, or commercial fishery in or near the study area
- A species for which most or all members occur in or migrate through the study area
- One for which specialized habitat occurs in the study area (e.g., spawning or overwintering habitat)
- Subject of public or agency scoping comments

Table 3.12-1: Fish Species of Concern for the Point Thomson Project

Species	Reason For Concern
Arctic Cisco	Population that migrates along nearshore habitats of the study area supports subsistence fisheries at Kaktovik and Nuiqsut and a commercial fishery in the Colville River.
Least Cisco	Population that migrates along nearshore habitats of the study area supports a subsistence fishery in the Colville River.
Dolly Varden	Sport fisheries occur in the Sagavanirktok and Canning Rivers within the study area and the species is an important subsistence resource for Kaktovik residents. Dolly Varden spawn and overwinter in the Canning/Staines, Sagavanirktok, Shaviovik, and Kavik Rivers and migrate along nearshore habitats in the study area.
Arctic Grayling	Sport fisheries occur in the Sagavanirktok and Canning Rivers. Arctic grayling spawn, rear, and overwinter in the Canning/Staines, Sagavanirktok, Shaviovik, and Kavik Rivers within the study area.
Broad Whitefish	Population overwinters and spawns solely in the Sagavanirktok River and migrates to the Colville River where there is a subsistence fishery.
Humpback Whitefish	Population that migrates along nearshore habitats of the study area supports a subsistence fishery in the Colville River.
Arctic Cod	EFH has been designated for arctic cod within the marine study area. Arctic cod are a primary component of the arctic marine food chain and an important subsistence food.
Pacific Salmon	Pacific salmon EFH has been designated for four streams and in marine portions of the study area. Small runs of pink and chum salmon are found in some of the larger streams of the North Slope. Records of sockeye, Chinook, and coho salmon along the Beaufort Sea coast are extremely rare and attributed to straying.

Scoping comments were received relating to crabs and sculpins, but these organisms were not included in the species of concern. Crabs have not been documented in the area. Sculpins, while they occur widely across the North Slope, are not the target of any known fishery and are not known to be dependant on specialized habitat within the study area.

Invertebrates are critical components of marine and freshwater habitats in the study area because fish, mammals, and birds feed on these organisms and depend on invertebrate abundance and biomass. Invertebrates include a diverse array of organisms such as polychaete and oligochaete worms, clams, crustaceans (which include a diversity of species from microscopic sized copepods and amphipods to large crabs), and insects (particularly larval forms). Aquatic invertebrates live on the surface of the substrate or in the water column (epibenthic) or buried in the substrate (infaunal or benthic).

Marine habitat in the study area includes coastal waters between the Canning/Staines and Sagavanirktok Rivers; Lion Bay, Mikkelsen Bay, Foggy Island Bay, and portions of the Canning/Staines and Sagavanirktok River deltas. The marine study area, particularly the nearshore environment, is used for migration (e.g., adult Pacific salmon, adult and immature arctic cisco and Dolly Varden), foraging (e.g., adult arctic cisco, least cisco, Dolly Varden, broad whitefish, and humpback whitefish), and spawning (e.g., arctic cod).

Freshwater habitat of the study area includes shallow, seasonally flooded ponds and wetlands, small tundra streams, and larger, braided rivers and streams. Most freshwater habitat in the study area is available only during the open water season because most of these habitats freeze to the bottom during winter (however, some aquatic invertebrates overwinter in sediments). Overwintering areas for fish species of concern on the North Slope are largely confined to large river systems outside the study area. Exceptions include overwintering sites for Dolly Varden in portions of the Canning/Staines, Sagavanirktok, Kavik, and Shaviovik Rivers.

Small runs of Pacific salmon are found in some of the larger streams of the North Slope. Within the study area, Pacific salmon occur in the Canning/Staines, Shaviovik, Kavik, Sagavanirktok, and West Sagavanirktok Rivers. Spawning has not been confirmed for all of these streams.

3.12.2 Review and Adequacy of Information Sources for Fish, Essential Fish Habitat, and Invertebrates

Most information on fish, fish habitat, and invertebrates in the study area has been gathered in association with past proposed development projects within or adjacent to the study area. Most have been baseline or reconnaissance studies performed intermittently since 1974 by consultants for oil and gas companies. Limited studies have been completed by state and federal agencies.

Fish studies have not been repeated for more than a single study season, except monitoring conducted at the Endicott causeway development (Sagavanirktok River delta) since the 1980s. For invertebrates, minimal studies have been conducted within the study area. However, reliable studies of arctic environments have been conducted in marine habitats as part of the NOAA Outer Continental Shelf Environmental Assessment Program (OCSEAP) and for freshwater habitats at Prudhoe Bay and in the Teshekpuk Lake region.

Some information is available from EISs that have been completed recently for areas outside of the study area. Some peer-reviewed literature reviews have covered fisheries on the North Slope. ADF&G maintains a database of streams in which anadromous fish (i.e., Pacific salmon, Dolly Varden) have been found to be present, migrating, or spawning, based on nominations submitted as a result of agency reconnaissance.

Table H-12 in Appendix H discusses the publications, reports, and data available for fish and invertebrates that are cited in this Draft EIS and their relevance to the proposed project. Full references for the studies cited in this Draft EIS are in Chapter 9, References.

3.12.3 Fish Habitat

Fish assemblages within the study area are composed of species that inhabit marine habitats, freshwater habitats, or that migrate between both. Fish found in marine habitats of the study area are discussed first, followed by a discussion of those occurring in freshwater.

Fish found in the study area follow several different life histories; they may spend their lifespan entirely in freshwater or entirely in the marine environment, or may migrate between the two environments. Table 3.12-2 describes arctic fish life history strategies.

Table 3.12-2: Life History Strategies of Arctic Fishes

Life History Strategy	Description
Freshwater	Spend lifespan entirely in freshwater.
Marine	Spend lifespan entirely in marine environment.
Diadromous (general term)	Migrate between freshwater and marine environments; may migrate regularly between breeding grounds in freshwater or the ocean and feeding grounds in the other environment (Quinn 2005). Both anadromous and amphidromous fish that migrate between freshwater and saltwater (Gallaway and Fechhelm 2000).
Anadromous (subset of diadromous)	Spawn in freshwater and spend a portion of the lifespan in the marine environment (Craig 1989a).
Amphidromous (subset of diadromous)	Immature fish return to freshwater before they reach adult size and spawn (Quinn 2005). On the ACP, spawning and overwintering take place in rivers and streams; fish migrate each summer to feed in coastal waters (Gallaway and Fechhelm 2000).

The following sections describe these habitats and how fish species utilize these habitats throughout their life stages. Following the habitat discussions, life histories of fish species important to humans that may be impacted by the proposed project are described.

3.12.3.1 Marine Habitat and Fish Use

Marine fish habitats in the study area consist of coastal areas in which marine and freshwater intermix; portions of the Sagavanirktok and Staines River deltas, Lion Bay, Mikkelsen Bay, and Foggy Island Bay are included within the study area. These areas are described below, from east to west. Figure 3.12-1 shows these bays and their relationship to barrier islands and freshwater streams. These habitats are important to fish because up to 90% more prey biomass is found within the nearshore marine environment than in freshwater on the North Slope; this is the primary feeding area for diadromous fish on the North Slope (Gallaway and Fechhelm 2000).

The Staines River, a large ***distributary*** of the Canning River, discharges into eastern Lion Bay. The Canning River originates in the Brooks Range. The western portion of the Staines River delta is within the study area.

Lion Bay is formed by a barrier-island lagoon system located approximately 51 miles east of Prudhoe Bay. The bay averages 2.5 to 3 miles wide and 9 to 12 feet deep. Mary Sachs Entrance connects Lion Bay to the Beaufort Sea. Flaxman Island and the mainland near Brownlow Point frame the eastern end of Lion Bay. West of Mary Sachs Entrance, the barrier island system is located farther from the mainland and islands become smaller and more scattered. The Staines River provides the majority of freshwater input to Lion Bay. Several smaller tundra streams west of the Staines River provide additional discharge.

Mikkelsen Bay (20 miles west of Point Thomson) is bordered on the west by Tigvariak Island and on the east by Bullen Point. The bay is approximately 6.6 miles wide at the 16-foot ***isobath***, approximately 3 miles from shore in most locations. A 0.6-mile-wide shoal (less than 3 feet) separates Tigvariak Island from the mainland at the west end of the bay. A shallow distributary of the Shaviovik River, the No Name River, discharges into Mikkelsen Bay. Several small tundra streams provide additional freshwater input to the nearshore environment between Badami and the Staines River.

Foggy Island Bay is separated from Mikkelsen Bay by the alluvial fan of the Shaviovik River and Tigvariak Island. Foggy Island Bay is bordered on the west by the alluvial fan of the Sagavanirktok River and Point Brower. Rivers that drain into Foggy Island Bay include the east channel of the Sagavanirktok, the Kadleroshilik, and the main channel of the Shaviovik.

The Sagavanirktok River originates high in the Brooks Range. The delta, located 40 miles west of Lion Bay, consists of a broad alluvial fan that separates Foggy Island Bay from Prudhoe Bay. At the delta, flow splits into east and west main channels that lie on either side of the Endicott Causeway. The west channel discharges over a braided plain that empties to the coast between Prudhoe Bay and Endicott Causeway. The eastern channel discharges over a braided plain between Endicott Causeway and Foggy Island Bay, with a smaller distributary discharging directly into the bay. In summer, it discharges large amounts of freshwater into nearshore waters. During periods of westerly winds, this discharge mixes with that from the Shaviovik River in the nearshore waters in the vicinity of Bullen Point, decreasing surface salinity toward Point Thomson. Portions of the delta experience brackish water intrusions (Craig 1989a). The eastern portion of the Sagavanirktok delta is included within the marine study area.

Within these bays, the habitat most sensitive to disturbance for fish is the nearshore environment. Nearshore habitat is made up of three types of marine habitats: delta fronts (locations in which freshwater from river deltas mixes with coastal waters), coastal lagoons, and open coast (NRC 2003a). Nearshore habitats are important to fish partly because of ***upwelling*** of deeper ocean water that occurs along the coast (NRC 2003a). Upwelling increases primary productivity, which provides food for marine ***zooplankton*** and free-living ***epibenthic organisms*** (Schell and Horner 1981; see Section 3.12.7, Invertebrates and Other Lower Trophic Levels, for more information). Zooplankton and epibenthic organisms are primary components of the food chain in the nearshore environment. Marine invertebrates that move into nearshore waters during summer serve a vital function. Nearshore waters adjacent to large river systems (e.g., Staines River, Sagavanirktok River) tend to be warmer and more nutrient-rich than other nearshore habitats (NRC 2003a). Warm, nutrient-rich waters provide the potential for increased primary productivity, increased productivity of zooplankton and epibenthic organisms, and increased value to fish.

Fish presence in and use of the study area have been evaluated in nearshore marine habitats (sampling locations are shown in Figure 3.12-1):

- Ward and Craig (1974) compiled results of 17 different studies from 1962 to 1974; data were presented for eight nearshore marine sites between the Sagavanirktok and Kavik Rivers.
- Cannon et al. (1987) sampled three sites in Foggy Island Bay, one site in the eastern Sagavanirktok River delta, and several sites at Endicott in 1985. Work was part of a large investigation that sampled from Foggy Island Bay to the Kuparuk River delta.
- Glass et al. (1990) sampled two sites in Foggy Island Bay, two sites in the eastern Sagavanirktok River delta, and several sites at Endicott in 1986. Work was part of a large investigation that sampled from Foggy Island Bay to the Kuparuk River delta.
- Fechhelm et al. (1996) sampled Mikkelsen Bay during July and August 1995 at four sites along the coastline
- Fechhelm et al. (2000) sampled six sites in Lion Bay in July and August 1999
- Wilson (2001) sampled five sites in Lion Bay in 2001
- Williams and Burrill (2011) sampled two sites in Lion Bay during July, late August, and September 2010
- A time series of summer fish monitoring studies were conducted in the Prudhoe Bay/Sagavanirktok Delta region from 1981 to present (Gallaway and Fechhelm 2000, Fechhelm et al. 2009). These studies were specifically designed to monitor the effects of oil development, specifically causeways, on regional fishery resources.

Based on these studies, the most abundant fish species captured in the nearshore areas of Foggy Island, Mikkelsen, and Lion Bays are least cisco, arctic cisco, broad whitefish, Dolly Varden, fourhorn sculpin, arctic cod, and saffron cod. Other fish species use the marine study area, but occur in lesser numbers. Appendix B includes a comprehensive list of fish species that occur in the study area, including scientific and Inupiaq names. Fish use nearshore habitats of the study area for different reasons:

- Marine species such as arctic cod, fourhorn sculpin, and arctic flounder migrate from deep marine waters into shallow, low-salinity nearshore waters and estuaries during summer for different purposes, such as rearing and feeding (Morrow 1980).
- Diadromous species such as Dolly Varden, arctic and least cisco, and broad and humpback whitefish overwinter in upriver environments and feed in nearshore areas of the study area each summer (Gallaway and Fechhelm 2000). Some, especially Dolly Varden, enter study area streams to feed during summer (Hemming 1996). Pacific salmon enter five of the larger streams of the study area, presumably for spawning; however, spawning has been confirmed for three streams (Johnson and Blanche 2011; Section 3.12.4.7). Diadromy enables these fish to exploit prey such as zooplankton and epibenthic organisms that can be more abundant in the nearshore zone than in upriver habitats (Craig 1989a).
- Freshwater species such as arctic grayling and round whitefish spend their entire life history in rivers and lakes of the ACP, though most migrate to low-salinity estuarine and nearshore waters in early summer during the peak discharge of freshwater into these environments for feeding and rearing (Hemming 1993).

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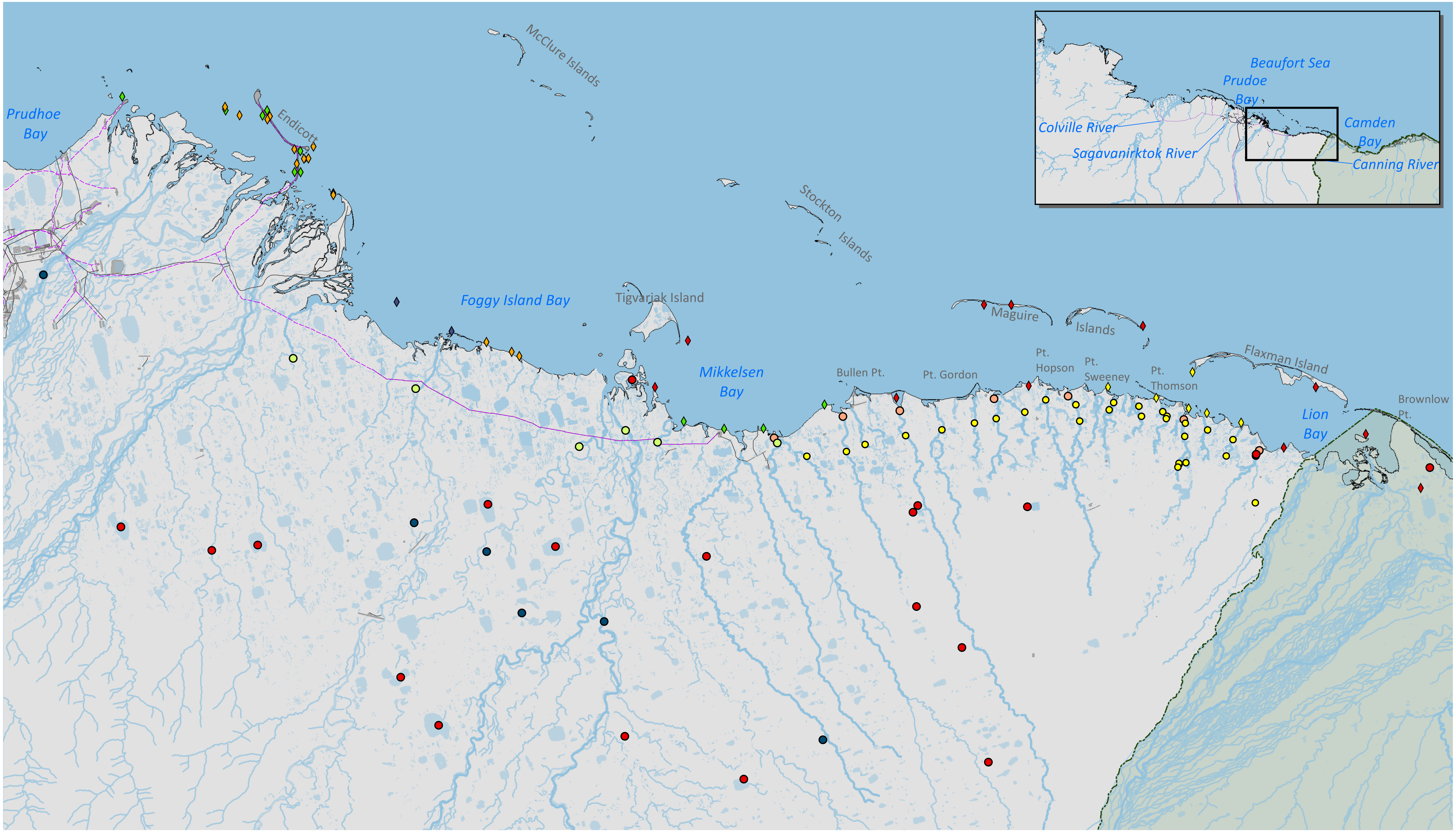

POINT THOMSON PROJECT EIS

Legend

Freshwater Sampling
- Hemming 1996
- Ward and Craig 1974
- Winters and Morris 2004
- WWC and ABR 1983

Marine Sampling
- Cannon et al 1987
- Fechhelm 1996
- Fechhelm et al. 2000
- Glass et al. 1990
- Ward and Craig 1974

- Existing Pipelines
- Existing Facilities and Roads
- Arctic National Wildlife Refuge

N

0 2.5 5 Miles

Figure 3.12-1

Fish Sampling Locations in the Point Thomson Study Area

Date: 23 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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The use of nearshore habitats within the study area by diadromous fish is of particular importance. Arctic and least cisco and broad and humpback whitefish that feed in and migrate through the study area are important subsistence species in Colville River subsistence and commercial fisheries (see Section 3.22, Subsistence and Traditional Land Use Patterns for additional information). Dolly Varden that use the study area contribute to sport fisheries in the Canning and Sagavanirktok Rivers (ADNR 2009a).

3.12.3.2 Freshwater Habitat and Fish Use

Fish habitat between the Sagavanirktok and Staines/Canning Rivers is dominated by seasonally flooded wetlands and ponds less than 4 feet deep; other important habitats (in order of decreasing occurrence) include tundra streams, mountain streams, and lakes. These habitats are important to fish because they are used for summer growth (Fechhelm et al. 1992) and, to a lesser extent, for overwintering (Craig 1989a). Overwintering habitat is especially important to diadromous fishes because entire stocks overwinter within limited areas on the North Slope. Several types of freshwater habitat are present within the study area. Fish use of these environments is discussed below.

Both mountain and tundra streams occur in the study area. Section 3.6 (Hydrology) provides a detailed description of study area streams and Table 3.12-3 describes study area stream characteristics as fish habitat. Both stream types provide fish habitat in summer. Winter stream fish habitat in the study area is limited to deep pools and springs in mountain streams that do not freeze to the streambed and brackish water deltas (Schmidt et al. 1989). Springs that support overwintering fish are found within the study area in the Shaviovik and Kavik Rivers (Craig and McCart 1975). Tundra streams in the study area do not provide winter fish habitat because these streams tend to dry or nearly dry in the fall and freeze to the streambed during winter (ExxonMobil 2009b). Both mountain and tundra streams within the study area are documented by ADF&G as anadromous (Johnson and Blanch 2011). Figure 3.12-2 shows the location and extent of anadromous streams in the study area and Table 3.12-4 describes the anadromous fish species and habitat use for each stream.

Lakes and ponds in the study area are smaller and less numerous than areas to the west (e.g., Prudhoe Bay, Kuparuk, and NPR-A) and are described in detail in Section 3.6 (Hydrology). These water bodies tend to be shallow and those exceeding 6 feet in depth are uncommon within the study area (ExxonMobil 2009b). Of 31 lakes and mine sites investigated as potential project water sources, only six had depths of 6 feet or deeper; five of these were gravel mine sites (ExxonMobil 2009b). During summer, small ponds that are accessible from streams serve as important feeding areas for fish. Freshwater bodies warm quickly in the spring and provide productive habitats for fish growth (Moulton and George 2000) and arctic fishes that utilize these warmer waters have higher growth rates than fishes in colder waters (Fechhelm et al. 1992). Fish leave shallow ponds and lakes in late summer because these water bodies freeze to the bottom in winter (BLM 2008); some aquatic invertebrates overwinter in the sediments (Kertell 1993).

Overwintering habitat in the study area is rare due to the shallow depth of most lakes, ponds, and streams. Freshwater habitat is reduced 95 percent by late winter (Craig 1989a). Overwintering habitat is considered to be one of the most limiting factors for both freshwater (Reynolds 1997) and diadromous fish populations (Craig 1989a). During winter, water bodies typically freeze to approximately 6 feet in depth; depths of approximately 7 feet or more are considered the minimum to support overwintering freshwater fish (PAI 2002). Water bodies must also be of sufficient size to sustain fish oxygen demands for several months, depending on the number and species of fish present. Oxygen depletion caused by overcrowding or overdemand by biological and chemical processes can result in fish mortality (Schmidt et al. 1989). The largest amounts of overwintering fish habitat in the ACP occur in the two largest rivers, the Mackenzie and Colville (Gallaway and Fechhelm 2000); these drainages are outside the study area.

Table 3.12-3: Stream Characteristics of Selected Streams of the Study Area

Stream Name	Stream Type	Description
Sagavanirktok River	Mountain (anadromous)	Two main stable, gravel armored channels; substrate ranges from coarse gravels and small cobbles near Deadhorse to sands and silts at the mouth; discharges to Beaufort Sea and Foggy Island Bay.
East Sagavanirktok Creek	Tundra (anadromous)	*Beaded stream* (deep thaw pads connected by narrow, deep channels; contains deep pools and submerged and aquatic vegetation); 3 miles upstream from the mouth, drainage branches into two channels; joins the East Channel Sagavanirktok River in the delta; discharges to Mikkelsen Bay.
Kadleroshilik River	Mountain (anadromous)	Split-channel system; large gravel bars composed of uncompacted fine to coarse gravel; vegetated cutbanks to 10 feet on outside of meander bends; water depths not exceeding 7 feet in lower reaches; low sediment transport as there is no delta or islands at mouth; discharges to Foggy Island Bay.
West Shaviovik Creek	Tundra (anadromous)	Single channel beaded stream; soft organic substrate; shallower reaches contain dense stands of emergent vegetation; vegetated streambanks; spring floodwaters spread out over adjacent vegetated areas; joins Shaviovik River 3 miles from its mouth.
Shaviovik/ Kavik Rivers	Mountain (anadromous)	Braided system, headwater areas contain perennial springs or groundwater upwelling zones; extensive gravel bars and vegetated terraces in floodplain; floodplain up to 2 miles wide in lower reaches. Delta with multiple distributaries in lower 5 miles of river. The main channel drains into Foggy Island Bay west of Tigvariak Island.
No Name River (Shaviovik distributary)	Tundra (anadromous)	Shallow, single-channel system; extensive gravel bars; vegetated terraces on both sides of active channel; active channel 230 - 328 feet wide in lower reaches during late summer; drains into Mikkelsen Bay.
Stream 3 (East Badami Creek)	Mountain (anadromous)	Shallow, gravel bottom single-channel system; wide, mostly dry gravel bed; large floodplain; little flow; deep pools near mouth and at mile 5; active channel 33 to 49 feet wide in late summer; gravel bar deposits on the inside of meander bends; tundra vegetation on cutbank side; cutbanks < 7 feet; water depth not exceeding 7 feet; tributaries connected to small lakes.
Stream 4	Tundra	Shallow, beaded, gravel bottom stream with sedge-lined banks.
Stream 6	Tundra	Shallow, beaded; lagoon at mouth; gravel bottom with peat along stream margins; sedge-lined banks.
Stream 7	Tundra	Shallow, gravel bottom with sedge-lined banks, connected to one lake in middle reach.
Stream 9	Tundra (anadromous)	Shallow, gravel bottom, gravel bars present; creek a series of discontinuous pools; connected to a lake near mile 7; originates in high tundra; some deep holes in lower reaches; lagoon at mouth.
Stream 10	Tundra	Shallow, beaded, gravel/peat bottom; lagoon at mouth.
Stream 11	Tundra	Shallow, beaded, sedge-lined peat banks.
Stream 12	Tundra	Shallow, beaded; lagoon at mouth.
Stream 13	Tundra	Shallow, beaded, peat bottom with some gravel present, sedge-lined banks, stream mostly discontinuous, connected to several lakes.
Stream 15	Tundra	Shallow, beaded, gravel bottom; sedge-lined banks with discontinuous gravel bars; connected to several lakes in upper reaches.
Stream 16	Tundra	Shallow, sedge-lined banks with discontinuous gravel bars; connected to several lakes in middle and upper reaches.

Table 3.12-3: Stream Characteristics of Selected Streams of the Study Area

Stream Name	Stream Type	Description
Stream 20	Tundra	Shallow, beaded, gravel bottom, sedge-lined banks; connected to a lake in upper reach.
Stream 21	Tundra	Shallow, gravel bottom, sedge-lined banks with *Arctophila fulva* throughout at least one bead; connected to several large lakes.
Stream 23	Tundra	Shallow, connected to several large lakes, beaded in middle reaches, peat/gravel bottom, sedge-lined banks.
Stream 24	Tundra (anadromous)	Shallow, single channel, beaded in upstream reaches; lagoon at mouth; large lake near headwaters but no connection; stream mostly discontinuous. Thin peat bottom over gravel to cobble/gravel bottom, sedge-lined banks.
Stream 26	Tundra	Shallow, thin peat bottom over gravel; no apparent flow; sedge-lined banks, *Arctophila fulva* present in stream.
Stream 27	Tundra	Shallow, gravel bottom, sedge-lined banks.
Stream 28	Tundra (anadromous)	Shallow, beaded, small cobble/gravel bottom; low flow, sedge-lined and gravel banks; low flow, sedge-lined and gravel banks.
Canning/ Staines Rivers	Mountain (anadromous)	Braided through narrow valleys in upper reaches; wide gravel floodplain in middle reaches with many braided channels; delta 25 miles long and approximately 15 miles wide at the Beaufort Sea.

Sources: Craig 1977, WCC and ABR 1983, BPXA 1995, Fechhelm et al. 1996, Hemming 1996, Moulton and George 2000, Winters and Morris 2004

Streams listed from west to east.

For additional information on these streams, including drainage area, refer to Section 3.6 (Hydrology).

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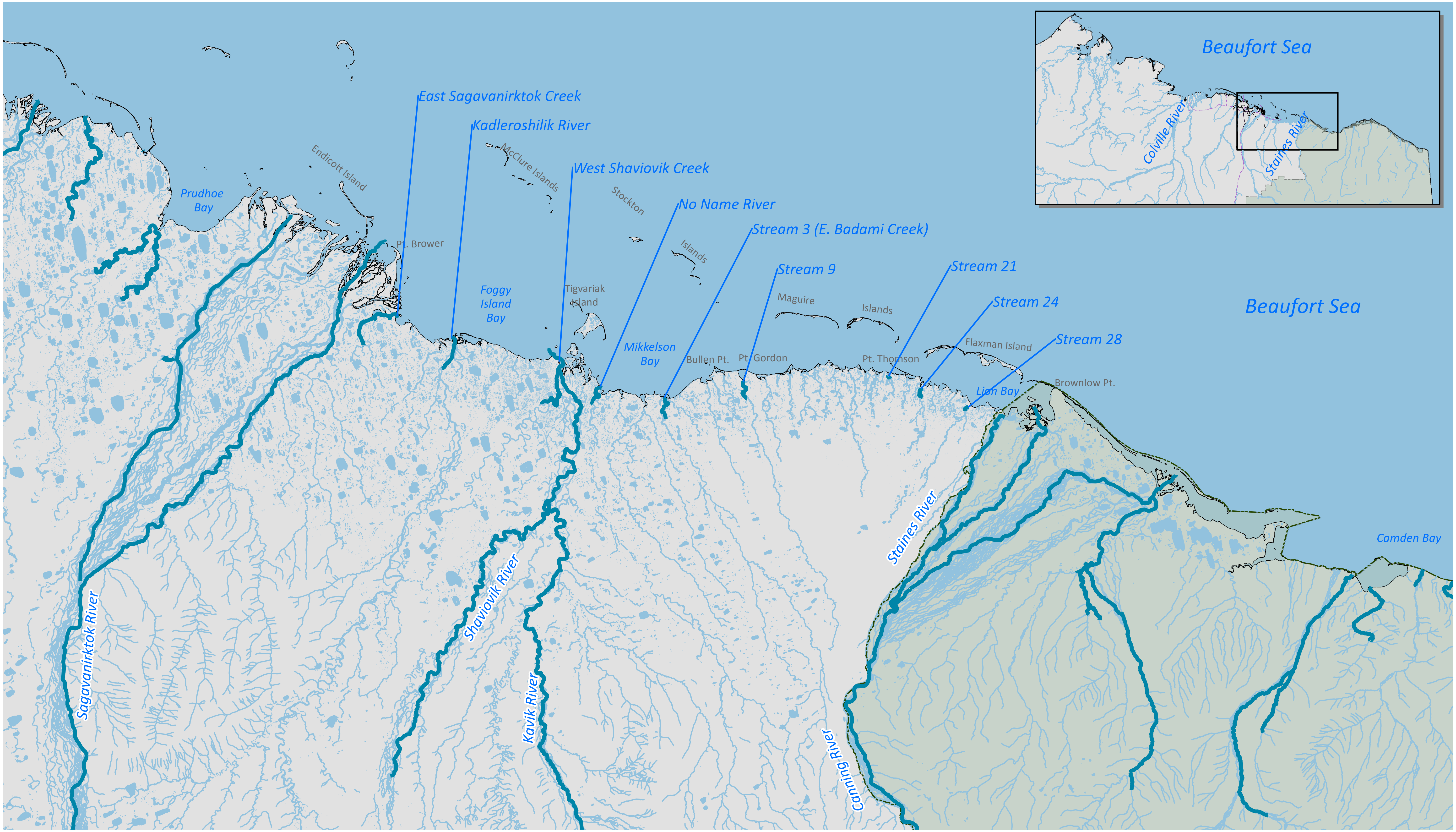

POINT THOMSON PROJECT EIS

Legend

- Anadromous Streams
- Arctic National Wildlife Refuge

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Figure 3.12-2

Anadromous Streams In and Near the Point Thomson Study Area

Date: 23 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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Table 3.12-4: Entries from ADF&G Anadromous Waters Catalog (AWC) from the Canning to the Sagavanirktok River

Stream Name	AWC Water Body Number	Dolly Varden	Whitefish sp.	Broad Whitefish	Least Cisco	Chum Salmon	Pink Salmon
Canning/Staines Rivers*	330-00-10210/ 330-00-10230	s	p			p	p
Stream 28	330-00-10234	r					
Stream 24	330-00-10238	r					
Stream 21	330-00-10246	r					
Stream 9	330-00-10280	r					
Stream 3 (E. Badami Creek)*	330-00-10290	r					
No Name River	330-00-10300	r					
Shaviovik River	330-00-10310	p					s
West Shaviovik Creek	330-00-10310-2006	r					
Kavik River	330-00-10310-2041	p					s
Kadleroshilik River	330-00-10320	r					
E. Sagavanirktok Creek	330-00-10330	r					
Sagavanirktok River* and West Channel Sagavanirktok River	330-00-10360 330-00-10361	s, r	p	p	p	p	s

Source: Johnson and Blanche (2011)

s= spawning, p= present, r=rearing

* Tributaries to these rivers are listed in the AWC and were combined into the records for the main drainage. In some cases, anadromous species migrate through study area streams to reach spawning and rearing areas further upstream. The table includes all the streams within the study area that provide habitat for anadromous species migrating to spawning areas upstream, but the upstream tributaries that are outside the study area are not listed in the table.

Most of the overwintering habitat in the study area likely is contained within rehabilitated mine sites and successful rehabilitation and habitat restoration of several North Slope abandoned gravel pits has been documented (Hemming 1988, 1993, 1995; Hemming et al. 1989). For instance, the distribution of arctic grayling within the oil field has expanded since large mine sites in the Prudhoe Bay and Kuparuk areas have become artificial lakes providing overwintering habitat (NRC 2003a), a gravel mine site connected to the Sagavanirktok River contains 88 times more water than overwintering areas within the river proper (Hemming 1988), and arctic grayling introduced into some rehabilitated mine sites established reproducing populations (Hemming 1995).

Fish presence in and use of freshwater habitats in the study area have been investigated by the following scientists (locations of sampling areas are shown on Figure 3.12-1):

- Craig and McCart (1974) sampled potential overwintering and spawning habitat for Dolly Varden from the Sagavanirktok River to the Canning River in early spring and fall of 1972 and 1973.

- Ward and Craig (1974) compiled data for eight sites in lakes between the Canning and Sagavanirktok rivers and six sites on streams between the Shaviovik and Sagavanirktok rivers. Data were summarized from results of 17 different studies from 1962-1974.
- WCC and ABR (1983) sampled seven study sites on streams between the Shaviovik and Canning Rivers in 1983.
- Hemming (1996) sampled six study sites on streams between East Badami Creek and the Sagavanirktok Rivers in 1995.
- Winters and Morris (2004) sampled 24 study sites on streams between Stream 4 and Stream 28 (east of Badami to west of the Staines/Canning River) in 2002 and 2003.
- Johnson and Blanche (2011) have compiled results of intermittent ADF&G reconnaissance sampling in North Slope streams.

These studies indicated the presence of 14 species of freshwater and diadromous fish in many, if not most, streams and ponds in the study area. Fish species presence in the study area is shown by drainage in Table 3.12-5. Based on studies of fish presence, the most abundant fish species captured in study area freshwater habitat are ninespine stickleback and Dolly Varden. Fish use freshwater habitats in the study area for the following reasons:

- Freshwater species such as ninespine stickleback, arctic grayling, and round whitefish spend their entire life cycle in rivers and lakes of the ACP, though most migrate to low-salinity estuarine and nearshore waters in early summer during the peak discharge of freshwater into these environments for feeding and rearing (Hemming 1993).
- Diadromous species such as Dolly Varden, arctic and least cisco, and broad and humpback whitefish overwinter in mountain stream environments and feed in nearshore areas of the study area each summer (Gallaway and Fechhelm 2000). Streams of the study area are used for summer rearing by immature Dolly Varden, and though the number of fish found per drainage may be relatively small, in aggregate, they represent important summer rearing habitat for Dolly Varden (Hemming 1996). Pacific salmon enter five of the larger streams of the study area, presumably for spawning; however, spawning has not been confirmed for all of these streams (Johnson and Blanche 2011; Section 3.12.4.7).

Fish use of stream habitats for summer rearing and feeding and deepwater habitats for overwintering within the study area is of particular importance. Dolly Varden and arctic grayling (to a lesser extent) using study area streams contribute to sport fisheries in the Canning and Sagavanirktok Rivers (ADNR 2009a). Younger age classes of Arctic cisco overwinter in the Sagavanirktok River (Fehchhelm et. al 2009).

Table 3.12-5: Fish Presence by Stream in the Study Area

	Arctic Grayling	Dolly Varden	Arctic Cisco	Broad Whitefish	Burbot	Least Cisco	Chum Salmon	Pink Salmon	Fourhorn Sculpin	Ninespine Stickleback	Round Whitefish	Lake Trout	Humpback Whitefish	Slimy Sculpin
Sagavanirktok River	X	X	X	X	X	X	X	X	--[a]	X	X	X	X	X
Kalderoshilik River	X	X	--	--	--	--	--	X	--	X	--	--	--	X
Shaviovik River	X	X	--	--	--	--	--	X	--	X	--	--	--	--
Kavik River	X	X	--	--	--	--	--	X	--	X	--	--	--	--
Stream 1 (First unnamed stream east of Kavik River)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Second unnamed stream east of Kavik River	--	--	--	--	--	--	--	--	--	X	--	--	--	X
Stream 3 (East Badami Creek)	--	X	--	--	--	--	--	--	--	--	X	--	--	--
Stream 4	--	--	--	--	--	--	--	--	--	X	--	--	--	--
Stream 6	--	X	--	--	--	--	--	--	X	X	--	--	--	--
Stream 7	--	--	--	--	--	--	--	--	--	X	--	--	--	--
Stream 9	X	X	--	--	--	--	--	--	--	X	--	--	--	--
Stream 10	--	--	--	--	--	--	--	--	--	X	--	--	--	--
Stream 11	--	--	--	--	--	--	--	--	--	X	--	--	--	--
Stream 12	--	--	--	--	--	--	--	--	--	X	--	--	--	--
Stream 13	--	--	--	--	--	--	--	--	--	X	--	--	--	--
Stream 15	--	X	--	--	--	--	--	--	--	X	--	--	--	--
Stream 16	--	X	--	--	--	--	--	--	--	X	--	--	--	--
Stream 18	--	X	--	--	--	--	--	--	--	X	--	--	--	--
Stream 21	--	X	--	--	--	--	--	--	--	X	--	--	--	--

Table 3.12-5: Fish Presence by Stream in the Study Area

	Arctic Grayling	Dolly Varden	Arctic Cisco	Broad Whitefish	Burbot	Least Cisco	Chum Salmon	Pink Salmon	Fourhorn Sculpin	Ninespine Stickleback	Round Whitefish	Lake Trout	Humpback Whitefish	Slimy Sculpin
Stream 22	--	X	--	--	--	--	--	--	--	X	--	--	--	--
Stream 24	--	X	--	--	--	--	--	--	X	X	--	--	--	--
Stream 26	--	--	--	--	--	--	--	--	--	X	--	--	--	--
Stream 27	--	X	--	--	--	--	--	--	--	X	--	--	--	--
Stream 28	--	X	--	--	--	--	--	--	--	X	--	--	--	--
No Name River	X	X	--	--	--	--	--	--	X	X	X	--	--	--
West Shaviovik Creek	X	X	--	--	--	--	--	--	--	X	--	--	--	--
East Sagavanirktok Creek	X	X	--	--	--	--	--	--	--	X	--	--	--	--
Canning River	X	X	X	X	--	X	X	X	--	--	X	--	--	--

Sources: Ward and Craig 1974, Craig and McCart 1975, WCC and ABR 1983, Adams and Cannon 1987, Schmidt et al. 1989, Winters and Morris 2004

[a] (--) indicates no fish caught

3.12.4 Fish Species Life History

A synopsis of life history and relative abundance is provided below for major fish species found in the study area. Fish species are presented from most abundant to least abundant, as found in Lion Bay (Fechhelm, et al. 2000), with an emphasis on species important to subsistence and commercial harvest.

A brief discussion of additional species occurring in smaller numbers or not making up a large portion of commercial or subsistence harvests is included below. These species may be important as forage for other fish species or for marine mammals.

3.12.4.1 Arctic Cisco

Arctic cisco is one of the most abundant and important diadromous fish species in the nearshore Alaskan Beaufort Sea (Fechhelm et al. 2009). They support a commercial fishery in the Colville River, a subsistence fishery at Nuiqsut (Fechhelm et al. 2009), and a subsistence fishery at Kaktovik (Craig 1989b).

Young-of-the-year (YOY) arctic cisco emerge by breakup and are flushed from Canadian spawning grounds in the Mackenzie River to the Beaufort Sea (Fechhelm et al. 2009). In years with strong, persistent east winds, they are carried along the nearshore coast by wind-driven currents to Alaska. YOY arctic cisco are first caught in the Prudhoe Bay area from early-August through mid-September and near Point Thomson somewhat earlier. Sustained east winds carry young fish westward to the Colville River, which provides overwintering habitat. The Colville River is the only drainage west of the Mackenzie River that appears to be large enough to support large numbers (several million) of overwintering subadult and adult arctic cisco, though the Sagavanirktok River can support younger age classes. Because overwintering habitat for YOY arctic cisco is thought to be rare east of the Sagavanirktok River, individuals that fail to reach the Sagavanirktok or Colville Rivers likely do not survive (Fechhelm et al. 2009). During years with no strong, persistent east winds, poor recruitment of age classes to overwintering habitat results in poor harvest of that age class in Colville River fisheries (Daigneault and Reiser 2007).

No studies have evaluated the lower delta of the Canning River for its capacity to provide overwintering habitat for arctic cisco, even though it is the third largest drainage on the Alaskan North Slope. Studies by Fechhelm et al. (1996 and 2000) indicate that arctic cisco overwintering capacity of streams in the study area east of the Sagavanirktok River is limited. However, Fechhelm et al. (2000) noted the additional studies would be needed to confirm that study area streams do not provide overwintering habitat for arctic cisco.

After spending approximately 7 years in the Colville or Sagavanirktok River drainages, most Beaufort Sea arctic cisco return to the Mackenzie River to spawn (Fechhelm et al. 2009); fish migrate through study area nearshore waters to complete this journey.

Though streams between the Colville and Mackenzie Rivers are thought not to support spawning populations of arctic cisco, these fish were abundant in catches along the adjacent coasts during the open water season (Gallaway and Fechhelm 2000). Arctic cisco were the most commonly caught fish during fyke net sampling in Lion Bay in 1999 and 2001 (Wilson 2001) and the second most abundant in 2010 (Williams and Burrill 2011). Additionally, YOY arctic cisco was the most abundant species in catches over the past 26 years in the nearby Prudhoe Bay region (Fechhelm et al. 2009). Importance of the nearshore study area as feeding, rearing, and migration habitat for arctic cisco is indicated by their abundance there.

3.12.4.2 Dolly Varden

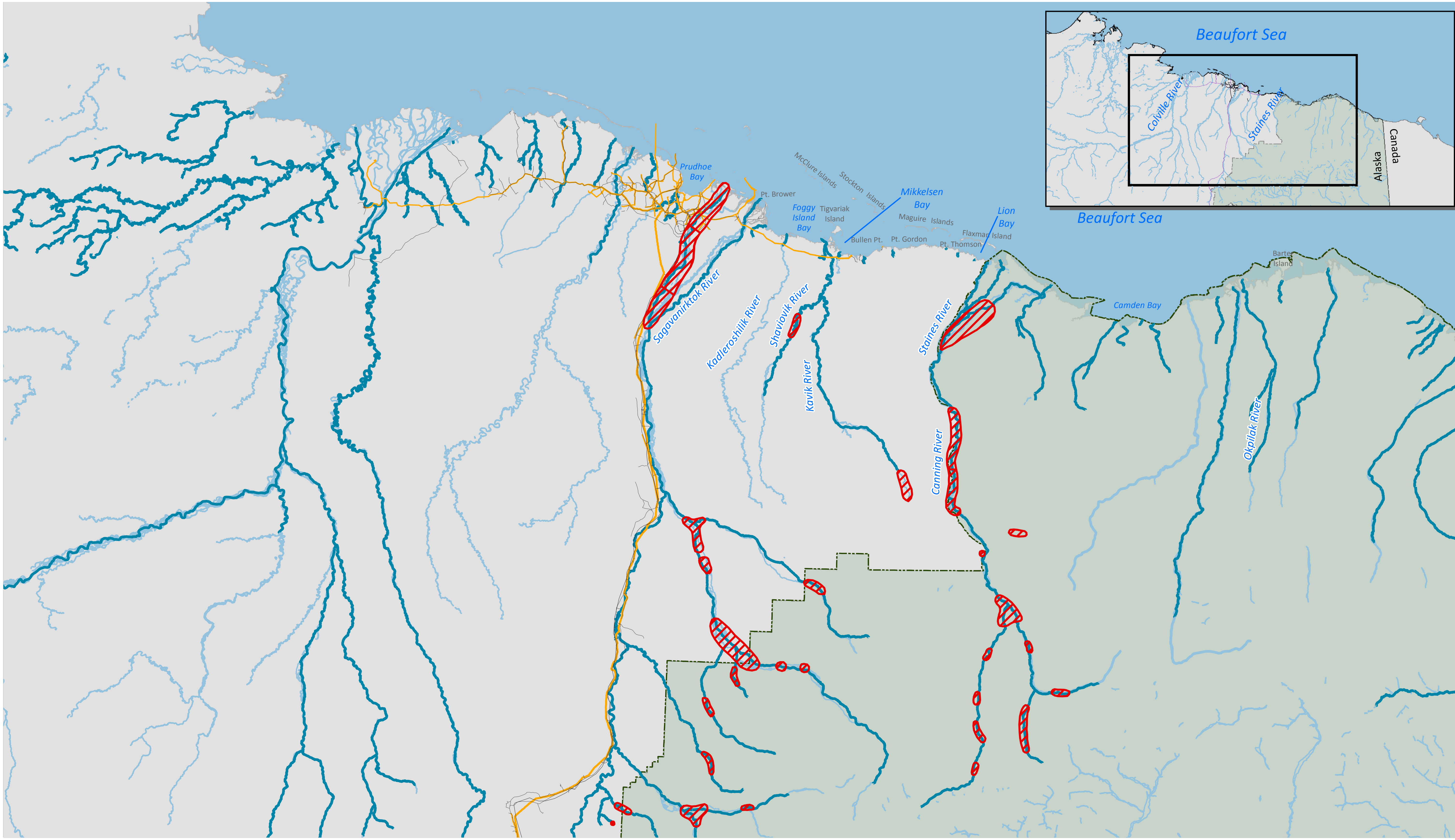
Dolly Varden are common in Beaufort Sea coastal waters during summer (Fechhelm et al. 2000), and contribute to sport fisheries in the Canning and Sagavanirktok Rivers (ADNR 2009a).

Dolly Varden are strong swimmers and make substantial migrations along the Beaufort Sea coast areas in summer, such that they are common along the coast (Gallaway and Fechhelm 2000). Many of the mountain streams between the Colville and Mackenzie Rivers harbor spawning populations for Dolly Varden (C. R. Hemming 1996), including the Canning, Kavik, Shaviovik, and Sagavanirktok Rivers in the study area (Johnson and Blanche 2011, Ward and Craig 1974; Table 3.12-4). Several streams in the study area have also been nominated for presence and rearing (Johnson and Blanche 2011). Overwintering habitat within the study area appears to be limited to the Canning/Staines, Shaviovik, Kavik, and Sagavanirktok Rivers (Craig and McCart 1975, Hemming 1996); but additional overwintering habitat likely exists (Craig and McCart 1975). Confirmed Dolly Varden overwintering areas within study area streams are shown in Figure 3.12-3.The Sagavanirktok River (in the western study area) is thought to harbor the largest Dolly Varden populations on the North Slope (Gallaway and Fechhelm 2000).

After hatching, Dolly Varden generally remain in their natal freshwater streams for 2 to 3 years before migrating to saltwater environments (Craig 1989a). Relatively low numbers of juvenile Dolly Varden, most likely overwintering in mountain streams, use study area streams for rearing during summer (Winters and Morris 2004). While in the saltwater environment, fish migrate and feed (Gallaway and Fechhelm 2000) along the study area coast during the open water season. Fish may feed along edges of ice floes offshore later in the season (Gallaway and Fechhelm 2000). In the fall, fish return to freshwater streams that contain open water overwintering habitats, though not always their natal streams (Craig 1984). Overwintering fish require water deeper than 7 feet (Moulton and George 2000) or with perennial warm-water springs (i.e., that provide open water habitat and prevent eggs from freezing; DFO Science 2002). Fish return to natal streams when sexual maturity is reached (ages 7 to 9). Some males may undergo precocious maturation, in which sexual maturity is reached at a younger age and body size, and fish do not migrate to saltwater environments (Craig 1977). Precocious nondiadromous males mate by “sneaking” or depositing milt into a nest redd while a diadromous female is spawning with a diadromous male (DFO Science 2002). Freshwater environments of the study area, therefore, provide rearing habitat to fish age 2 and younger, and to precocious nondiadromous males.

Based on geography and DNA analysis, all Dolly Varden spawning in streams from the Colville River to the Canning River belong to the Sagavanirktok River stock (SAG stock), while fish from areas farther east belong to either the Refuge (spawning in rivers east of the Canning River within the Arctic Refuge) or Canada stocks (Krueger et al. 1998). Dispersion from the Staines and Canning Rivers remains unstudied; however, mixed stock analysis indicates that Dolly Varden move freely between Alaska and Canada. Fish sampled at Mikkelsen Bay and Endicott were most likely to be from the SAG stock; a smaller portion of fish captured in these areas were from Refuge or Canada stocks with more of these fish captured in Mikkelsen Bay than in Endicott (Krueger et al. 1998), indicating use of the study area by stocks originating east of the study area may increase as distance to their spawning areas decreases.

Dolly Varden was among the most abundant species captured in Lion Bay, Mikkelsen Bay, Foggy Island Bay, and Sagavanirktok River delta (Adams and Cannon 1987, Glass et al. 1990, Fechhelm et al. 1996, Fechhelm, et al. 2000, Wilson 2001, Williams and Burrill 2011). Lion Bay may serve as important foraging habitat for local populations of Dolly Varden, likely those spawning in the Canning/Staines Rivers (Fechhelm et al. 2000).



POINT THOMSON PROJECT EIS

Legend

- Existing Road
- Existing Pipeline
- Anadromous Streams
- Documented Overwintering Fish Habitat
- Arctic National Wildlife Refuge

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Figure 3.12-3

Overwintering Fish Habitat
in and Near the Point Thomson Study Area

Date: 23 October 2011
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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During the open water season, juvenile Dolly Varden use small streams in the Point Thomson study area for rearing (Winters and Morris 2004). The Staines and Canning River system is thought to serve as an important summer feeding area for juvenile anadromous Dolly Varden (Craig 1977). Numerous Dolly Varden overwintering sites have been identified in the Canning River system (Craig and McCart 1975).

In the nearshore marine environment, both large and small Dolly Varden presence is likely greatest in July (Fechhelm et al. 2000). A similar pattern has been observed farther to the east at Simpson Cove, Kaktovik, and Beaufort Lagoon in the Arctic Refuge (Underwood et al. 1995). In the freshwater environment, sampling indicates that Dolly Varden are most abundant in study area streams by August; by this time juveniles have dispersed from nearby overwintering habitats in mountain streams (Winters and Morris 2004).

3.12.4.3 Arctic Grayling

Arctic grayling are the second most widespread fish species in the oil field region, from the Colville River to Stream 3 (Moulton and George 2000), and support sport fisheries in the Canning and Sagavanirktok Rivers (ADNR 2009a). Arctic grayling reside in freshwaters throughout the Alaskan, Canadian, and Siberian arctic, including streams draining to the Beaufort Sea coast (Morrow 1980, Hemming 1996). Fish may migrate between freshwater drainages by entering brackish coastal waters. Most grayling overwinter in deep areas of large rivers, such as the Canning, Sagavanirktok, or Colville River (Moulton 1980, Moulton and George 2000). Overwintering habitat in small tundra streams is limited to absent (Hemming 1993), but overwintering areas have been identified in some study area mountain streams, including the Sagavanirktok, Shaviovik, and Kavik Rivers (Craig and McCart 1975). Arctic grayling migrate from their overwintering habitats to small tundra streams to spawn shortly after breakup (Scott and Crossman 1973, Craig and McCart 1975).

Most adults leave the streams after spawning; however, some adults and juveniles will remain in spawning locations until freeze up (Craig and McCart 1975). Between Prudhoe Bay and the Mackenzie River delta, arctic grayling were the most abundant and widely dispersed fish species caught (Craig and McCart 1975). They were captured in No Name River, Shaviovik River, West Shaviovik Creek, Kadleroshilik, and East Sagavanirktok Creek in low numbers (Hemming 1996). However, Winters and Morris (2004) rarely caught arctic grayling in Point Thomson area streams.

3.12.4.4 Least Cisco

Least cisco is among the most abundant species of the Beaufort Sea during summer (Gallaway and Fechhelm 2000) and is a main target of the fall subsistence fishery at the Colville River (Daigneault and Reiser 2007).

Spawning populations of least cisco appear to be absent from the Sagavanirktok River and the mountain streams draining the 373 miles of coastline between the Colville and Mackenzie Rivers.

Colville River adult least cisco are known to travel and feed considerable distances to the east (Gallaway and Fechhelm 2000). During summer, adult least cisco are abundant in Lion Bay (Fechhelm et al. 2000, Wilson 2001, Wilson and Burrill 2011), Mikkelsen Bay, and the Sagavanirktok River delta (Gallaway and Fechhelm 2000). Relatively few adult least cisco appear to disperse as far east as Camden Bay (19 miles east of the Canning River; Fechhelm et al. 2000). Recapture at Lion Bay of fish tagged at Prudhoe Bay indicates adult least cisco occurring in the Lion Bay area likely originate from the Colville River (Fechhelm et al. 2000).

Juvenile least cisco are not expected to occur in the Lion Bay area. Juvenile least cisco from the Colville River move into the nearshore environment, and then disperse eastward, aided by wind-driven currents as far as the eastern end of Simpson Lagoon, to approximately 50 miles west of Point Thomson (Fechhelm et al. 1994). The small fish are not likely to disperse another 56 to 62 miles east to Lion Bay (Fechhelm et al. 2000). Catches of small least cisco were low or minimal in Mikkelsen Bay and Lion Bay during years in which large catches were reported in the Prudhoe Bay area (Fechhelm et al. 1996, 2000), indicating the area is outside their normal summer foraging range (Fechhelm et al. 2000).

3.12.4.5 Broad Whitefish

Broad whitefish is one of the most abundant diadromous species found in Beaufort Sea coastal waters (Gallaway and Fechhelm 2000). At the Colville River, broad whitefish are the principal target of the summer subsistence fishery (Nelson et al. 1987) and are caught incidentally in the fall subsistence fishery (Daigneault and Reiser 2007).

Diadromous broad whitefish originate from two population centers along the Beaufort Sea (Fechhelm 1999). These centers include the tundra streams west of and including the Sagavanirktok River and east of and including the Mackenzie River drainage. Spawning populations of broad whitefish appear to be absent from the mountain streams draining the 310 miles of coastline between the Sagavanirktok and Mackenzie Rivers. Broad whitefish juveniles appear to be intolerant of high salinities and thus do not disperse far from natal river deltas (Fechhelm 1999).

Broad whitefish have been observed in the Prudhoe Bay region to be intolerance of high salinity, which may limit dispersal and cause them to be more sensitive to coastal development (Fechhelm 1999). Throughout the majority of the open water season, younger fish from the Sagavanirktok River populations remain in low-salinity waters of the delta (Fechhelm et al. 1999); however, Cannon et al. (1987) found that in early September, YOY broad whitefish moved into the more saline waters of Prudhoe Bay to feed. Juvenile broad whitefish catches were low in both Mikkelsen Bay (Fechhelm et al. 1996) and Lion Bay (Fechhelm et al. 2000). Older fish disperse larger distances from natal rivers than juveniles, and make regular movements between the Colville and Sagavanirktok Rivers via Simpson Lagoon (Gallaway and Fechhelm 2000). Adult broad whitefish were abundant in Mikkelsen Bay (Fechhelm et al. 1996) and Lion Bay (Fechhelm et al. 2000). Studies east of the Canning River have captured very few to no broad whitefish, suggesting they do not disperse that far east (Gallaway and Fechhelm 2000).

3.12.4.6 Humpback Whitefish

Humpback whitefish are caught incidentally in coastal sampling programs on the Beaufort Sea coast (Fechhelm et al. 2000). They are harvested in the fall subsistence fishery on the Colville River and caught incidentally during the summer fishery (Fechhelm et al. 2009).

Similar to least cisco and broad whitefish, humpback whitefish have a discontinuous distribution along drainages of the Beaufort Sea coast (Fechhelm et al. 2009). Eastern population centers include the Mackenzie River drainage and several other smaller western Canadian arctic rivers. A western center originates in the Colville River and extends to numerous other rivers located to the west. Similar to broad whitefish, humpback whitefish are also intolerant of high salinity conditions, and during summer they remain in low salinity nearshore waters and in river deltas (Fechhelm et al. 2009).

Humpback whitefish were relatively common in catches prior to construction of the West Dock causeway in Simpson Lagoon, but were rarely caught during sampling in the Prudhoe Bay region from 1981 to 1995 (Fechhelm et al. 2009). After construction of a breach in the West Dock causeway during the 1995/1996 winter, catches increased, providing evidence that the eastward dispersal of whitefish had been impeded by the causeway (Fechhelm 1999).

Adult humpback whitefish were abundant in sampling in Lion Bay, whereas they were not at Mikkelsen Bay (Fechhelm et al 1996); however, this survey was conducted prebreach and current catch rates at Mikkelsen Bay would likely be greater. Their presence in Lion and Mikkelsen Bays indicates the study area is part of the summer foraging range for humpback whitefish (Fechhelm et al. 2000).

Juvenile humpback whitefish do not likely disperse as far east as the study area from the Colville River. However, adult humpback whitefish caught in the nearshore study area likely do originate from the Colville River population center (Fechhelm et al. 2000). Adults from the Mackenzie River population have not been documented traveling west along the Arctic Refuge coast (Fruge et al. 1989, Palmer and Dugan 1990).

3.12.4.7 Pacific Salmon

Pacific salmon are rarely caught along the Beaufort Sea coast. Small runs of salmon are found in some of the larger streams of the North Slope, including pink salmon in the Colville and Sagavanirktok Rivers, and chum salmon in the Colville, Sagavanirktok, and Mackenzie Rivers (Craig and Haldorson 1981,1986). A single adult pink salmon was captured in Lion Bay, near Point Thomson in 2010 (Williams and Burrill 2011) and three adult chum salmon were captured in Lion Bay during 2001 (Wilson 2001). The AWC documents salmon in four project area streams (Johnson and Blanche 2011; Table 3.12-4):

- Canning/Staines Rivers (pink and chum salmon present)
- Shaviovik River (pink salmon spawning)
- Kavik River (pink salmon spawning)
- Sagavanirktok River (pink salmon spawning and chum salmon present)

Occurrences of other species of salmon in arctic coastal waters are thought to be strays from southern populations (e.g., Bering Sea; Craig and Haldorson 1986). Chinook, sockeye, and coho salmon are particularly rare, and no known spawning stocks have been found (Craig and Haldorson 1986, Fechhelm and Griffiths 2001).

While ADF&G reports chum salmon as present in the Sagavanirktok River, no records of spawning are on file. Pink salmon spawning has been observed in the Sagavanirktok River (Johnson and Blanche 2011). Pink salmon generally do not migrate far upstream to spawn and may spawn in the intertidal areas (Morrow 1980).

Additionally, no juvenile salmon have ever been caught in the nearby Prudhoe Bay area (Fechhelm et al. 2009). Because they are infrequently encountered in the region, effects on salmon have not been regarded as a main environmental concern in development of oil industry infrastructure in Prudhoe Bay. However, some evidence indicates that Chinook salmon occurrence on the North Slope may be increasing (BLM 2008), and scientists have postulated that climate change could allow invasion of southern stocks from the Bering Sea northward, where spawning populations might be established (Babaluk et al. 2000).

3.12.4.8 Arctic Cod

Arctic cod are important as a subsistence food, and also make up part of the diets of numerous marine mammals, birds, and fish, and as such are a primary constituent of the arctic marine food chain (Craig and Haldorson 1981, Finley and Evans 1983, Bradstreet et al. 1986, Hobson and Welch 1992). Arctic cod were one of the main species captured in Lion Bay in 1999 and in 2010 (Fechhelm et al. 2000, Williams and Burrill 2011). Catches at Prudhoe Bay were variable over 26 years of sampling (Fechhelm et al. 2009).

Arctic cod is a ***demersal*** marine fish species with a circumpolar distribution (Fechhelm et al. 2009); distribution is associated with lowered salinity, higher water temperatures (Moulton and Tarbox 1987), and/or the presence of ice (Morrow 1980). Arctic cod move inshore to spawn during winter. Migrations occur from nearshore to offshore, which are partially associated with spawning and the movement of ice (Morrow 1980). Arctic cod may feed along the transition layer between marine and brackish water masses (Moulton and Tarbox 1987). Because arctic cod associate with specific oceanographic conditions, their abundance in nearshore waters is variable (Moulton and Tarbox 1987). In 2010, 77 percent of the arctic cod captured in Lion Bay were captured in a 3 day period in late August (Williams and Burrill 2011). During this time, winds from the north to northwest resulted in the onshore water movement and likely resulted in the increase of arctic cod (Williams and Burrill 2011). YOY arctic cod were captured in the Beaufort Sea and Kaktovik Lagoon (approximately 68 miles east of Point Thomson) in November 1975 (Griffiths et al. 1977).

3.12.4.9 Other Marine Species

Fourhorn sculpin and arctic flounder are common in coastal waters of the Beaufort Sea in summer but they are not the target of commercial or subsistence fisheries (Fechhelm et al. 2009). Both have a near circumpolar distribution in brackish and marine waters (Fechhelm et al. 2009).

Saffron cod are found along both the western and eastern Beaufort Sea coast in brackish and marine waters (Fechhelm et al. 2009). These cod frequently enter freshwater and may migrate substantial distances upriver (Morrow 1980).

Fourhorn sculpin and arctic flounder migrate to higher productivity shallower waters in summer months and move to deeper waters during winter, whereas saffron cod move to nearshore habitats during the winter and offshore during the summer (Morrow 1980).

All three species were abundant in catches in Lion Bay in 1999, with fourhorn sculpin second only to arctic cisco in catches (Fechhelm et al. 2000).

3.12.4.10 Other Freshwater Species

Ninespine stickleback are the most frequently captured fish species in coastal lakes and streams in the ACP region (WWC and ABR 1983, Hemming 1996, Moulton and George 2000, Winters and Morris 2004). Many piscivorous fish feed on the ninespine stickleback (Scott and Crossman 1973, Morrow 1980) as well as piscivorous birds such as the Pacific loon (Russell 2002). Ninespine stickleback have a circumpolar brackish and freshwater distribution (Morrow 1980). These fish are tolerant of low oxygen environments and brackish water (Scott and Crossman 1973, Morrow 1980). Ninespine stickleback exhibit seasonal movements, shifting their distribution from deeper water in the spring for spawning and then offshore in the fall (Scott and Crossman 1973, Morrow 1980). Because ninespine stickleback are found in nearly all area streams sampled, it is likely these fish overwinter to some extent within study area streams (WCC and ABR 1983, Winters and Morris 2004).

3.12.5 Essential Fish Habitat

The 1996 Sustainable Fisheries Act reauthorized the Magnuson-Stevens Fishery Conservation and Management Act Reauthorization (16 U.S.C. 1801, *et seq.*) (Magnuson-Stevens Act Reauthorization). The Magnuson-Stevens Act Reauthorization also introduced new requirements for the description and identification of Essential Fish Habitat (EFH) in fishery management plans, minimizing adverse impacts on EFH, and proposing actions to conserve and enhance EFH. EFH guidelines were set forth by the NMFS to help Fisheries Management Councils fulfill requirements of the Magnuson-Stevens Act Reauthorization. Consultation between federal permitting or action agencies and NMFS Habitat Conservation Division is required by the Magnuson-Stevens Act Reauthorization when an action may adversely affect designated EFH. The Magnuson-Stevens Act Reauthorization also requires that the federal permitting or action agency respond to comments made by NMFS.

EFH is defined as waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (50 CFR Part 600). For the purposes of this definition, “waters” means aquatic areas and their associated physical, chemical, and biological properties; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means the habitat required to support a sustainable fishery and healthy ecosystem; and “spawning, feeding, and breeding” is meant to encompass the complete life cycle of a species (50 CFR Part 600).

EFH is designated based on best available scientific information (NMFS 2005). Information levels used to describe the level of understanding are defined by the Magnuson-Stevens Act Reauthorization: Level 1 corresponds to distribution; Level 2 to density or relative abundance, Level 3 to growth, reproduction, or survival rates; and Level 4 to production rates (NMFS 2005). Arctic cod EFH is designated based on Level 1 information for only adults and late juveniles; insufficient information is available to designate EFH for eggs, larvae, and early juveniles (NPFMC 2009). Pacific salmon EFH in Alaska is designated based on Level 1 information for all species and life stages (NMFS 2005).

3.12.5.1 Marine EFH

The Arctic Fisheries Management Plan (AFMP) was developed by the North Pacific Fisheries Management Council (NPFMC) for fish in the Chukchi and Beaufort seas; it was implemented November 3, 2009 (NPFMC 2009, 74 CFR 56734). Increasing water temperatures, changes in fish stock distributions, and changes in ice cover could favor development of commercial fisheries in AFMP waters; the current policy prohibits commercial fishing in the Chukchi and Beaufort seas until there is sufficient information available to enable sustainable management of commercial fisheries in the arctic (NPFMC 2009, 74 FR 56734). EFH is designated in the Arctic Ocean for snow crab, saffron cod, and arctic cod. Of these, arctic cod is the only species in the Arctic Management Area for which designated EFH extends into the study area.

The ranges of all five species of Pacific salmon extend into the Point Thomson study area (NMFS 2005). Marine and nearshore EFH has been designated for pink, chum, sockeye, Chinook, and coho salmon. Records of sockeye, Chinook, and coho salmon are extremely rare in this region; Craig and Haldorson (1986) reviewed salmon presence on the North Slope and concluded these species were likely strays, noting that occurrences usually consisted of single individuals. The NMFS and the NPFMC issued a ROD in 2005 for the EFH Identification and Conservation in Alaska EIS that determined how EFH would be identified in Alaskan waters (NMFS 2005). The current descriptions of these habitats, including EFH for Alaska salmon, were defined in the selected preferred alternative. Marine and nearshore EFH has the same definition for juvenile and adult life stages of all five salmon species, and is designated as the mean higher tide line to the 200-nautical mile limit of the U.S. Economic Exclusive Zone (EEZ) in the Arctic Ocean:

> "For salmon FMP species, the analysis is broken into three parts: marine, nearshore, and freshwater. Marine and nearshore salmon EFH is generally described to include all marine waters from the mean higher tide line to the limits of the EEZ since science recognizes that salmon are 1) distributed throughout all marine waters during late juvenile and adult life stages and 2) found nearshore and along coastal migration corridors as early juvenile life stages out-migrate and adult life stages return to and from freshwater areas, respectively." (NMFS 2005)

3.12.5.2 Freshwater EFH

The EFH Identification and Conservation in Alaska EIS (described in Section 3.12.5.1) also described freshwater EFH (NMFS 2005). Freshwater salmon EFH is described in the selected preferred alternative of the FEIS as:

> "Freshwater areas used by egg, larvae, and returning adult salmon will be analyzed as those areas indexed in ADF&G's *Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes*, specifically Pacific salmon species. Freshwater salmon systems are generally defined as those areas above mean higher tide to the upper limits of those freshwater systems supporting salmon and may include contiguous wetland areas, such as those areas hydrologically connected to the main water source via access channels to an adjacent river, stream, lake, pond, etc." (NMFS 2005)

Freshwater areas used by egg, larvae, and returning adult salmon in Alaska for the purposes of this document are defined as those areas indexed in ADF&G's Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fish specifically for salmon species. Freshwater EFH as designated includes habitats designated for both chum and pink salmon (Johnson and Blanche 2011):

- The Canning/Staines, Sagavanirktok, and Kavik Rivers have all been designated for chum salmon presence
- The Sagavanirktok, Shaviovik, and Kavik Rivers have been designated for pink salmon spawning
- The Canning/Staines Rivers have been designated for pink salmon presence

The entries in ADF&G's catalog are updated each year, with the result that additional reaches of streams may be identified as anadromous in the future.

3.12.6 Fish of the Arctic Refuge

Because of its proximity and biological similarity to the study area, information on fish and fish habitat resources of the Arctic Refuge were reviewed in this Draft EIS. Much of the freshwater study area contains similar habitat and a similar fish assemblage (Hemming 1996). Juvenile arctic cisco migrate westward along the Arctic Refuge coast and the study area coast, overwinter and rear in the Colville River, and return eastward to the Mackenzie River in Canada as adults to spawn. Stocks of Dolly Varden overwintering within Arctic Refuge streams may feed along the coast or within small streams of the study area during migration. Coastal marine fish assemblages of the study area and the Arctic Refuge are similar to those of the rest of the Beaufort Sea coast.

3.12.7 Invertebrates and Other Lower Trophic Levels

Aquatic invertebrates are an important component of the arctic food web. Marine and freshwater invertebrates are the primary food for many fish and marine mammal species, or are the food of prey items for carnivorous marine and terrestrial mammals. Aquatic invertebrates include organisms such as clams, crabs, snails, insects, polychaete and oligochaete worms, copepods, and amphipods.

Aquatic invertebrates in the study area range in size from microscopic (larval or adult forms) to larger forms such as crabs. Organisms may live within the substrate (***infauna***) or on or above the substrate (***epifauna***) of a water body.

The sections below describe marine and freshwater invertebrates and habitats. Algae and phytoplankton are also discussed because of the importance of phytoplankton to the food web.

3.12.7.1 Marine Invertebrates

Marine invertebrates (especially shrimp and amphipods) that enter nearshore environments in summer serve a vital function as primary food sources for diadromous fish – they provide the energy needed for annual growth and to accumulate reserves needed for overwintering survival (Gallaway and Fechhelm 2000). Primary productivity in the study area is driven mainly by ***epontic*** (ice) ***algae*** and phytoplankton. Epontic algae is estimated to provide approximately 5 percent of the primary productivity in the Beaufort Sea (Schell and Horner 1981), and its relative importance to the marine food web is highest during the spring and early summer months (Campbell 1981). During mid- to late summer, phytoplankton emerges as the dominant source of primary productivity in Lion Bay (Campbell 1981) and becomes the primary base for macroinvertebrate feeding in nearshore habitats.

Benthic and motile invertebrates, also located near the base of the marine food web, are a critical component to marine life because all other species at higher ***trophic*** levels are dependent on their abundance and biomass. Invertebrates that are currently present in the area of potential project footprint have adapted to survive and reproduce in conditions where bottom fast ice can bind to, or otherwise disturb substrates during much of the year. Diversity and abundance of marine benthos species are highly dependent on local environmental conditions; high water quality, variable substrate sizes, and aquatic vegetation are most favorable for benthic invertebrate colonization. In the project area, water quality conditions are optimal (see Section 3.7, Water Quality) and are considered suitable for benthic invertebrate colonization. However, substrates are generally uniform in composition and lack a mix of favorable substrates for diverse invertebrate populations. Substrates are mostly composed of mud and silt (Barnes and Reimnitz 1974) with a sporadic boulder and cobble distribution (MMS 1990). These are conditions that offer little opportunity for invertebrate colonization in interstitial spaces. Although two kelp beds have been documented seaward of the barrier islands offshore of the study area, no such habitat has been documented to date in Foggy Island Bay, Mikkelsen Bay, or Lion Bay.

Habitats similar to the study area have been studied for marine invertebrates in association with North Slope development projects such as the Final EISs for OCS Lease Sales 97, 109, 124, 144, 186, 195, and 202 (MMS 1987a, b, 1990a, 1996, 2003) and the Liberty EA (MMS 2007). Because of the cold and generally ***oligotrophic*** conditions, the Beaufort Sea is generally expected to support fewer species than other arctic waters (Curtis 1975), although portions of the study area may be include pockets of relative productivity because of influx of warmer, more nutrient-rich waters from the Staines and Sagavanirktok Rivers (Cannon et al. 1987, ExxonMobil 2009b). Soft-bottom habitats such as those in the study area typically support benthic communities of microalgae, bacteria, polychaete and oligochaete worms, small mollusk species, and amphipods (MMS 1990). In other similar areas of the Beaufort Sea, infaunal invertebrate communities are comprised of polychaetes, clams, and various crustaceans, while epibenthic (taxa are usually made up of amphipods, copepods, isopods, and mysids (shrimp; Carey and Ruff 1977, LGL et al. 1998). Oligochaete worm and clam abundance typically increases with depth in the nearshore 0-6 foot zone (LGL et al. 1998). Abundance and distribution data in the nearshore arctic coast area collected as part of the NOAA Outer Continental Shelf Environmental Assessment Program (Broad et al. 1978, 1979, 1981) indicate that polychaete worms and small mollusks are the predominant infaunal organisms, while isopods, nemerteans, and benthic amphipods are the predominate epifaunal invertebrates. Approximately 75 to 80 percent of the biomass was made up of mollusks, and 10 to 15 percent of polychaetes.

3.12.7.2 Freshwater Invertebrates

Wetlands in the ACP have potential for excellent production of macroinvertebrates (Bergman, et al. 1977), an important food source for fish (Moulton et al. 2007) and waterbirds (Kertell 1993). Most streams and wetlands in the study area freeze to the bottom during winter (BPXA 1995); however, some species of aquatic invertebrates overwinter in frozen stream sediments (Kertell 1993). While no formal studies of freshwater invertebrates have been conducted in the project area since Ward and Craig (1974) sampled the Kavik River, information is available from similar North Slope freshwater habitats near the Prudhoe Bay development (Kertell 1993) and to the west of the project area in the Teshekpuk Lake region (Moulton et al. 2007). Macroinvertebrate taxa diversity near Prudhoe Bay was found to be positively correlated with aquatic vegetation such as grasses and sedges. The more sensitive larval taxa in the orders of Trichoptera (caddisflies) and Plecoptera (stoneflies), and some juvenile and adult gastropods (e.g., snails) appeared to prefer the emergent vegetation habitat, while taxa in the more insensitive larval Orders Diptera (flies, specifically midges [family Chironomidae]) and Oligochaeta (earthworms and their relatives) displayed an ability to tolerate more open and exposed conditions. In the Teshekpuk Lake region, members of the family Chironomidae were the dominant organisms in terms of biomass, and some locations supported sizable populations of organisms in the Gastropoda and Trichoptera orders. Chironomidae are often the predominant taxa found in Alaskan stream surveys, most likely due to their high tolerance for harsh environments and their ability to recolonize quickly subsequent to disturbance (Rosenberg et al. 1986). In Alaska, Chironomidae recolonization after disturbance may take longer than in other geographic locations (up to 10 to 20 years instead of 3 to 4 years) due to colder substrate conditions (Johnson 1987, ExxonMobil 2009b).

3.13 LAND OWNERSHIP, LAND USE, AND LAND MANAGEMENT

The study area for land ownership, land use, and land management is generally the area from the Brooks Range to the Arctic Ocean, including the ocean itself several miles offshore, and from Kaktovik to Deadhorse (see Figure 3.13-1).

3.13.1 Key Information About Land Ownership, Land Use, and Land Management

Land ownership, use, and management in the study area are primarily dominated by two principal land owners: the State of Alaska and the U.S. government/Arctic Refuge; however, the project is located exclusively on state land. Examination of broader land ownership and management in the vicinity of the project is warranted because the landscape is principally flat and entirely treeless, so refuge lands used for recreation and subsistence, and as habitat for wildlife (which move across the refuge boundary), are within the area potentially affected by the project. The following key points characterize land ownership, land use, and land management in the study area:

- The study area is located within the North Slope Borough; the project itself would be located entirely on land owned by the State of Alaska
- There are no settlements or residents in the area between Kaktovik and Deadhorse; land uses in the study area include subsistence and traditional uses by local residents, outdoor recreation, industrial land uses, and transportation
- State-owned land in the study area has been designated as Resource Management Land; intended management uses include resource development and general public uses, with the exception of overland motor vehicle use unless for subsistence
- The borough has zoned lands in the study area as Conservation District and Resource Development District; the project is proposed almost entirely within the existing RD District
- The project would be located on land that is managed by the State of Alaska for oil and gas development; other lands in the study area are managed for wildlife habitat and wilderness values
- The western boundary of the Arctic Refuge lies approximately 2 miles from the proposed project site (see Section 3.13.3, below and Section 3.14, Arctic National Wildlife Refuge for additional detail about the refuge)

3.13.2 Review and Adequacy of Information Sources for Land Ownership, Land Use, and Land Management

Information sources for this chapter were primarily federal, state, and local government agencies and documents. Types of information include Alaska Statutes and NSB Municipal Code, land use planning documents, and personal communications with agency representatives. These sources provided adequate information about land ownership, land use, and land management in the project area. Most land management governs broad areas, and there is little information that is specific to those portions of federal or state land nearest to the project site that is separate from these much broader management guidelines.

Table H-13 in Appendix H discusses the publications, reports, and data available for land ownership, land use, and land management related to the proposed project. Full references for the studies cited in this Draft EIS are in Chapter 9, References.

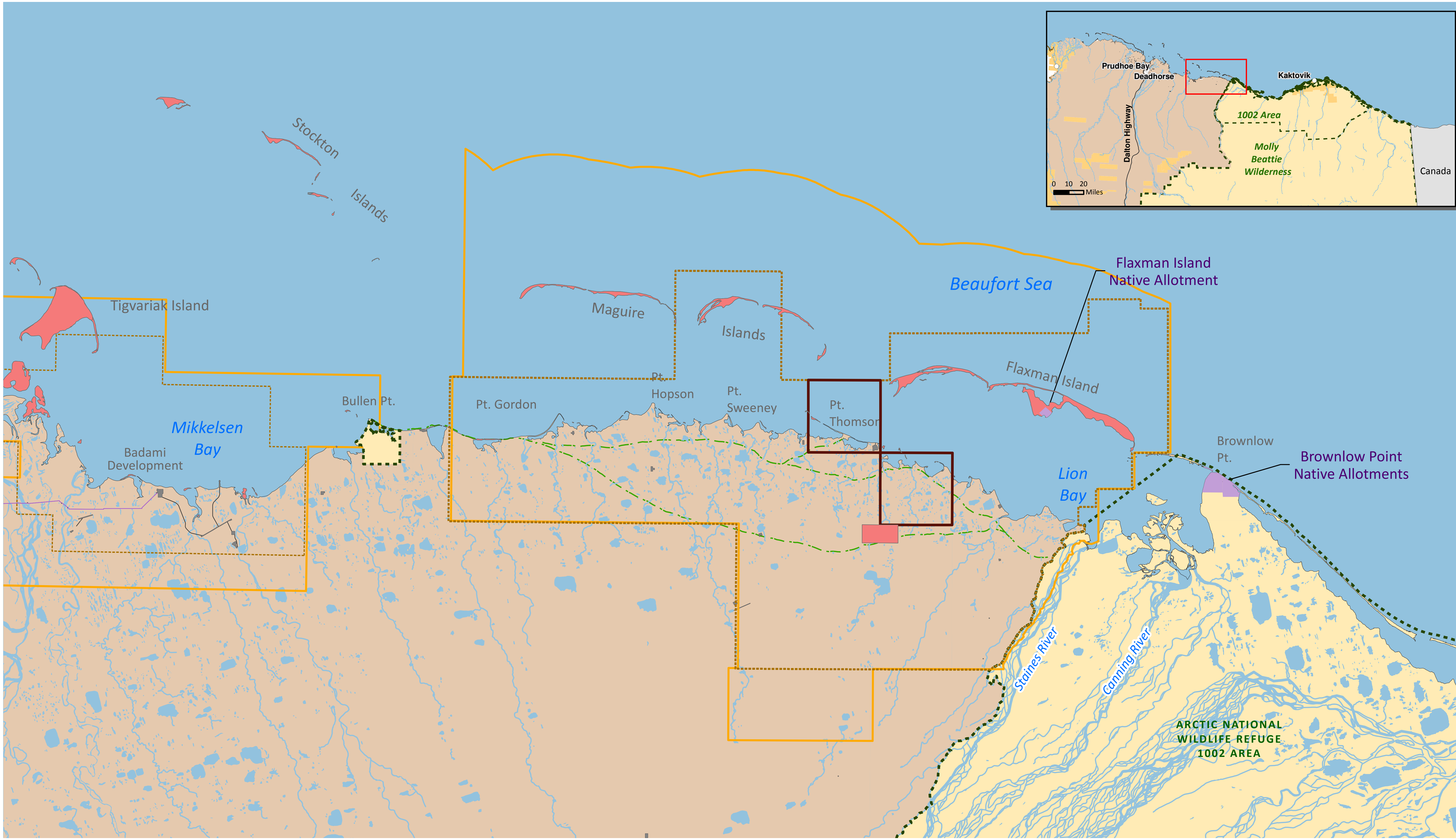
3.13.3 Land Ownership

Land in the study area—some 120 miles east-west and 40 miles north-south—is principally owned by the State of Alaska (west of the Canning River) and the federal government/Arctic Refuge (east of the Canning River; see Figure 3.13-1). All of the land in the project area lies within the NSB, which is the local government with the largest area in the U.S., at about 60.6 million acres. Most of the land within the borough boundaries is owned by the federal and state governments. The borough does not currently own any land near the Point Thomson area. Under Alaska's municipal land entitlement law (AS 29.65), the borough is allowed title to 89,850 acres of state land and has made selections. Lands selected by the borough must be approved by the ADNR before patent, or title to the land, is issued. Among these, the borough selected a 320-acre parcel 2 miles south of the Point Thomson Project—a site proposed for use in the project. In addition, the borough has selected lands immediately west of the Canning River and about 20 miles upstream from the coast, and lands farther west at the confluence of the Kavik and Shaviovik Rivers and at Tagvariak Island off the mouth of the Shaviovik. The borough-selected lands include all islands in the area, including the string of large barrier islands such as Flaxman Island located 2 to 3 miles offshore and any smaller islands located closer to shore. These include three small islands immediately east and west of the existing Central Pad area. The borough does not yet have patent to these lands.

Under the terms of the Alaska Native Claims Settlement Act (ANCSA), which established regional and village-centered corporations across Alaska and allowed the corporations to select federal lands in their regions, the Arctic Slope Regional Corporation (ASRC) and the Kaktovik Iñupiat Corporation (KIC) own lands at the edges of the study area but none near the Point Thomson Project. The state owns submerged lands under ocean waters for 3 miles offshore of Alaska coastline, including state-owned islands; the federal government owns submerged lands offshore of the Arctic Refuge, as determined in a landmark U.S. Supreme Court case known as the Dinkum Sands decision.

In the borough and along the coast, in particular, there are Native-owned parcels selected by local residents under the Native Allotment Act. Some of these are pending patent. In the immediate study area, there are three allotments—a 33-acre parcel on Flaxman Island, and two parcels at 160 and 120 acres adjoining each other, located on the tip of Brownlow Point, according to BLM's Spatial Data Management System (see Figure 3.13-1). None of these are located directly within the areas proposed for project facilities, but they would be within view of proposed project sites. Several other Native allotments are widely scattered in areas between the refuge and Prudhoe Bay (see Figure 3.13-1).

In addition to the Arctic Refuge, the federal government also owns a 605-acre parcel at Bullen Point that once was a distant early warning line station for national defense and more recently was used as an unmanned radar site. This station, located about 15 miles west of Point Thomson along the coast, has now been closed completely (HDR 2010b). Soil cleanup was reported complete in October 2010.



POINT THOMSON PROJECT EIS

Legend

- Existing Road
- Existing Pipelines
- Bullen-Staines River Trail RS 2477
- Existing Facilities**
- Current Leases at Point Thomson
- Federal Land
- Point Thomson - Native Allotment
- State Lands Selected by the North Slope Borough
- Native Corporation Land
- State Land
- Point Thomson Unit- In Dispute*
- Oil and Gas Development Unit
- North Slope Borough Resource Development District (zoning). All other area state and private lands in the mapped area fall within the Conservation District.

* * On the main map, these existing pads are not in use or built upon except at Point Thomson itself and at Badami. At Prudhoe Bay on the inset map, most pads are in use for oil and gas development.

* Dissolution of the Point Thomson Unit by Alaska Dept. of Natural Resources is in dispute in state court.

Figure 3.13-1
Land Ownership and Management

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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Other land rights in the area include state oil and gas leases held by ExxonMobil and a Revised Statute 2477 (RS2477) public right-of-way. These are discussed in the following subsection under "Management Direction" for state lands. Offshore, the state and federal governments have sold oil and gas leases. Shell Exploration and Production Company has been actively preparing for drilling 12 to 15 miles offshore of the Canning/Staines River delta.

3.13.4 Land Use

The portion of the project area between the communities of Kaktovik and Deadhorse is uninhabited. Human use is low by comparison to urban and most rural areas. Human uses of the study area fall into three main categories: subsistence and traditional uses by local residents of the NSB, outdoor recreation, and industrial land uses associated principally with gas and oil exploration. Another use, related to the others, is transportation. While use levels are low, the sensitivity level of subsistence and recreation users can be high (see Section 3.18, Recreation) and there is potential for conflict between these land uses and industrial land uses. State lands in the area are managed for oil and gas development and otherwise for general uses and for maintenance of wildlife populations. Refuge lands in particular are managed for conservation and wildlife habitat. The ADF&G manages wildlife populations and hunting across the area and works in conjunction with federal land managers on refuge lands. The borough has zoned the broad area as Conservation District and the project area associated generally with the previously defined Point Thomson Unit as a unit of its Resource Development (RD) District. The RD District is shown on Figure 3.13-1. The management intent is further described in the following section.

Subsistence and traditional uses principally include hunting and fishing. Sections 3.15 and 3.17 describe these uses in greater detail. These uses occur year-round, on the ocean, on the coastal plain and its rivers, and in the Sadlerochit and greater Brooks Range mountains. Hunters use the sea ice in winter and spring, and take advantage of frozen conditions to travel across the coastal plain and to the mountains in winter. Hunters also travel by boat in the summer along the coast and, during fall whaling season, well offshore. Trips by snowmobile or boat may be short day trips or may involve days or weeks of working out of remote camps (Pedersen 1990, NSB 1983)

Recreation near the Point Thomson area is thought to be low on state land and only somewhat higher on Arctic Refuge lands. The Canning River is one of the main recreation corridors for river floaters and float hunters in the refuge. Because the western side of the river forms the boundary between the state and federal land, those using the river corridor may camp or hike on state or refuge land. The Bullen Point airstrip and other airstrips and lakes large enough for aircraft landings reportedly are used for recreational fishing and hunting trips (ATSDR 1997, HDR 2010c). Ocean waters are also used for recreation, such as kayaking and, farther offshore, occasional cruise ships (see Section 3.18, Recreation).

Industrial land use has occurred principally since the late 1960s and early 1970s and has included oil and gas exploration activity and military activity. Actual industrial land use has been intermittent, although the State of Alaska holds an oil and gas lease sale annually. The baseline land use for this Draft EIS includes no active industrial land use east of the Badami and Bullen Point industrial developments, although oil and gas leases have existed in the area since 1977, and the Point Thomson Unit partners drilled 21 exploratory wells and conducted seismic studies over 30 years prior to 2007 (ExxonMobil 2011c). There are several currently unused gravel pads and capped exploratory wells in the area. The only existing industrial land use between Bullen Point and the Canning River delta is associated with the existing Point Thomson Project itself, established in 2009. In late winter 2010, the Point Thomson Central and PTU-1 pads (existing gravel pads) had operating camps on them, and a private seasonal two-lane ice road along the coast for industrial use connected Point Thomson to the state road system at Prudhoe Bay. Other local site clean-up efforts near the Bullen Point radar site (west of Point Thomson) and West Staines 2 (south of Point Thomson) appear to have taken advantage of the ice road and had camps on them, with active work to clean up contaminated soil. In summer, industrial uses occurred between 2008 and 2011 on the ocean in the form of boat and barge traffic to Point Thomson. Since the Point Thomson Project began in 2008 and 2009, helicopter traffic has occurred frequently in the area west of Point Thomson.

Scientific research is another general human use of the area, with four to eight private and government researchers inhabiting camps on the Canning River delta each summer. One or two seasonal research camps located on the delta have been in place each year since 2002 for various bird research projects, and researchers transit the area by small boat and fly in and out from an informal beach landing site. Scientific research and "meeting treaty obligations" related to conservation of migratory birds are part of the purposes of the Arctic Refuge.

3.13.5 Land Management Direction

3.13.5.1 State of Alaska

The State of Alaska has issued area plans for its lands in many parts of the state under AS 38.04.065 but has no adopted "area plan" for its lands in the project area (HDR 2010c). State lands on the North Slope fall under AS 35.05.180 "Oil and Gas and Gas Only Leasing" and are therefore not subject to general land planning provisions. The North Slope lease area encompasses 5.1 million acres lying between the NPR-A and the Arctic Refuge. The area is divided into 1,225 tracts. A lease sale for state lands not already leased is issued annually. The ADNR Division of Oil and Gas develops and manages the state's oil and gas leasing programs, including conducting the competitive oil and gas lease sales for the Point Thomson area. In 1969, state land classification orders CL 617 and CL 618 classified the state land in the project area as Resource Management land (RMG), classifying it for resources in general for an area that at that time was not fully explored. Recent ADNR documentation (ADNR 2010a) states that if it were reclassified today as a whole, state land on the North Slope would be classified as "oil and gas land": "…where known oil and gas resources exist and where development is occurring or is reasonably likely to occur, or where there is reason to believe that commercial quantities of oil and gas exist" (11 AAC 55.135).

"A classification identifies the primary use for which the land will be managed, subject to valid existing rights and to multiple use" **(**11 AAC 55.040). The classifications do not preclude general uses of state land. State land in the study area, including land leased for oil and gas purposes, is considered general land open to public use for all generally allowed uses on state land (11 AAC 96.020). There is an exception for one type of use—that related to use of motorized vehicles. This exception is stated briefly in designation of these lands as a special use area:

> "For the North Slope Area, ADL number 50666, for all state land in townships within the Umiat Meridian, a permit is required for motorized vehicle use, unless that use is for subsistence purposes or is on a graveled road." 11 AAC 96.014(b)(1)

The ADNR indicated that this special use restriction, in conjunction with Dalton Highway restrictions in AS 19.40.210, limits overland public access on the coastal plain (HDR 2010c, d; see Section 3.18, Recreation), but use is not prohibited. Actual oil and gas developments (roads, drilling pads) on leased state land are subject to access restrictions by the lessors. For example, the network of roads in the greater Prudhoe Bay area is generally off limits to public use unless specifically authorized by the companies (such as residents of Nuiqsut at certain times of year, and tour buses) and there is a security checkpoint to turn people back. However, in actual practice, residents of the North Slope cross roads and pipelines without restrictions as they travel across country by snowmobile.

In Alaska, as in most coastal states, land below ordinary high tide (the "beach") typically is open to the public for public access, except where permitted for specific uses such as large commercial or public docks or ports, or similar developments. The Alaska Constitution provides that "waters are reserved to the people for common use." Submerged lands constitute part of the state public domain.

The State of Alaska asserts that a public highway right-of-way exists across state and federal lands under RS2477. The Bullen-Staines River Trail (RST 1043), including two main routes and a spur trail, passes directly through the project area. The route is listed as about 22 miles long, from Bullen Point to the Staines River/Canning River delta. The state asserts an RS2477 as a 100-foot-wide public access right-of-way with the mapped line as an estimated centerline (HDR 2010d). The right-of-way is not surveyed; however, the state recognizes the right of public access on its own lands along such routes.

Status of Point Thomson Oil and Gas Leases

The ADNR is a cooperating agency for this Draft EIS and provided the following information about the current status of contested land rights associated with this project (HDR 2010e). The project would be located on state land that has been managed by the State of Alaska principally for oil and gas development since at least the 1970s.

ADNR approved a Point Thomson Unit agreement in 1977, as a group or "unit" of oil and gas leases that would be regulated and developed under a unified approach. Leases in the unit were held by several companies and other investors. ExxonMobil was the lead operator for the unit. At its maximum, the unit contained dozens of leases and covered 116,600 acres (Rosen 2009). In 2005, the ADNR rejected ExxonMobil's 22nd plan of development and held the PTU in default for failure of ExxonMobil and the other leaseholders to commit to adequate exploration and production between 1977 and 2005. The ADNR commissioner terminated the PTU in 2006. ExxonMobil appealed, and in 2007, a state court remanded the 2006 PTU termination back to ADNR for appropriate remedy.

During the remand proceedings, ExxonMobil and its partners proposed a new plan of development that committed to some production of hydrocarbons, but in 2008 the ADNR commissioner again terminated the unit as not in the public's interest. The Alaska Superior Court reversed the 2008 termination in January 2010. In February 2010, ADNR filed a petition with the Alaska Supreme Court for review of the superior court's 2010 decision reversing the ADNR commissioner's 2008 PTU termination. The state's current position is that there is no longer a PTU. Shortly after terminating the PTU, ADNR issued a decision that 31 of the leases in the former PTU had expired. The leaseholders appealed and offered testimony regarding their plan to drill wells and produce hydrocarbons on certain leases by 2014. Based on this appeal, the ADNR commissioner issued a conditional interim decision in January 2009 reinstating two leases (ADL 47559 and 47571) for bringing two wells into production by 2014 (see Figure 3.13-1). The leaseholders obtained the necessary permits for drilling the two wells and currently are working on fulfilling the requirements of the conditional interim decision. The recent Point Thomson development is the result, and this Draft EIS is necessary to complete the project and produce hydrocarbons under the terms of the conditional interim decision. The two existing leases shown on the figure each are square parcels (2 miles on a side) located corner to corner, with the existing Point Thomson development (Central Pad) located at the adjoining corners. Each of the parcels encompasses some state land and some submerged land (ocean) also owned by the state.

It is ExxonMobil's position that the PTU has been and still is in effect, consistent with the Alaska Superior Court decision that ADNR has appealed.

The State of Alaska and the Point Thomson leaseholders are continuing discussions on the development of the Point Thomson reservoir, and the status of the gas leases may change as a result of settlement actions between the State of Alaska and ExxonMobil. The leaseholders proposing the project evaluated by this Draft EIS would need other leases for drilling wells and establishing support facilities in addition to the two leases currently recognized by ADNR and in use for the project as currently permitted by the state.

3.13.5.2 North Slope Borough

The NSB asserts jurisdiction over activities within its boundaries on private and state-owned lands. NSB Municipal Code Title 19 addresses land use and zoning.

The two land use zones pertinent to the study area are the Conservation District and the RD District. Most of the nonfederal lands of the ACP currently are classified as Conservation District (NSB code 19.40.070). The code states:

> "The District is intended to conserve the natural ecosystem for all the various plants and animals upon which Borough residents depend for subsistence. Subject to this overall intent, it can accommodate resource exploration and development on a limited scale, but major resource development projects must apply for rezoning to the Resource Development District."

This district allows, with public notice and administrative approval, issuance of commercial recreation permits, limited scale development such as ice roads (e.g., those that existed in the area in 2009 and 2010), and oil and gas exploration.

The RD District, according to NSB code (19.40.080), is "intended to address the cumulative impacts of large scale development, and to offer developers quick, inexpensive, predictable permit approvals. The purpose of the RD District is to accommodate large scale resource extraction and related activities" which:

> "(1) Do not permanently and seriously impair the capacity of the surrounding ecosystem to support the plants and animals upon which Borough residents depend for subsistence; (2) Are planned, phased and developed as a unit, or series of interrelated units under an approved Master Plan, with provisions made for all necessary public and private facilities; and (3) Meet the policies of the Comprehensive Plan and Coastal Management Program as well as the conditions of approval and special policies imposed on each individual Resource Development District at the time of designation." NSB Code 19.40.080

Point Thomson is one of several "Resource Development Areas" listed in the code as being included in the RD District. The Badami development area is the next nearest and is separated from the Point Thomson area by several miles (HDR 2010f). The NSB code notes that an approved master plan, required for activity to commence within the RD District, does not yet exist for the Point Thomson RD area. Submittal of a master plan is anticipated as a routine part of project approvals. The NSB indicates, based on preliminary talks with ExxonMobil, that the borough anticipates an application from ExxonMobil for rezoning to incorporate a larger area that would adjoin the Badami RD area and incorporate the entire proposed pipeline route (HDR 2010f).

While the NSB has selected some state lands in the study area, there is no documentation of the purpose of the specific selections and no specific management intent (HDR 2010g, h).

3.13.5.3 U.S. Government

Arctic Refuge

The Arctic Refuge was first established as a “wildlife range” “for the purposes of preserving unique wildlife, wilderness, and recreation values” (USFWS 2008b). In 1980, the Alaska National Interest Lands Conservation Act (ANILCA) enlarged the wildlife range to 19 million acres and renamed it a refuge, with the following purposes: (1) to conserve fish and wildlife populations and habitat in their natural diversity, (2) to fulfill international treaty obligations, (3) to provide the opportunity for continued subsistence uses by local residents; and (4) to ensure water quality and necessary water quantity within the refuge.

ANILCA Section 704 established an eight million acre federally-designated wilderness area within the refuge. The northwest corner of the Molly Beattie Wilderness is at the foot of the Sadlerochit Mountains 30 miles from the coast and from the Point Thomson project area. ANILCA Section 1001 directed the Secretary of the Interior to conduct studies of federal lands in the Arctic, including studies of oil and gas resources and transportation routes, wilderness characteristics, and wildlife resources, and to make findings and recommendations. Section 1002 specifically established an oil and gas and wildlife study area (the “1002 Area”) on the coastal plain within the refuge and specified that the government would include studies of the impacts of oil and gas production on the refuge and would allow seismic studies to refine public understanding of oil and gas potential (Figure 3.13-1 shows the 1002 Area and the Molly Beattie Wilderness). ANILCA Section 1003 prohibited any oil and gas production from the refuge until specifically authorized by Congress.

The stipulated studies for the 1002 Area have been completed and submitted to Congress. A 1987 Secretary of the Interior report to Congress recommended authorization of full oil and gas leasing of the 1002 Area. Although the question of opening the 1002 Area to oil and gas development has been proposed multiple times in both houses of Congress, the issue has been highly charged among the public, however, no bill has been passed that would either open the area to oil and gas drilling or include it in the wilderness preservation system.

The refuge is managed under a 1988 Comprehensive Conservation Plan (CCP). The USFWS has begun the process of plan revision, with a final decision scheduled for 2012 (HDR 2010i). The existing plan provides greater detail on the administration of the refuge under the purposes that established the original Wildlife Range and the subsequent Wildlife Refuge. In general, the refuge is managed largely for its wildlife resources and wilderness values both inside and outside of the designated wilderness area. Until Congress acts to determine a definitive management direction for those portions of the refuge that are closest to the proposed Point Thomson Project (the western edge of the 1002 Area), minimal management applies. Much of the refuge outside the designated wilderness (including the 1002 Area) is under minimal management, which the CCP defines in part as follows:

> “Management under this category is directed at maintaining the existing conditions of areas that have high fish and wildlife values or other resource values. Minimal management areas are

> suitable for wilderness designation, although the (Fish & Wildlife) Service's wilderness proposals do not necessarily include all lands in the minimal management category. Areas proposed for wilderness designation would be placed in minimal management until actually designated by Congress."

The minimal management category allows for human uses such as recreation and subsistence, and has allowances for uses such as prescribed burns, oil and gas exploration, structures associated with guiding, and fisheries development structures, where such uses are compatible with refuge purposes and allowed under ANILCA.

Other specific information on management direction in the CCP may be found in other sections of this Draft EIS, such as Section 3.14, Arctic National Wildlife Refuge, and Section 3.18, Recreation. The Kaktovik Iñupiat Corporation owns land within the refuge boundaries in the area around Kaktovik. The closest of these private lands lie 40 miles east of the proposed project site.

Bullen Point

The federal government (U.S. Air Force) manages the Bullen Point Short Range Radar Site, although the radar operation itself has been terminated. Originally established in the 1950s, the site has been contaminated and has been undergoing cleanup over several years. The environmental restoration work is complete, and demolition of all structures is planned but not yet funded or scheduled (HDR 2010b). It is the Air Force's intention to turn over the 605-acre site to the BLM and ultimately to the State of Alaska once cleanup is complete; the state has indicated interest in acquiring the land (HCG 2005).

3.14 ARCTIC NATIONAL WILDLIFE REFUGE

The Arctic National Wildlife Refuge (Arctic Refuge) is part of the National Wildlife Refuge system. The western edge of the Canning/Staines River delta forms the western refuge boundary, which lies approximately 5.5 miles from the current Point Thomson development area and about 2 miles from the East Pad location in the Applicant's Proposed Action.

3.14.1 Key Information about the Arctic Refuge

This Draft EIS includes a separate section on the Arctic Refuge due to its proximity to the project and the Thomson Sand Reservoir. Other sections of this Draft EIS provide additional information about many of the topics outlined in the following subsections.

The following key points characterize the Arctic Refuge:

- The Arctic Refuge includes 19 million acres, 8 million acres of which are designated as wilderness. The nearest designated wilderness to the Point Thomson project site is inland approximately 30 miles, and extends up to the coast east of Kaktovik.
- ANILCA identified a portion of the Arctic Refuge on the coastal plain as a study area for potential future oil and gas development; this area is commonly referred to as the 1002 Area, (see Figure 3.14-1).
- The Arctic Refuge manages the 1002 Area as a Minimal Management Area, in part for its wilderness values. The nearest portion of the 1002 Area lies about 2 miles from the nearest portion of the proposed project.
- The 1002 Area has conflicting national values for its domestic oil and gas reserves and for its wilderness qualities.
- Wildlife, vegetation, recreation, visual, noise, and other sections of the Draft EIS apply also to the Arctic Refuge.

3.14.2 Review and Adequacy of Information Sources for the Arctic Refuge

The primary sources of information on the Arctic Refuge are documents and information obtained from the Arctic Refuge managers and other relevant sections of this Draft EIS. In general, these sources are adequate to describe the Arctic Refuge issues pertinent to this project. While a legislative EIS was conducted for the entire coastal plain of the Arctic Refuge in the 1980s and a current EIS for the revised comprehensive conservation plan is available, very little information specific to the extreme northwest corner of the Arctic Refuge has been generated, except as part of a general treatment of the broader area or region.

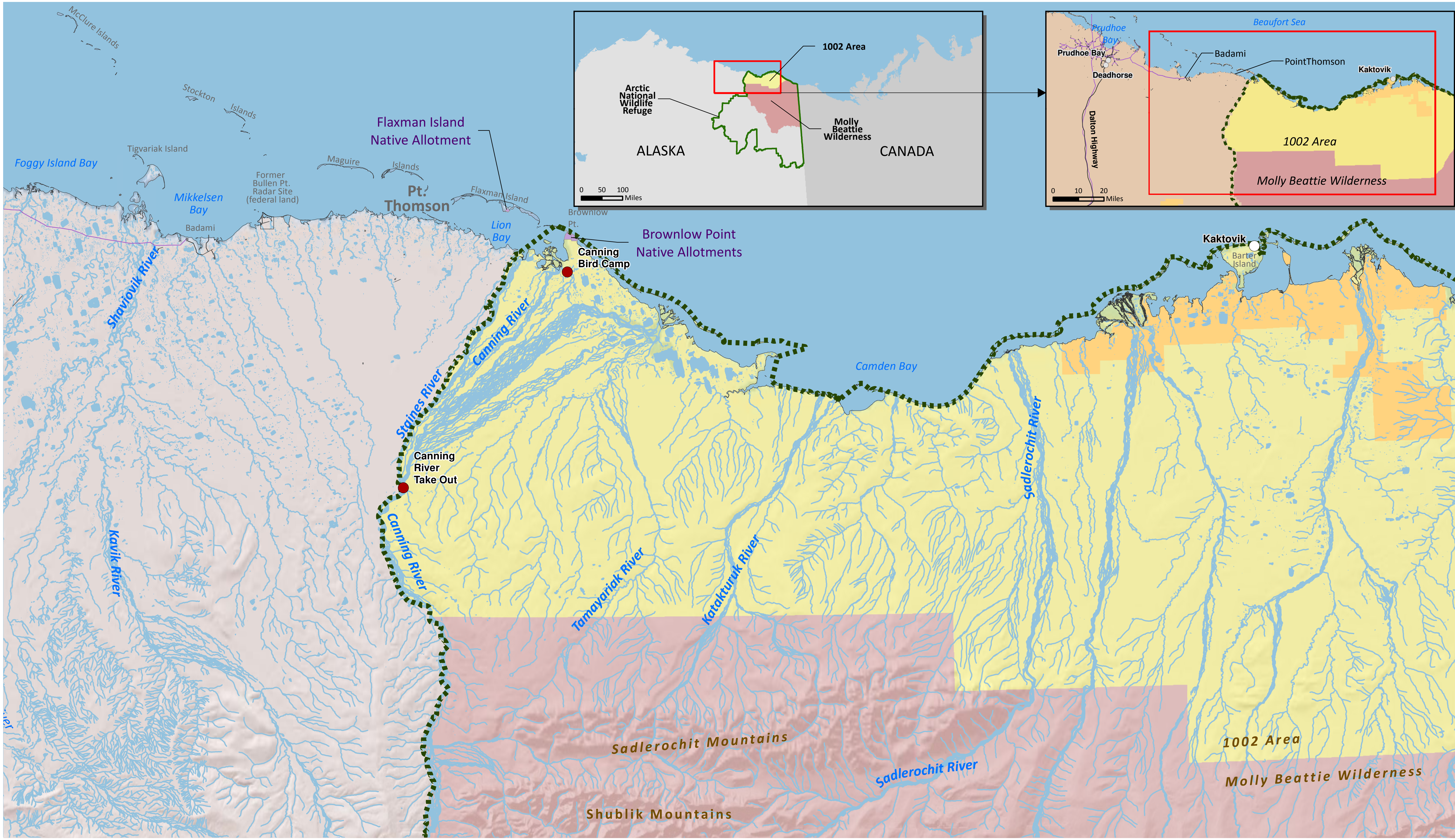
Table H-14 in Appendix H discusses the publications, reports, and data available for the Arctic Refuge related to the proposed project. Full references for the studies cited in this Draft EIS are in Chapter 9, References. Other sections of the Draft EIS address the data used in those sections and may apply, in part, to the Arctic Refuge.

3.14.3 Arctic Refuge Purposes and Management

The Arctic Refuge comprises six different arctic and subarctic ecological zones spanning 200 miles north to south. It is known for its wildlife and its wilderness values. At 19 million acres, the Arctic Refuge is the largest wildlife refuge in the nation (similar in size to South Carolina). It is also the farthest north refuge, and was established first in 1960 as the Arctic National Wildlife Range. In 1980, Congress expanded the wildlife range and renamed it a refuge with passage of the ANILCA (USFWS 2008c). When enlarging and renaming the Arctic Refuge, Congress designated within its boundaries:

- Eight million acres as part of the National Wilderness Preservation System (ANILCA Section 702).
- Three rivers as part of the Wild and Scenic Rivers System—the Ivishak, upper Sheenjek, and Wind Rivers (ANILCA Section 602).
- Much of the ACP (commonly referred to as the "1002 Area" after ANILCA Section 1002) for further study to assess:
    - Potential oil and gas resources.
    - The impact of developing oil and gas resources on wildlife and other Arctic Refuge resources.
- The interim preservation of wilderness qualities of the 1002 Area so that Congress in the future could consider including the area in the National Wilderness Preservation System (See further discussion in Section 3.13, Land Ownership, Land Use, and Land Management).

Arctic Refuge purposes were spelled out in a public land order that established the original "wildlife range" in 1960 and in ANILCA in 1980. The USFWS manages the Arctic Refuge for a variety of purposes, from meeting treaty obligations to maintaining opportunities for subsistence to preserving wildlife and wilderness values. Refuge management is directed by a Comprehensive Conservation Plan (CCP; USFWS 1988). The proposed Point Thomson Project site is not on Arctic Refuge land, and the USFWS has no management authority at the proposed project site, which is on State lands. Arctic Refuge management is germane to this project because the project site is close to the boundary, the subsurface hydrocarbon reservoir is thought to extend right to border of the Arctic Refuge, and refuge issues are highly charged in the public debate over development of oil and gas to help meet the nation's energy needs and the debate over protection of an ecosystem-scale refuge and wilderness. Arctic Refuge purposes and management are further explained in 3.13, Land Ownership, Land Use, and Land Management.



POINT THOMSON PROJECT EIS

Legend

- Existing Road
- Existing Pipeline
- Existing Facilities**
- State Land
- Native Corporation Land
- 1002 Area
- Mollie Beattie Wilderness
- Point Thomson - Native Allotment
- Arctic National Wildlife Refuge
- Place of Interest
- Town

* * On the main map, these existing pads are not in use or built upon except at Point Thomson itself and at Badami. At Prudhoe Bay on the inset map, most pads are in use for oil and gas development.

N

0 5 10 Miles

Figure 3.14-1

Arctic National Wildlife Refuge

Date: 23 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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3.14.3.1 Fish and Wildlife

The Arctic Refuge as a whole contains the greatest diversity of wildlife species of any protected area in the circumpolar north, including nearly 45 mammal, 180 bird, and 36 fish species (USFWS 2008c). Some of the species common to the ACP and coastal waters, with ranges that include portions of the Arctic Refuge and the Point Thomson project area, include caribou, musk oxen, brown bears, wolves, polar bears, ringed and bearded seals, buff-breasted sandpipers, eiders, long-tailed ducks, snow geese, arctic char, and grayling.

The USFWS and ADF&G both have management authorities regarding fish and wildlife species and their habitats in the Arctic Refuge. Most pertinent to this Draft EIS, the focus of USFWS wildlife management in Minimal Management areas, including the 1002 Area, is to maintain the status quo for animal species using those areas. The USFWS, while having jurisdiction over wildlife within the Arctic Refuge, has an interest in the welfare of species that use the Arctic Refuge lands, including those species that move across its borders and potentially back and forth between federal and state-owned lands (USFWS 2008d). ADF&G has authority to manage these populations regardless of land ownership.

Other sections of this Draft EIS address wildlife in general in the project area and are applicable to the Arctic Refuge.

- Sections 3.10 and 5.10, Terrestrial Mammals, and Sections 3.11 and 5.11, Marine Mammals, address wildlife populations and habitats in general, with reference to species such as caribou and polar bears that move in and out of the Arctic Refuge.
- Sections 3.9 and 5.09, Birds, address bird populations and habitats, including those species that may move back and forth from state to federal refuge lands.
- Sections 3.12 and 5.12, Fish, Essential Fish Habitat, and Invertebrates, address fish populations and habitats, with specific reference to Arctic Refuge fish resources.

3.14.3.2 Traditional and Current Human Uses

While 40 percent of the Arctic Refuge is designated wilderness, wilderness conservation and human use of the Arctic Refuge have never been mutually exclusive. Public Land Order 2214, which created the original Arctic National Wildlife Range in 1960, stated that one purpose of the Range was to preserve the area's unique recreational values. In 1980, ANILCA added the purpose of providing "the opportunity for continued subsistence uses by local residents" (USFWS 2008b).The USFWS acknowledges that the lands comprising the Arctic Refuge have played an integral role in the well-being of local Alaska Native peoples for thousands of years, and manages the refuge to accommodate both subsistence activities and recreation within the Arctic Refuge borders (USFWS 2008b).

Other sections of this Draft EIS address prehistoric, historic, and contemporary uses of the project area, including Arctic Refuge lands, by people who live in the project area and practice subsistence hunting, and by people who visit the project area for recreation.

- Sections 3.21 and 5.21, Cultural Resources, address historic and prehistoric sites.
- Sections 3.13 and 5.13, Land Ownership, Land Use, and Land Management, address Arctic Refuge lands as part of larger patterns of traditional use.
- Sections 3.18 and 5.18, Recreation, explicitly address recreation within the Arctic Refuge.

Sections 3.22 and 5.22, Subsistence and Traditional Land Use Patterns, address subsistence hunting and other subsistence use patterns.

3.14.3.3 Aesthetics

In part because of the proximity of the Point Thomson project to the Arctic Refuge and its associated subsistence, recreation, and wilderness values, the aesthetics of the visual and acoustic environment is evaluated as part of this Draft EIS. Section 3.19, Visual Aesthetics, assesses visual resources, and Section 3.20, Noise, assesses the acoustic environment. Both sections evaluate the existing environment in the northwest corner of the Arctic Refuge.

3.14.4 The Arctic Refuge's National Values

As mentioned above and further detailed in Section 3.13, Land Ownership, Land Use, and Land Management, Congress created a dichotomy regarding the coastal plain portion of the Arctic Refuge when it passed ANILCA in 1980. Congress made this 1002 Area a study area for potential future oil and gas development and has reserved decisions about long-term management of the area to itself. Congress has repeatedly considered opening the 1002 Area to oil and gas development, and has seen at least one bill proposing to designate the area as official wilderness. Congress has not made a final decision, and the result has been the prominence of the Arctic Refuge in the ongoing national debate.

In a 1987 Secretary of the Interior recommendation to Congress regarding the 1002 Area, Secretary Donald Hodel made the case that the 1002 Area should be fully opened to oil and gas leasing and production because it was in the public interest economically and for national security. In 2003, the State of Alaska promoted further testing in the Arctic Refuge because developing the 1002 Area's oil and gas reserves is justified by the state's and nation's need for additional hydrocarbon production, the need to maintain TAPS, and the promise of a gas pipeline to the North Slope (ADNR 2003). Similar sentiments are expressed regularly by Alaska's congressional delegation.

For wilderness proponents, the Arctic Refuge is symbolic of the concept of wilderness in the U.S. value system. It is important not just to those who visit it (addressed in Section 3.18, Recreation) but also symbolically to those who may not visit, similar to the Little Bighorn Battlefield or Statue of Liberty National Monuments might be to Americans who never visit Montana or New York. Alaska is seen nationally as a storehouse of the nation's best wild areas, and the Arctic Refuge is seen as one of Alaska's most important conservation areas (Nash 2001). As explained in Land Management (see Section 3.13.5), the USFWS manages the 1002 Area as a Minimal Management Area to preserve its high wildlife and wilderness resource values. Representative tangible and intangible wilderness values could include maintaining the natural conditions such as intact ecosystems, healthy airsheds and watersheds, and visual and sound scapes; retaining the primeval character of and influence on the land; and providing opportunities for solitude, primitive and unconfined outdoor recreation, risk, adventure, education, personal growth experiences, a sense of connection with nature and values beyond one's self, a link to our American cultural heritage, and mental and spiritual restoration in the absence of urban pressures (USFWS 2008e).

3.15 SOCIOECONOMICS

The study area for the socioeconomic analysis encompasses the entire NSB because of the potential for regional effects on tax revenue and employment. Within the NSB, the analysis focuses on the communities of Kaktovik and Nuiqsut as they are the closest geographically to the project and are more likely to experience localized effects on community culture, subsistence, employment, and income. Anaktuvuk Pass is briefly discussed because of its connection to the project area through subsistence sharing with residents of Nuiqsut. The economic and regional hub of Barrow and the industrial enclave of Deadhorse may experience impacts from increased economic and industrial activity.

3.15.1 Key Information About Socioeconomics

The social and economic setting of the NSB is shaped by its remote location, sparse population, traditional values, and cultural history. The population of the NSB was less than 10,000 in 2010 with 60 percent of permanent residents residing in Barrow, the region's hub (USCB 2010a). The population has declined over the past 10 years due to outward migration (Williams et al. 2010). The communities of the NSB have mixed cash economies, in which both subsistence activities and wage employment provide food and income for households. Native Alaskans comprise 71 percent of the resident population; traditional subsistence activities and sharing play a central role in the maintenance of cultural values (USCB 2010a).

Per capita income in the NSB has increased slightly since 1993, but 20.8 percent of households in the NSB villages fall below the poverty level and the number of households at or near the federal poverty guidelines is increasing (Shepro et al. 2003). The cost of living in the NSB is high due to the cost of transporting goods and materials into remote communities. Unemployment is also high in all of the communities in the NSB; many communities have few available employment opportunities. In 2003, the NSB was the top employer of residents in the borough (Shepro et al. 2003). The oil and gas industry employed over 8,000 workers, but less than 1 percent of these were permanent residents of the NSB (QCEW 2009). The oil and gas industry also contributes to resident income through permanent fund dividends (PFD) and Native corporation dividends.

Oil and gas property taxes make up 97 percent of the property tax collected by the NSB and over 85 percent of the NSB's operating budget (NSB 2010a). Through taxes paid to the borough government, oil and gas revenues indirectly fund the bulk of the jobs, services, and capital improvement projects in the borough. Most utilities, community facilities, and public services are provided by the NSB.

3.15.2 Review and Adequacy of Information Sources for Socioeconomics

Data describing the social and economic structure of the Point Thomson study area is available from varied sources, including federal, state, and borough census efforts. Discrepancies in the scale and collection methods of sources make it difficult to select a single source of data for use in this analysis.

Demographic data is available from the U.S. Census Bureau's 2010 census. In 2010, changes in the enumeration of workers in the industrial enclaves of Deadhorse and Prudhoe Bay (Census Tract 3) resulted in the inclusion of roughly 2,500 nonresident workers in the total NSB population (HDR 2011j). In the past, workers at these locations were not considered residents of the NSB; less than 1 percent permanently resides in the NSB, while 72 percent live elsewhere in Alaska and 28 percent reside outside of the state (Hadland et al. 2011). The inclusion of the nonresident worker population in the 2010 Census numbers results in a dramatic increase in the reported population of the NSB and shift in the demographic characteristics of the borough. The nonresident workers are predominantly white and male. The nonresident worker population is also older than the resident NSB population.

Because of the skewed nature of the 2010 Census data for the NSB, this analysis also relied on Alaska Department of Labor and Workforce Development (ADLWD) population and demographic data for comparison purposes. The 2009 ADLWD demographic data, based on PFD applications, provides NSB-level demographic data that excludes nonresident workers and provides an accurate picture of NSB demographics. ADLWD demographic data is not available for individual communities in the NSB (Williams et al. 2010).

The American Community Survey (ACS) has replaced the U.S. Census long-form survey since the 2000 Census. The ACS uses a smaller sample size averaged over a 5 year period to evaluate social, economic, and demographic characteristics of the NSB. Thus far, the ACS has not proven as effective in providing data of similar quality as the U.S. Census long-form. The ACS's relatively small sample sizes and low response rates have led to high margins of error for small communities and populations. As a result, use of the ACS is limited to the borough-wide discussions.

The 2003 NSB Census, authored by Shepro et al., is used to provide economic and income data for the NSB and NSB communities. Like the ACS data, these data should also be viewed with caution as the response rate of income-related questions was low in many communities. This data is supplemented by the Internal Revenue Service's (IRS) Statistics of Income (SOI) and student Free and Reduced-Price Lunch (FRPL) eligibility to provide an analysis of how income and poverty levels have changed in NSB communities over time.

Data discrepancies also exist in employment and wage data. The ADLWD publishes a Quarterly Census of Employment and Wages (QCEW) data for the NSB. However, employment data is collected by place of work, not place of residence and these data sets include over 8,000 nonresident workers. The unemployment rate published by the ADLWD also incorporates nonresident workforce data and thus reports an unemployment rate far below other available estimates. This analysis uses the 2003 NSB census data of employment and unemployment as it provides a detailed picture of employment, breaking down workers by NSB-relevant sectors.

The discussion of community characteristics and culture is based on reviews of census data, community profiles, and project-related public outreach activities, including public scoping meetings and interviews with local residents. The Survey of Living Conditions in the Arctic (SLiCA) also provides several proxy measures of the culture and well-being of Iñupiat people in the Arctic (Poppel et al. 2007).

Table H-15 in Appendix H discusses the publications, reports, and data available for socioeconomic data that are cited in the Draft EIS and their relevance to the proposed project. Full references for the studies cited in the following text are in Chapter 9, References.

3.15.3 Demographics

The NSB consists of north and northeastern Alaska from the coast to the Brooks Range. The NSB is the largest borough in Alaska, comprising over 15 percent of the state's total land area. However, fewer than 7,000 people reside in the 88,800 square miles that the NSB encompasses–a population density of 0.08 persons per square mile. Most people reside in one of the eight communities (see Figure 3.15-1):

- Anaktuvuk Pass
- Atqasuk

- Barrow
- Nuiqsut
- Kaktovik
- Point Hope
- Point Lay
- Wainwright

Burch (1975) estimated that the population of the North Slope region, prior to European contact, was about 3,000 people. However, the first official population count in 1880 recorded 1,102 people living in the area now encompassed by the NSB (MMS 1989). The dramatic decline in the population after contact is attributed to disease, starvation, and alterations to traditional ways of life.

Table 3.15-1 presents population data for the NSB from 1980 to 2010. The NSB grew from 1,258 residents in 1939 to 7,385 residents in 2000, with an average annual rate of growth of 2.3 percent. The U.S. Census reports the population of the NSB in 2010 as 9,430, indicating an annual average growth rate of 2.4 percent over the last 10 years (USCB 2010a). The increase in reported population is almost entirely attributable, however, to changes in census methodology that resulted in the inclusion of roughly 2,500 nonresident workers in Deadhorse and Prudhoe Bay (see Section 3.15.2, Review and Adequacy of Information Sources, for more information). Excluding nonresident workers from the population, the 2010 population is closer to 6,900, suggesting an annual average decline of 0.7 percent (USCB 2010a). In comparison, ADLWD estimates the population in 2009 at 6,798 (Williams et al. 2010).

The NSB has the fourth highest birthrate of any borough or census area in Alaska, leading to a high natural rate of population increase. However, the NSB experienced a net loss of 1,824 people between 2000 and 2009 due to outward migration, the fourth highest loss of any borough or census area in the state (Williams et al. 2010). Population loss is common for regions in rural Alaska and is often influenced by the local economy, employment, and education opportunities (Williams et al. 2010).

Table 3.15-1: North Slope Borough Population, 1980 - 2010

	Year			
Community	1980	1990	2000	2010
Anaktuvuk Pass	203	259	282	324
Atqasuk	107	216	228	233
Barrow	2,267	3,469	4,581	4,212
Kaktovik	165	224	293	239
Nuiqsut	208	354	433	402
Point Hope	464	639	757	674
Point Lay	68	139	247	189
Wainwright	405	492	546	556
North Slope Borough Total	4,199	5,979	7,385	9,430*

Source: USCB 2010a
* NSB 2010a population includes nonresident workers in census tract 3 representing Prudhoe Bay and Deadhorse.

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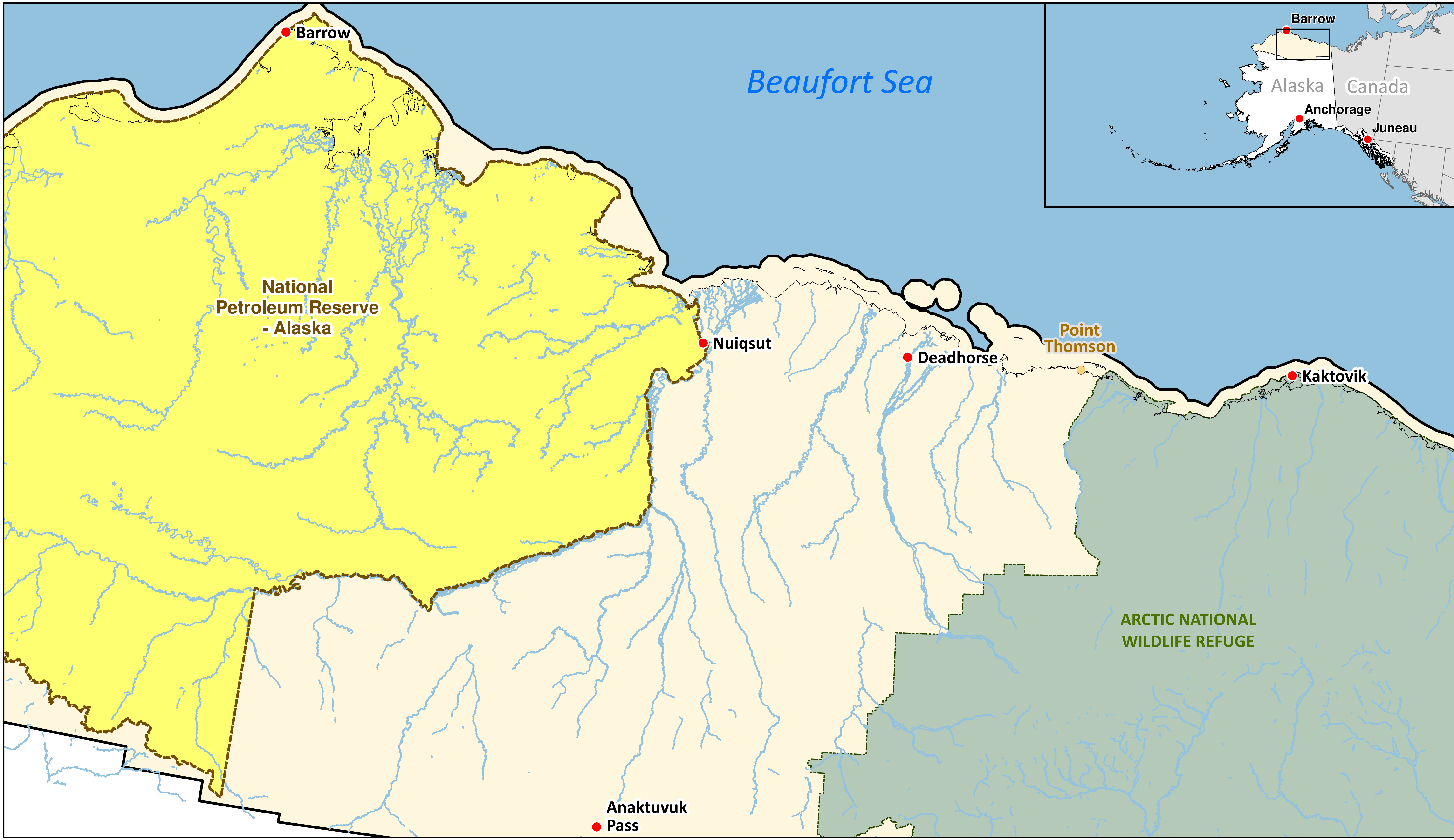

POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- North Slope Borough
- National Petroleum Reserve - Alaska
- Town
- Point Thomson Project

N

0 25 50 Miles

Figure 3.15-1

Point Thomson Project and Communities in the North Slope Borough

Date: 24 October 2010
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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Table 3.15-2 presents 2010 U.S. Census demographic data for the communities in the study area and the NSB. The population of the NSB is young. The 2010 U.S. Census reports the median age of the NSB as 35.1. This number is misleading, however, as it contains nonresident workers in Prudhoe Bay and Deadhorse, where the median age was 49.1 in 2010 (USCB 2010a). The ADLWD reports that the median age of the NSB in 2009 was 25.4 with 38 percent of the population under the age of 18, making it the fifth youngest population in Alaska and almost 7 years younger than the state median age (Williams et al. 2010). Between 2000 and 2009, the median age in the NSB declined by 1 year (Williams et al. 2010). According to the 2010 U.S. Census, over 60 percent of the population of the NSB is male. This value is also skewed by the inclusion of nonresident workers in the 2010 U.S. Census numbers; 90 percent of nonresident workers are male (USCB 2010a). The ADLWD reports that the resident population of the NSB is generally balanced between males (51.5 percent) and females (48.5 percent), comparable to the state population (Williams et al. 2010).

Most residents of the NSB classify themselves as one race: American Indian/Alaska Native. The 2010 Census shows that 67 percent of the population in the NSB is classified as minority (more than one race or single race other than white) and 54 percent are Alaska Native (USCB 2010a). The presence of nonresident workers, 85 percent of whom are white, again skews these values. Excluding Deadhorse and Prudhoe Bay populations, the NSB population is 86 percent minority and 71 percent Alaska Native. Alaska Natives make up 15 percent of Alaska's population (USCB 2010a).

Table 3.15-2: Demographics in the Point Thomson Area (2010)

Area	Anaktuvuk Pass		Kaktovik		Nuiqsut		NSB Total*	
General Characteristics	#	%	#	%	#	%	#	%
Total population	324	—	239	—	402	—	9,430	—
Male	180	55.6	125	52.3	208	51.7	5,904	62.6
Female	144	44.4	114	47.7	194	48.3	3,526	37.4
Median age (years)	27.0	—	30.5	—	25.5	—	35.1	—
White	23	7.1	24	10.0	40	10.0	3,147	33.4
Black or African American	1	0.3	0	0.0	1	0.2	94	1.0
American Indian and Alaska Native	270	83.3	212	88.7	350	87.1	5,100	54.1
Asian	0	0.0	0	0.0	0	0.0	425	4.5
Native Hawaiian and Other Pacific Islander	1	0.3	0	0.0	0	0.0	104	1.1
Some other race	0	0.0	0	0.0	0	0.0	67	0.7
Two or more races	29	9.0	3	1.3	11	2.7	493	5.2
Hispanic or Latino (of any race)	7	2.2	0	0.0	0	0.0	249	2.6
Average household size	3.27	—	3.29	—	3.47	—	3.34	—

Source: USCB 2010a

* NSB Total population includes nonresident workers in census tract 3, including Prudhoe Bay, Deadhorse.

Barrow is the largest and most racially diverse community in the NSB, making up 60 percent of the borough's population (USCB 2010a). The remaining seven villages in the NSB share similar characteristics with relatively small populations and a high percentage of Alaska Native residents. Kaktovik and Nuiqsut have populations of 239 and 402, respectively. Anaktuvuk Pass has a population of 324 (USCB 2010a). Both Anaktuvuk Pass and Nuiqsut were abandoned in the early 20th century, but repopulated in the 1940s and 1970s, respectively. Both communities experienced rapid population increases shortly after due in large part to net inward migration. Both Kaktovik and Nuiqsut have experienced a decline in population since 2000 (USCB 2010a).

The percentage of the population that were identified as Alaska Native in Kaktovik, Nuiqsut, and Anaktuvuk Pass was 89 percent, 87 percent, and 83 percent, respectively (USCB 2010a). This percentage was high relative to the NSB average, but similar to that of the other villages in the borough. The median ages in 2010 in Nuiqsut and Anaktuvuk Pass were similar to the median age reported for the NSB by the ADLWD (Williams et al. 2010). The median age in Kaktovik was slightly older and the population also had a large number of individuals under 24 and over 40 with few individuals in between (USCB 2010a).

In addition to the eight communities of the NSB, the industrial areas of Prudhoe Bay, Kuparuk, and Deadhorse represent a large concentration of people in the NSB. According to the ADLWD estimates, just three people were permanent residents in Deadhorse in 2009 but at any given time, between 5,000 and 7,000 workers may be found in the area on a two week rotation in the oil fields (Williams et al. 2010).

3.15.4 Community Characteristics and Culture

Many factors contribute to the economic and social characteristics and culture of communities on the North Slope. The Arctic Human Development Report (AHDR) observed that in addition to common measures of human development (which include standards of living, health, and education) other region-specific factors should be considered when evaluating human development in the Arctic (AHDR 2004). Factors to be considered in the discussion of community characteristics include community history, governance, and maintenance of traditional values, including subsistence activities and language retention. Discussion of Cultural Resources, Subsistence and Traditional Land Use Patterns, and Health can also be found in Sections 3.21, 3.22, and 3.23, respectively.

3.15.4.1 North Slope Borough

The ancestors of the Iñupiat people have lived on the North Slope for millennia and were active in harvesting marine and land mammals and maintaining an extensive trade network in the region. European contact in the early to mid 1800s changed many aspects of the Iñupiats' way of life and instigated sequential boom and bust economic cycles. Commercial whaling, fur trading, and reindeer herding all served a turn as the dominant economic activity in the region from the mid 1880s to the 1940s (MMS 1989). Oil exploration in the 1960s led to the oil development in Prudhoe Bay and the TAPS in the 1970s.

The discovery of oil instigated a movement for increased local control over natural resources and governance in the region. The passage of the ANCSA in 1971 and the formation of the NSB in 1972, in response to the discovery of oil, were two key events that changed the social, economic, and political lives of the Inupiat people on the North Slope (NRC 2003a). The formation of the NSB allowed residents to capture some of the benefits of oil and gas development by providing a mechanism to tax the oil and gas industry. With oil and gas tax income, NSB succeeded in providing new services, infrastructure, and employment opportunities to residents. ANCSA allowed for the incorporation of the ASRC and eight Native corporations to hold the title to selected lands and manage cash settlements from oil development.

The communities of the NSB are rural and only accessible by ice road, water, or air. The Dalton Highway provides the only year-round road access to the area from Fairbanks to Deadhorse. It does not provide direct access to any of the NSB communities. Passengers commonly travel by air while goods are brought in by air, truck on the Dalton Highway, or barge during the open water season. Goods are often shipped through Deadhorse or Barrow to the more remote communities (ADCCED 2011).

Traditional Iñupiat values are an important part of the life and culture of the communities in the region. These values focus on the close ties that the Iñupiat share with natural resources, family and kin, and others in the community. Iñupiat values, including a respect for nature, cooperation, sharing, and hunting traditions, are directly reflected in subsistence activities and practices. Others, such as knowledge of language, family and kinship, humor, compassion, love and respect for elders, humility, avoidance of conflict, and spirituality reflect cultural continuity and the strong personal ties within the communities of the NSB. Although there have been substantial social, economic, and technological changes to the Iñupiat way of life, traditional values continue to provide the framework for many Native residents (NSB 2011wb).

Language retention is one measure of cultural continuity among Inupiat people. In 2007, 44 percent of residents in the North Slope Region reported that they spoke Inupiaq very well and 48 percent of residents report that they understood it very well. Forty-five percent of respondents reported being very satisfied with the promotion of cultural values in their community (Poppel et al. 2007). These values were higher than the averages reported for other regions in northern Alaska. Participation in subsistence activities provides an additional measure of cultural continuity and ties to nature. Throughout the borough, traditional marine mammal hunts and other subsistence practices continue to be an active part of the culture. Subsistence participation is discussed below and in Section 3.22, Subsistence and Traditional Land Use Patterns.

Education is an important indicator of community development and well-being. The school attendance rate in the NSB School District in 2009/2010 was 85 percent, lower than for the state at 92 percent, but comparable to other rural school districts in northern Alaska (ADEED 2011a). The adult population of the NSB has a lower level of educational attainment compared to the state average but is also comparable to other rural regions. From 2005 to 2009, an average of 80 percent of the adults over the age of 25 had graduated from high school as compared to 91 percent in Alaska (ACS 2005-2009). The trend in educational attainment in the NSB has been improving. In the last twenty years, the percent of high school graduates in the population over 25 has risen from 68 percent in 1990 to 77 percent in 2000 (U.S. Census Bureau 1990, 2000).

3.15.4.2 Kaktovik

Kaktovik lies on the north shore of Barter Island, between the Okpilak and Jago Rivers on the Beaufort Sea coast. The village is located 90 miles west of the Canadian border and 310 miles southeast of Barrow. Kaktovik is adjacent to the northern edge of the 19.6-million-acre Arctic Refuge (see Figure 3.15-1). Access to Kaktovik is provided by scheduled airline and air taxi service from Barrow and Fairbanks. Freight is transported to the village by barge in the summer and by air year-round (ADDCED 2011).

Until the late nineteenth century, Barter Island was an important trading center for the Iñupiat from Alaska, Inuit from Canada, and Athabascans from south of the Brooks Range. The community was permanently established in 1923 when fur trader Tom Gordon moved his trading post to Barter Island, near the site of a precontact settlement (Jacobson and Wentworth 1982). During the 1930s and 1940s, the decline of the fur market, crash of the reindeer herd, and an especially harsh winter brought many people close to starvation and dispersed the population (Jacobson and Wentworth 1982).

In 1947, the construction of the DEW Line system and radar installation brought significant employment to Kaktovik, which attracted residents from other communities on the North Slope, including nonnatives. In 1970, Kaktovik had the highest percentage of nonnative residents of any village on the North Slope (MMS 1989). The city was incorporated in 1971 and the DEW line was decommissioned in 1987 and replaced with minimally attended radar equipment (MMS 1989). More details on the history of Kaktovik can be found in Section 3.21, Cultural Resources.

The KIC has the right to select 92,160 acres of federal land in the Kaktovik area. A 1983 land trade with the U.S. Department of the Interior gave the ARSC subsurface rights to KIC lands. While the lands have been identified as having oil and gas potential, development cannot occur unless Congress opens the coastal plain in the Arctic Refuge to oil and gas leasing.

The people of Kaktovik have maintained traditional Iñupiat practices. Subsistence harvests in Kaktovik are highly dependent on marine mammals, specifically bowhead whales and bearded seals, and caribou. Subsistence activities play a large role in both cultural and economic activities. In 2003, approximately 93 percent of Iñupiat households and 80 percent of nonnative households in Kaktovik participated in the local subsistence economy. Sixty-eight percent of all Kaktovik households reported that half or more of their diet consisted of local subsistence resources, a decrease from 83 percent in 1998 (Shepro et al. 2003). More information on subsistence practices and usage is discussed in Section 3.22, Subsistence and Traditional Land Use Patterns.

Residents of Kaktovik identified community concerns as part of the 2011 Kaktovik Comprehensive Land Use Plan. Many of the issues raised centered on land ownership and use, including tourist use of tribal lands for recreation. Other issues identified included climate change, negative impacts on wildlife from scientific studies, and the need to improve communication and coordination with USFWS. Kaktovik residents expressed the desire for increased local employment opportunities and additional community facilities (NSB in draft).

3.15.4.3 Nuiqsut

Nuiqsut is located on the west bank of the Nechelik Channel of the Colville River Delta, about 35 miles from the Beaufort Sea coast and 135 miles southeast of Barrow (see Figure 3.15-1). It is located in the northeast section of the NPR-A, and is 8 miles south of the Alpine Oil Field (Alpine; URS 2005). The community is accessible by air year-round and by water in the summer. Since the construction of Alpine, residents have winter ground transportation access via an ice road connecting the community to the Kuparuk Oil Field. From Kuparuk, residents can access the all-season road system to Deadhorse, Fairbanks, and Anchorage (Haley et al. 2008).

The Colville Delta has traditionally been a subsistence harvest, gathering, and trading place for the Iñupiat. Archaeological evidence in the lower Colville River region suggests occupation dating back at least 500 years (Libbey et al. 1979). The arrival of nonnative peoples, the introduction of the whaling industry, and the subsequent crash in the population of the caribou herd dramatically changed the way of life for Iñupiat in the Colville Delta. The old village of Nuiqsut was abandoned in the late 1940s but was resettled in 1973 by 27 families (approximately 145 people) from Barrow (Libbey et al. 1979). The city was incorporated in 1975 (URS 2005).

The Kuukpik Corporation (KC) has rights to select 115,200 acres of federal land in the Nuiqsut area. In 2005, 69,880 acres had been patented to the corporation; KC also owns 46,400 acres within the NPR-A (URS 2005). ASRC owns the subsurface rights to KC lands as well as other lands in the Nuiqsut area.

The discovery of Alpine, under land owned by KC, brought significant change to Nuiqsut. Alpine is one of the largest discoveries of oil in the United States in recent decades. Ownership of 50 percent of the oil field surface lands by KC and subsurface lands by ASRC provided important leverage for NSB and Nuiqsut residents in the development at Alpine (Haley 2008). In the surface-use lease agreement and pipeline right-of-way negotiations, KC secured a royalty share in the oil, 500,000 cu ft of natural gas per year, use of winter ice roads, hunting and fishing access, first preference for work to KC and its eight joint ventures, good faith hire for Nuiqsut residents, matching funds for scholarships for industry job training, and one million dollars at closing in annual land rents and production payments (Haley et al. 2008). In 2007, the value of KC's royalty share was more than $10 million per year and its joint ventures had received approximately $250 million in contract work related to Alpine (Haley et al. 2008).

The majority of the population of Nuiqsut is Iñupiat for whom subsistence practices represent important economic and cultural activities. Caribou, bowhead and beluga whale, seal, moose, and fish are staples of the subsistence diet (ADCCED 2011). In 2003, 81 percent of households and 95 percent of Iñupiat residents reported participating in subsistence activities. Sixty-three percent of residents reported that half or more of their diet consisted of local subsistence resources (Shepro et al. 2003). The Kuukpik Subsistence Oversight Panel receives $60,000 annually from ConocoPhillips Alaska to monitor oil field development and mitigate potential subsistence impacts (URS 2005).

Issues, concerns, and comments were gathered from residents in Nuiqsut as part of the 2005 NBS Comprehensive Plan process. Many of the concerns centered on issues related to nearby oil development and resulting impacts to subsistence use, access, local control, and governance (URS 2005).

3.15.4.4 Anaktuvuk Pass

Anaktuvuk Pass, at 2,200 feet elevation in the central Brooks Range, is the last remaining settlement of the Nunamiut (inland northern Iñupiat). The village is located on the divide between the Anaktuvuk and John Rivers (see Figure 3.15-1), 250 miles northwest of Fairbanks and about the same distance south of Barrow in Gates of the Arctic National Park and Preserve (URS 2005). Year-round access to Anaktuvuk Pass is limited to transportation by airplane. In the winter, "cat-trains" are used to transport cargo from the Dalton Highway (ADCCED 2011).

The Nunamiut have lived in the region for over 4,000 years, depending on caribou hunting and supplementing their inland subsistence resources with blubber, seal skins, and other goods obtained in trade with coastal Iñupiat (MMS 1989). The population is 83 percent Iñupiat and subsistence activities play a large role in both cultural and economic activities. Caribou is the primary source of meat; other subsistence foods include fish, moose, sheep, brown bear, ptarmigan, and water fowl (ADCCED 2011). Subsistence goods are commonly traded between the communities of Anaktuvuk Pass, Nuiqsut, and Kaktovik. More information on subsistence practices and sharing in Anaktuvuk Pass is discussed in Section 3.22, Subsistence and Traditional Land Use Patterns.

3.15.4.5 Barrow

Barrow, the northernmost community in the United States, is located on the Chukchi Sea coast 10 miles south of Point Barrow, on the northern edge of the NPR-A (see Figure 3.15-1). Barrow is the regional hub and the seat of the NSB government. ASRC is also headquartered in Barrow as well as most regional organizations, including the regional health and social services provider, low income housing provider, the Alaska Eskimo Whaling Commission, Ilisagvik College, and other regional nonprofits (ADCCED 2011). As a result of these organizations, much of the outside funding, including grants, state, and federal funding, allocated for communities in the NSB flows through Barrow. Barrow also serves as a regional hub for goods and materials that enter the region. Jet service and cargo planes provide year-round access to Barrow. Barges are used to transport freight in the summer (NSB 2011wb).

Barrow is the most racially diverse community in the NSB. In 2010, 61 percent of the population of Barrow was Alaska Native; other notable populations include white (17 percent) and Asian (9 percent) (USCB 2010a). Subsistence practices are a major part of the economy and culture, primarily for the Iñupiat residents. The subsistence culture is centered on the annual harvest of the bowhead whale, an activity that provides key social and community organization (ADCCED 2011). More information on subsistence practices is discussed in Section 3.22, Subsistence and Traditional Land Use Patterns.

3.15.4.6 Deadhorse

Deadhorse is located a short distance from the Beaufort Sea coast at the northern end of the Dalton Highway. Deadhorse exists to support the needs of the oil and gas industry in the NSB (ADCCED 2011). Deadhorse has few full-time residents (three people in 2009), but supports a transient population of 5,000 to 7,000 workers that rotates in and out of the oil field work sites (Williams et al. 2010).

Other than the Dalton Highway, there are no public roads out of Deadhorse to the surrounding communities. Private roads are built and maintained by the oil companies and access may be obtained with permission. Barges access Prudhoe Bay during the open-water season. The Deadhorse Airport provides charter flights and regularly scheduled, commercial flights to Anchorage and Barrow. Road access is important to the area because hauling goods and materials by truck is cheaper than barge or air.

3.15.5 Employment

Table 3.15-3 shows employment in the NSB by sector. The NSB is the largest employer of residents in the borough, directly employing 32 percent of the resident population in 2003. The NSB School District, the eight village corporations, the service industry, and ASRC were also top employers (Shepro et al. 2003). Unemployment in the NSB is high, however. In 2003, unemployment in the region was over 22 percent and just 57.5 percent of the labor force was employed full time (Shepro et al. 2003). Since 1998, the number of permanent full time jobs has decreased while the number of residents who are unemployed or employed part time has increased (URS 2005).

Table 3.15-3: Estimated Number of Resident Jobs by Sector, North Slope Borough (2003)

	Anaktuvuk Pass		Kaktovik		Nuiqsut		NSB Total	
Sector	#	%	#	%	#	%	#	%
NSB Government	51	38.9	27	32.1	29	24.0	705	32.2
NSB School District	30	22.9	21	25.0	27	22.3	409	18.7
Village Corporations	19	14.5	18	21.4	37	30.6	295	13.5
Other	2	1.5	3	3.6	10	8.3	108	4.9
Service	4	3.1	0	0.0	0	0.0	88	4.0
ASRC	3	2.3	5	6.0	3	2.5	66	3.0
City Governments	12	9.2	3	3.6	5	4.1	62	2.8
Ilisagvik College	0	0.0	0	0.0	0	0.0	61	2.8
Federal Government	1	0.8	1	1.2	0	0.0	53	2.4
Transportation	0	0.0	0	0.0	1	0.8	43	2.0
Private Construction	4	3.1	5	6.0	3	2.5	31	1.4

Table 3.15-3: Estimated Number of Resident Jobs by Sector, North Slope Borough (2003)								
	Anaktuvuk Pass		Kaktovik		Nuiqsut		NSB Total	
Sector	#	%	#	%	#	%	#	%
Trade	0	0.0	0	0.0	0	0.0	26	1.2
State Government	2	1.5	0	0.0	1	0.8	23	1.0
Oil Industry	3	2.3	1	1.2	3	2.5	10	0.5
NSB Capital Improvement Projects	0	0.0	0	0.0	2	1.7	8	0.4
Communications	0	0.0	0	0.0	0	0.0	6	0.3
Finance	0	0.0	0	0.0	0	0.0	197	9.0
Total Employment	131		84		121		2191	
% Unemployed		20.1		14.1		16.6		22.9
% Employed Full Time		37.5		58.6		37.2		57.5

Source: Shepro et al. 2003

The NSB, NSB School District, and city governments are the primary public sector employers; the public sector provides 61 percent of resident employment in the region (Shepro et al. 2003, ACS 2005-2009). Public sector employment has declined since 1998 (Northern Economics 2006). In the private sector, ASRC, the village corporations, and the service sector are the top employers although the private sector provides just 36 percent of resident employment in the borough (Shepro et al. 2003, ACS 2005-2009). Since 1998, employment in the construction sector has declined while service sector employment increased (Northern Economics 2006). Commercial fishing provides additional employment opportunities in the North Slope area; in 2008, six borough residents held commercial fishing permits (ADCCED 2011).

Unlike resident employment, total employment in the NSB, which includes both resident and nonresident workers, is dominated by the private sector. There were 13,670 jobs held by both residents and nonresidents in the NSB, with over $1,140 million earned in total wages in 2009 (QCEW 2009). The public sector made up just 15 percent of total employment and 8 percent of total wages. The private sector made up 85 percent of total employment and 92 percent of the total wages earned. Within the private sector, 62 percent of jobs are within the oil and gas industry, which includes extraction and oil and gas support services; these jobs provide 74 percent of the total wages earned in the NSB (QCEW 2009). Despite the availability of over 8,000 oil industry-related jobs in the NSB, just 23 residents were directly employed in the oil industry in 2003 (Shepro et al. 2003). Some of the employment with the regional and village corporations is also indirectly related to the oil industry through support and contract work.

Employment on a community level mirrors the trends within the NSB. The borough government is one of the top employers in all of the communities within the study area. The NSB, NSB School District, and the village corporations account for over 75 percent of the employment in Kaktovik, Nuiqsut, and Anaktuvuk Pass. Unemployment is also high in these three communities, ranging between 16 and 21 percent; less than 60 percent of the labor force is employed full time (Shepro et al. 2003). Employment in Nuiqsut differs slightly from other communities in the NSB as the Kuukpik Corporation is the top local employer (Shepro et al. 2003). The KC runs the local store and participates in eight joint ventures that have first preference for contract work at Alpine. The Alpine surface-use agreement stipulated programs include internships and job training opportunities for Nuiqsut residents and financial incentives for contractors to hire locals.

3.15.6 Income

The oil and gas industry has limited direct impact on the income of residents of the NSB through employment, but it funds most of the economic activity in the region through royalties, property taxes, and dividends. The primary route by which oil and gas revenues impact residents of the NSB is by providing over 98 percent of the tax base and 85 percent of the revenue of the borough government (NSB 2010a). Through the NSB, oil and gas property taxes indirectly fund the bulk of the jobs, services, and capital improvement projects in the borough. The NSB and some communities have also received funding for capital projects from NPR-A Impact Mitigation Grants distributed from revenues earned from oil and gas leases in the NPR-A (ADCCED 2011).

Other indirect impacts of oil and gas revenue include the state PFD (annual dividend checks for Alaska residents based on the investment of oil and gas royalties), and dividends from ASRC and village corporations whose subsidiaries provide services to companies operating in Prudhoe Bay. Iñupiat residents receive yearly dividends from these corporations. Annual revenues of ASRC were about $1.9 billion in 2009 and $2.3 billion in 2010; in 2009, the total dividends distributed were $60.9 million, or an average of $5,500 per shareholder (ASRC 2011). Dividends made up 8.5 percent of total personal income of NSB residents in 2008.

Economic indicators, however, do not necessarily fully capture activities related to subsistence activities or the cultural value that these activities represent. Furthermore, full time employment may not always be desirable, as time spent on wage work can often conflict with subsistence activities. The SLiCA data reports that 65 percent of Native residents in NSB communities believe that a combination of paid employment and subsistence harvesting is the most attractive way of life while just 27 percent would choose paid employment only. In the NSB villages, the preference for a lifestyle that includes both paid income and subsistence harvest is even higher at 73 percent (Poppel et al. 2007).

Table 3.15-4 provides income data for the communities of Kaktovik, Nuiqsut, and Anaktuvuk Pass, and for the NSB as a whole. In 2003, the per capita income in the NSB was $24,932 per year, compared with a state-wide per capita income of $32,604 per year (Shepro et al. 2003, Williams et al. 2006). Per capita income, adjusted for inflation, increased over 50 percent between 1993 and 2003 (Shepro et al. 2003). The nominal dollar value of median household incomes in the borough has also increased since 1993, but when adjusted for inflation, is found to have decreased by 1.5 percent between 1993 and 2003 (Shepro et al. 2003).

Per capita income in all three communities was low relative to the per capita income of the NSB as a whole. Community income statistics census should be interpreted with caution, particularly for Nuiqsut where 35 percent of households failed to report income information (Shepro et al. 2003). See Section 3.15.2, Review and Adequacy of Information Sources for additional discussion. Kaktovik experienced the largest increase in nominal per capita income between 1993 and 2003; median household and per capita income in Nuiqsut also increased (Shepro et al. 2003). Per capita income in Anaktuvuk Pass decreased between 1998 and 2003.

Table 3.15-4: Resident Income in the Point Thomson Area (2003)				
Area	Anaktuvuk Pass	Kaktovik	Nuiqsut	North Slope Borough Total
Economic Characteristics				
Median household income(in 2003 dollars)	$36,000	$57,000	$55,000	$55,793
Per capita income (in 2003 dollars)	$11,437	$17,889	$13,633	$24,932
Households below poverty level (percent)	36.7 %	7.3 %	18.5%	20.8% *

Source: Shepro et al. 2003
* Barrow not included

The IRS's SOI provide more recent data on income in the communities in the project area over time. Adjusted for inflation, per capita adjusted gross income has increased slightly in the NSB, from $20,762 in 2001 to $21,307 in 2007 (IRS 2003, 2006, 2010). In that time, the communities of Barrow and Nuiqsut both experienced an increase in per capita adjusted gross income, with both communities exceeding the NSB income per capita in 2007. In contrast, Kaktovik and Anaktuvuk Pass experienced a decrease in adjusted gross income per capita, falling by 18 percent to $18,912 and 30 percent to $12,234, respectively in 2007 (IRS 2003, 2006, 2010). These values are not directly comparable to the NSB Census per capita income.

The increase in per capita adjusted gross income in Nuiqsut between 2001 and 2007 is largely a result of an increase in dividends income, which made up 30 percent of total adjusted gross income in 2007 (IRS 2003, 2006, 2010). The reported amount of salaries and wages in the adjusted gross income in Nuiqsut actually fell between 2001 and 2007. Dividends income for the rest of the borough made up just 11 percent of total adjusted gross income (IRS 2003, 2006, 2010). The increase in dividends income is due in part to an increase in dividend payouts from the Kuukpik Corporation. In 2010, the average KC shareholder received between 12,000 and 20,000 in dividend payout from KC (NSB n.d.).

Despite an increase in per capita income, poverty levels in the NSB are still high and have increased since 1998 (Shepro et al. 2003). The 2003 NSB Census reported that 20.8 percent of households in the NSB villages (excluding Barrow) were below the poverty level. The percent of families under the poverty level in the state in 2003 was about 8 percent (±1.3 percent; ACS 2005-2009). Anaktuvuk Pass had the highest percentage of households below the poverty level (Shepro et al. 2003). Higher per capita incomes in the borough also may not translate into increased purchasing power because residents of rural Alaska must pay to transport consumer goods into these communities. In 2008, the cost of living in the Arctic region was 48 percent higher than in Anchorage (McDowell Group 2009). Finally, income is not distributed evenly among the NSB population. In 2003, the median income of Alaska Native households ranged between 45 and 66 percent of the median income of white households in Anaktuvuk Pass, Kaktovik, and Nuiqsut (Shepro et al. 2003).

The number of students eligible for the FRLP program provides a measure of income and households living near the poverty level in each community over time. To qualify for free lunches or reduced price lunches, a household's monthly income must fall at or below 130 percent or 185 percent, respectively, of the federal poverty guidelines, which are adjusted for the higher costs of living in Alaska. Between 2006 and 2011, the percentage of students qualifying for the FRPL program in the NSB increased significantly, from 26 percent in 2005 to 45 percent in 2011. Excluding Barrow, the percentage of students qualifying from the NSB villages in these years was even higher, rising to 64 percent in 2011. Despite the increase in students qualifying for the FRLP, the percentage of qualifying students in Nuiqsut was below both the borough and state averages. Over the last 5 years, an average of 30 percent of students qualified in Nuiqsut; 34 percent qualified in 2011. In contrast, over 80 percent of students in Kaktovik qualified for the FRPL program in 2011 (ADEED 2011b).

3.15.7 Tax Base

The NSB economy is primarily fueled by oil revenues; oil and gas properties provide 98 percent of the tax base and 85 percent of the revenue for the borough. This funding allows the borough government to provide public services to all of the communities. The NSB calculates the tax levied on oil and gas property based on Alaska Statutes that limit the rate at which the borough can tax property for operating expenses (AS 29.45.080). The NSB is not limited, however, on its ability to raise money for capital projects through raising bonds. Since its formation, the NSB has raised billions of dollars for capital projects by selling bonds and taxing oil and gas property to retire new bond indebtedness (Northern Economics 2006). As a result, the NSB has the highest per capita tax revenue in the state, nearly double that of the next highest municipality or borough, but it also had a per capita debt load of $55,403 in 2003, 15 times the state average (Northern Economics 2006). The actual and true full property value of the NSB's assets was valued over $12 billion in 2009 (NSB 2010a).

From 2006 to 2010, the percentage of the NSB revenue received from taxes levied on oil and gas properties rose from 70 to 88 percent of total revenue (NSB 2010a). The total general fund revenue in 2009/2010 was over $306 million, $270 million of which was from oil and gas property taxes. The borough received an additional $10 million from returns on investments of past property tax collected, although investment income has declined in recent years. The state and federal governments provide some funding to the borough; total funding from these sources was less than 3 percent of total revenue. The borough also collected service charges for utilities and received gaming revenue (NSB 2010a). Between 2000 and 2010, the NSB also received over $95 million in NPR-A Impact Mitigation Grants for planning, public services, and the construction and operation of public facilities (ADCCED 2011).

Oil and gas tax revenue rose rapidly from the borough's inception to peak at $240 million in 1986. Since 1986, however, tax revenue has declined due to depreciation in the value of oil and gas facilities (Northern Economics 2006). Due to facility depreciation, tax revenue and bonding capacity is projected to continue to decline, particularly in the short term. Increases in revenue would be contingent on new oil and gas developments. The NSB has also experienced a decline in investment income and in grants and funding provided by the state and federal governments (URS 2005). One of the goals of the NSB's 2005 Comprehensive Plan was to address the decline in revenues and identify potential nonprofit, state, and federal partners to help maintain services for residents (URS 2005).

NSB expenditures fall into three categories: operating expenses, debt service, and capital expenditures. Capital expenditures are primarily funded by bonds, whereas operating expenses and debt service come out of the general fund revenue. In 2009/2010, the NSB budgeted about 50 percent of its operating budget for NSB departments, and an additional 12.7 percent for the school district and college. Fifty percent of the departmental budget was allocated for employee salaries. The public works, administration and finance, and health departments received the largest portion of the departmental budget. The remaining 35 percent of revenue services the NSB's debt (NSB 2010a).

3.15.8 Housing

There are 2,708 housing units in the NSB, 2,079 of which are in the communities of Anaktuvuk Pass, Barrow, Kaktovik, and Nuiqsut (ACS 2005-2009). Occupancy rates in the NSB ranged between 68 and 81 percent. However, the presence of vacant housing does not indicate that there are no housing needs in the communities. The Kaktovik and Nuiqsut Comprehensive Land Use Plans identified the need for additional housing in both communities. Many households are overcrowded and some homes are in need of repair to become livable. The average household size in the borough was 3.27 people per household, above the 2.82 average in the state (ACS 2005-2009).

Tagiugmiullu Nunamiullu Housing Authority (TNHA) is the primary provider of low income housing in the NSB. Due to the cost of maintaining and repairing rental properties in remote communities, TNHA is in the process of selling its single family homes. Tenants are eligible to buy the homes at a discounted price and with a lease-to-purchase agreement so that their mortgage does not exceed their current rent. While encouraging home ownership, the loss of available rental properties makes it difficult for young families to find housing. Housing for elders is also an issue. TNHA recently built housing for elders in many of the NSB villages with funding from the U.S. Department of Housing and Urban Development (HUD). Native elders who receive dividends from ASRC and the village corporations often exceed HUD income requirements for senior housing and are not eligible to live in the new developments (NSB in draft).

3.15.9 Utilities, Community Facilities, and Public Services

The availability of utilities is increasing in most communities due to the recent completion of several capital improvement projects. This analysis also considers schools, health, and community facilities.

3.15.9.1 Kaktovik

The NSB provides all utilities to Kaktovik. Piped water and sewer systems are operated by the NSB Public Works Department (PWD) and service 90 percent of the households in the community. Approximately 98 percent of households use diesel fuel for heating (Shepro et al. 2003). Heating fuel is subsidized by the NSB and costs significantly less than the statewide average (AEA 2011). Electricity is generated using diesel fuel and is operated by the NSB (URS 2005).

Community services and facilities include a health clinic, senior housing, a city/community hall, and school/community library. In 2009-2010, the Harold Kaveolook School served 58 students from preschool through high school and employed 6 teachers (ADEED 2011a).

3.15.9.2 Nuiqsut

The NSB provides all utilities in Nuiqsut. Piped water and sewer systems were constructed in 2001 and are operated by the NSB PWD. Due to recent infrastructure improvement, 88 percent of residents have piped water service and 90 percent of residents have flush toilets (Shepro et al. 2003). The surface-use agreement between KC and ConocoPhillips Alaska provides natural gas for electricity generation and for the heating of homes and other facilities. The NSB constructed the transmission pipeline and processing facility; Nuiqsut residents only pay for the operations and maintenance costs of the system, resulting in some of the lowest energy rates in the state (AEA 2011).

Community services and facilities include a health clinic, community center, recreation center, and school library. In 2009-2010, the Nuiqsut Trapper School served 106 students grades preschool through 12 and employed 10 teachers (ADEED 2011a).

3.15.9.3 Anaktuvuk Pass

The NSB provides all utilities within Anaktuvuk Pass. In 2003, an estimate of 90 percent of households had running water and flush toilets (Shepro et al. 2003). Heating fuel is subsidized by the NSB and costs significantly less than the statewide average. Electricity is generated using diesel fuel (URS 2005). Community services and facilities include a health clinic, a senior/teen center, a city hall recreation building, a borough museum, and a school library. In 2009-2010 the Nunamiut School served 86 students from preschool through high school and employed 9 teachers (ADEED 2011a).

3.15.9.4 Barrow

The Barrow Utilities & Electric Cooperative operates the water and sewage treatment plants, generates and distributes electric power, and distributes piped natural gas for home heating. Electricity is generated using subsidized natural gas, resulting in electricity rates that are 30 percent lower than other borough communities (AEA 2011). As the economic and administrative hub of the NSB, many regional health and social services are located in Barrow. The Samuel Simmonds Memorial Hospital is a qualified acute care facility and State-certified Medevac Service. Other facilities include a health clinic, children’s receiving home, prematernal home, senior center, and family services center. Community facilities also include a youth center, community hall, Iñupiat Heritage Center museum, recreation center, and library (URS 2005). Barrow is home to several research facilities, including the Naval Arctic Research Laboratory and the Barrow Arctic Research Center (ADEED 2011a).

3.15.9.5 Deadhorse

In 1975 the NSB established Service Area 10 to provide utilities to industrial customers in the Deadhorse and Prudhoe Bay area, including solid waste collection and disposal, potable water production and distribution, and sanitary waste collection and disposal. The NSB provides police protection in the area, but does not provide housing, social services, or community services to Deadhorse/Prudhoe Bay.

3.16 ENVIRONMENTAL JUSTICE

The study area for environmental justice concerns mirrors that of socioeconomics. It includes the entire NSB with a focus on the communities of Kaktovik, Nuiqsut, and Anaktuvuk Pass.

3.16.1 Key Information About Environmental Justice

Federal agencies are required to consider impacts on minority and low-income populations (Executive Order No. 12898) and determine if a project would result in a "disproportionately high and adverse effect on minority or low-income populations." In the NSB, 67 percent of the population is classified as a minority (more than one race or a single race other than white; USCB 2010a). The minority population of the NSB is predominantly Native Alaskan. The communities of Kaktovik, Nuiqsut, and Anaktuvuk Pass have an even higher percentage of minority residents than the NSB as a whole.

The 2003 NSB Census reported that 20.8 percent of households in the villages of the NSB had incomes below the poverty line. Eligibility for FRPL programs, based on federal poverty guidelines specific to Alaska, suggest that the number of households that are at or near the poverty guideline has increased over the last 5 years. Thus, any adverse impacts of the project may affect minority or low-income populations.

3.16.2 Review and Adequacy of Information Sources for Environmental Justice

Demographic and income data for the NSB and the communities in the project area are available from the 2010 U.S. Census, the 2003 NSB Census, the American Community Survey (ACS), and the ADLWD Population Estimates. A full discussion of each of these data sets, including their strengths, limitations, and applicability to this Draft EIS, can be found in Section 3.15, Socioeconomics. Table H-16 in Appendix H discusses the publications, reports, and data available for transportation data that are cited in the Draft EIS and their relevance to the proposed project. Full references for the studies cited in the following text are in Chapter 9, References.

3.16.3 Environmental Justice Population

Executive Order 12898 mandates that federal agencies are required to consider impacts on minority and low-income populations and determine if a project would result in a "disproportionately high and adverse effect on minority or low-income populations." The CEQ guidance on evaluating environmental justice impacts under NEPA recommends that the consideration of a "disproportionately high and adverse effect" include:

(a) Whether there is or will be a major impact on the natural or physical environment that adversely affects a minority population, low-income population, or Indian tribe. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment; and

(b) Whether major environmental effects are or may be having an adverse impact on minority populations, low-income populations, or Indian tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group; and

(c) Whether the environmental effects occur or would occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards.

The CEQ guidance on environmental justice defines minorities to include "individuals who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic." Minority populations for environmental justice considerations should be identified where either the minority population of the affected area exceeds 50 percent, or the minority population percentage of the study area is meaningfully greater than the minority population percentage in the general population (CEQ 1997a). Low-income populations are identified using the annual statistical poverty threshold from Census Bureau's Current Population Reports Series P-60 on Income and Poverty. Under these definitions, the population of the NSB qualifies as a minority and low-income population and requires an evaluation of the potential disproportionate impacts of the Point Thomson Project. Population characteristics of the NSB and communities in the project area are summarized in Table 3.16-1. Additional demographic information can be found in Section 3.15, Socioeconomics.

Table 3.16-1: Summary of Population Characteristics

	Population[a]	Median Age[a]	% Native Residents[a]	% Minority Residents[a]	Per Capita Income **(2003)[b]**	% Households Below Poverty level (2003)[b]
State of Alaska	710,321	33.8	14.8	33.3	24,361	8.0
NSB[c]	9,430	35.1	54.1	66.7	24,932	20.8
Anaktuvuk Pass	324	27.0	83.3	92.9	11,437	36.7
Kaktovik	239	30.5	88.7	90.0	17,889	7.3
Nuiqsut	402	25.5	87.1	90.0	13,633	18.5

Source: [a]USCB 2010a; [b]Shepro et al. 2003
[c]NSB Total population includes nonresident workers in census tract 3, including Prudhoe Bay, Deadhorse.

In 2010, 67 percent of the population of the NSB was identified as a minority, predominately Native Alaskan (USCB 2010a). In addition to a large Native population (54.1 percent), the population of the NSB includes Asian (4.5 percent) and Hispanic or Latino populations (2.6 percent), as well as those who identify themselves as "two or more races" (5.2 percent). Minority populations in the communities of Kaktovik, Nuiqsut, and Anaktuvuk Pass are higher than in the NSB as a whole (67 percent) and in the State of Alaska (33 percent; USCB 2010a).

The populations of the Kaktovik, Nuiqsut, and Anaktuvuk Pass also qualify as low-income relative to the NSB as a whole and the State of Alaska. In 2003, the NSB Census reported that 20.8 percent of households in the villages of the NSB (excluding Barrow) live below the poverty line (Shepro et al. 2003). Per capita income in Kaktovik, Nuiqsut, and Anaktuvuk Pass was below that of the NSB as a whole. In comparison, in 2003, about 8 percent (± 1.3 percent) of families lived below the poverty line in Alaska, and per capita income was $24,361 (± $603; ACS 2005-2009). Additional income information can be found in Section 3.15, Socioeconomics.

During the formal scoping process, the team conducted scoping meetings in the communities of Kaktovik and Nuiqsut. Meetings were also conducted in Barrow where the majority of residents in the NSB reside. The scoping meetings helped to determine the potential project impacts on Native Alaskans and other environmental justice populations living in these communities. The CEQ guidelines also mandate the identification and consideration of differential patterns of consumption of natural resources, including subsistence usage. Subsistence practices are an important part of the economy and culture of the Native people of the NSB, and are considered in Sections 3.22 and 5.22, Subsistence and Traditional Land Use Patterns.

Section 5.16 of this document assesses the possibility of the project resulting in any disproportionately high and adverse effects on minority and low-income populations of the NSB and determines the presence or absence of environmental justice impacts.

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3.17 TRANSPORTATION

The study area for the transportation evaluation includes the area from the Canning/Staines River west beyond the Dalton Highway to the Nuiqsut Village. The southern boundary is approximately 5 miles south of the coast and the northern boundary extends approximately 5 miles offshore. Consideration of transportation modes and infrastructure that extend beyond the study area is included in the discussion to give context to the affected environment. Access to the study area is extremely limited, so the modes and infrastructure available are important to the existing transportation system.

3.17.1 Key Information about Transportation

Alaska's transportation system consists of roadways, railroads, air facilities, and marine facilities. Because of the large size, small population, and extreme climatic conditions of the state, marine and air transportation play a large role in the transport of materials and people throughout the state and particularly to facilities on the North Slope. Transportation facilities in and around the study area are primarily seasonal. The Dalton Highway is the only year-around public road. The Dalton Highway is a two lane gravel road, and it provides the only ground transportation access to Deadhorse. Other gravel roads leading out of Deadhorse are access-limited, controlled by the owner/operating companies. During the winter, sea ice or tundra ice roads are built by companies to access their facilities.

Air transportation, both fixed-wing and helicopter, is relied on to transport workers to and around the North Slope; however, unfavorable weather conditions can ground flights for days. Barge services are used to transport equipment and supplies during the summer open-water season. Figure 3.17-4 depicts existing transportation facilities in the study area, including barge routes, helicopter routes, and ice road locations.

In addition to these transportation systems, oil and gas products are transported from production areas on the North Slope through a series of pipelines to Pump Station 1 which connects to TAPS.

3.17.2 Review and Adequacy of Information Sources for Transportation

Some information on transportation has been gathered in association with past proposed development projects within or adjacent to the study area. Most have been baseline or reconnaissance studies performed intermittently since 1974 by consultants for oil and gas companies. Limited studies have been completed by state and federal agencies.

GIS and mapping data provided by the Applicant and other private companies were used along with readily available GIS data from ESRI, ADNR, or other state and federal agencies to create map figures and references. In addition, internet resources like maps, resource agency Web sites, community Web sites, and private company Web sites were used to develop the transportation information.

Table H-17 in Appendix H discusses the publications, reports, and data available for transportation data that are cited in the Draft EIS and their relevance to the proposed project. Full references for the studies cited in the following text are in Chapter 9, References. Transportation facilities associated with activities in the study area follow. Transportation options are also discussed for the local communities in the study area (Kaktovik and Nuiqsut).

3.17.3 Dalton Highway

The Dalton Highway provides the only road access to the North Slope. This 415-mile gravel highway from Livengood to Deadhorse was constructed to support oil development on the North Slope and was originally limited to authorized commercial traffic beyond the Yukon River Bridge. Since 1994, the entire Dalton Highway has been open to the public. Traffic on the road now consists of a mixture of commercial trucks, private vehicles, and commercial tour operators (ASCG 2005). Trucks carrying supplies, equipment, and goods use the highway in support of the oil industry at Prudhoe Bay. The highway is still mainly used as an industrial road, and traffic volumes are low; however, semi trucks and trailers now share the roadway with hunters and tourists. Noncommercial traffic occurs primarily during the summer and on the southern portion of the highway. According to the Alaska Department of Transportation and Public Facilities' (ADOT&PF) Northern Region's 2008 Annual Traffic Report, average annual daily trips (ADT) during a 24 hour period on the Dalton Highway were 230 (2010).

3.17.4 Oil Industry Roads

The oil industry has developed an extensive network of access roads to facilities on the North Slope. Almost 300 miles of roads have been developed to serve existing production fields on the North Slope (ASCG 2005). These roads are restricted to authorized traffic, which includes some use by local residents. The main road within the Prudhoe Bay and Kuparuk operations area is the Spine Road. This gravel road provides access from the Dalton Highway at Deadhorse to oil facilities from Endicott in the east to Kuparuk in the west. Most oil facilities on the North Slope are connected to Spine Road by gravel roadways that are typically 30 to 35 feet wide and approximately 5 feet in elevation.

3.17.5 Sea Ice Roads

According to the Applicant's *Plan of Operations for Point Thomson Drilling PTU-15 and PTU-16 Wells, North Slope, Alaska* (ExxonMobil 2009c), a sea ice road/bridge was constructed in the winter of 2008/2009. The sea ice road/bridge crossed the Sagavanirktok River for truck transport of a drilling rig to the Central Pad at Point Thomson. Depending on the construction of other sea and tundra ice roads, other potential river crossings include the Kadleroshilik River and Shaviovik River drainages.

Figure 3.17-1: *Ice Road on North Slope. Source: ASCG 2005*

According to the Associated Press, on February 9, 2010, a 60-mile sea ice road was constructed between Endicott and the Central Pad at Point Thomson. The road was used for truck transport of heavy equipment and materials for drilling, and provided access in support of Point Thomson development and operations. The sea ice road was constructed along the Beaufort Sea shoreline. The route along the shoreline was selected to avoid coastal native allotments. Residents of Kaktovik may also use the sea ice road for travel between Deadhorse and the community.

3.17.6 Onshore Ice Roads

Seasonal onshore ice roads are also used to access the drilling pad, water sources, and ice chip sites. Figure 3.17-4 shows the locations of ice roads located onshore and construction staging areas. Onshore ice roads may be constructed to detour around known bear dens along the sea ice road route. Further, onshore ice access roads require approval for the prepacking of snow from the ADNR.

Figure 3.17-2: *Off-road Vehicle. Source: Head 2010*

3.17.7 Off-Road

Besides the seasonal ice road access, some equipment and materials may be transported over land using a highway vehicle with a curb weight of up to 10,000 pounds, including a four-wheel-drive vehicle or a pickup truck. Recreational-type vehicles such as snowmachines or other tracked vehicles, motorcycle, or all-terrain vehicle with a curb weight of up to 1,500 pounds are also allowed. Use of larger vehicles or equipment requires a permit from ADNR. An authorization from ADF&G-Habitat is required for any motorized travel in fish bearing streams (ADNR 2009b).

3.17.8 Pipeline Systems

Oil produced on the North Slope is transported to Valdez through the TAPS. This system includes 800 miles of 48-inch-diameter crude oil pipeline, as well as pump stations, communications sites, and other support facilities. The pipeline delivers oil to the marine terminal at Valdez, where it is transferred to oil tankers for delivery to final markets.

Oil is transported from various oil production facilities on the North Slope to Pump Station 1 of the TAPS through various pipelines. Seven major trunk pipeline systems carry crude oil to the TAPS, and numerous production pad feeder pipelines carry oil from production facilities to these trunk lines. Crude and noncrude pipelines serving existing North Slope production facilities include approximately 415 miles of pipeline corridor (with some corridors including multiple pipelines bundled together) and are elevated aboveground on VSMs (BLM 2004). Access roads have been constructed adjacent to the pipelines to allow for inspections, maintenance, and repairs.

3.17.9 Aviation

Aviation is a critical transportation element on the North Slope, especially for remote sites such as Point Thomson, as it provides the only year-round access to Point Thomson's Central Pad. There is currently no airstrip at Point Thomson, though a helipad is located there. Helicopters are the main mode of travel to the site, deploying and rotating personnel, supporting on-site activities, and emergency medical evacuation, if necessary, during the construction and drilling phase of the project.

The closest state-owned and operated airport is the Prudhoe Bay/Deadhorse Airport, located approximately 65 miles to the west of Point Thomson, and 380 air-miles north of Fairbanks. Prudhoe Bay/Deadhorse Airport is the only public airport for the Prudhoe Bay area oil field complex. The airport is Federal Aviation Administration (FAA)-certified to provide passenger service by large (more than 30 seat) aircraft. In 2009, 19,600 aircraft operations occurred at the Prudhoe Bay/Deadhorse Airport (FAA 2011). This aircraft operations data is likely estimated since it is the same for most of the 30 years either reported or forecasted. These included air carrier, commuter/air taxi, itinerant general aviation, military, and local general aviation operations. For context, Fairbanks International Airport was reported by the FAA to have 121,295 aircraft operations in 2009 (FAA 2011).

The Prudhoe Bay/Deadhorse Airport has a 6,500-foot-long paved runway and a 6,500-foot-long paved parallel taxiway, along with other connecting taxiways and a paved terminal apron. There are also several other aprons serving the airport and lease holders. The airport has an FAA Flight Service Station and controls access with fencing on the apron side. Nearly all flights occurring at the Prudhoe Bay/Deadhorse Airport support the North Slope oil and gas industry, although there are a few private aircraft. Several airlines provide scheduled service from Ted Stevens Anchorage International Airport (ANC) and Fairbanks International Airport (FIA) to the Prudhoe Bay/Deadhorse Airport. Scheduled commercial and private service includes Alaska Airlines, Era Alaska, and ConocoPhillips/Shared Services Aviation.

There are also scheduled passenger flights on Era Alaska from Deadhorse to local communities, including Barter Island (Kaktovik), Nuiqsut, and Anaktuvuk Pass. Charter flights also access local destinations such as Kaktovik and the Arctic National Wildlife Refuge. Helicopters are used for passenger service and cargo service as charter flights. Airport leaseholders include: Alaska Airlines, Era Helicopters, Delta Leasing Alaska, Evergreen Helicopters of Alaska, and Carlile Transportation Systems, among other petroleum industry-related businesses.

3.17.10 Barge Service

Marine transportation is vitally important to the oil industry on the North Slope for the transport of equipment and materials to Point Thomson during the open water seasons when ice roads are not available or when heavy loads are not able to be transported via aircraft. Depending on near shore ice conditions, the open water season is generally from late July/early August through the end of September. This season is not entirely available for barging due to subsistence whaling activity. In the past, the Applicant has voluntarily signed a conflict avoidance agreement that includes planning barge routes during the Village of Kaktovik's and Nuiqsut's whaling season (generally from August 24 to September 23) to minimize potential impacts to subsistence hunting. This commitment was reached with the AEWC for exploratory drilling activities. The Applicant signed the conflict avoidance agreement in 2008, and the agreement has been renewed annually through 2010.

Alaska's major ports are in Anchorage, Seward, Valdez, and Whittier, and much of the cargo shipped to the North Slope passes through these ports. Some cargo is transferred from barge to railroad at the ports; other cargo continues by barge to the North Slope. There is no deepwater port on the North Slope; facilities are limited to shallow-draft docks with causeway-road connections to facilities at Prudhoe Bay and beach landing areas at some local communities. Freight is typically offloaded from cargo ships and barges to shallow-draft ships for lightering to shore. Smaller craft are sometimes used to transport cargo upriver to communities that are not situated on the coast, such as Nuiqsut and Kaktovik.

In the summer of 2008, barges delivered equipment, materials, and supplies for ice road construction, winter operations, and site preparation. In the summer of 2009, barges resupplied the Central Pad and backhauled waste to Prudhoe Bay for appropriate disposal. Barge service would continue to resupply Point Thomson through the life of the project.

3.17.11 Rail

Since it's completion in 1923, the Alaska Railroad has played a central role in Alaska's communities and the state's growth. According to the Alaska Railroad Corporation (ARRC), the trains haul nearly 8 million tons of freight and carry more than 500,000 travelers annually, providing transportation for Alaskans and visitors. The Alaska Railroad hauls freight in support of the coal, oil, and gas industry, which included hauling pipe and supplies for the TAPS (ARRC 2010). The Alaska Railroad provides freight service between ports at Anchorage, Seward, and Whittier and to Fairbanks.

The railroad serves an important role in transporting incoming freight, particularly during periods when barges cannot reach the North Slope. Cargo from barges can be off-loaded at these ports and transported by rail to Fairbanks, where freight for the North Slope can be off-loaded onto commercial trucks for delivery. Although rail transport plays a minor role in overall transportation of materials to the North Slope, it is an economical means of shipping large, heavy goods and is used for these goods on a regular basis (BLM 2004).

3.17.12 Local Community Transportation

The two villages closest to the project area are the Native villages of Kaktovik and Nuiqsut.

3.17.12.1 Kaktovik

Kaktovik is the nearest community, located approximately 62 miles east of Point Thomson. There are about 10 miles of roadway in Kaktovik ranging in width from 10 to 20 feet. Kaktovik residents travel between their homes, public facilities, the airport, and the landfill. The airstrip and landfill are both located on USAF property (ASCG 2005).

Barges deliver goods during the summer, which is approximately 2 months. Small boats are used on the sea or rivers for summer travel to neighboring communities. Snowmachines are used on frozen land, sea, and rivers in the winter.

Figure 3.17-3: Landing craft at beach in Kaktovik.
Source: ASCG 2005

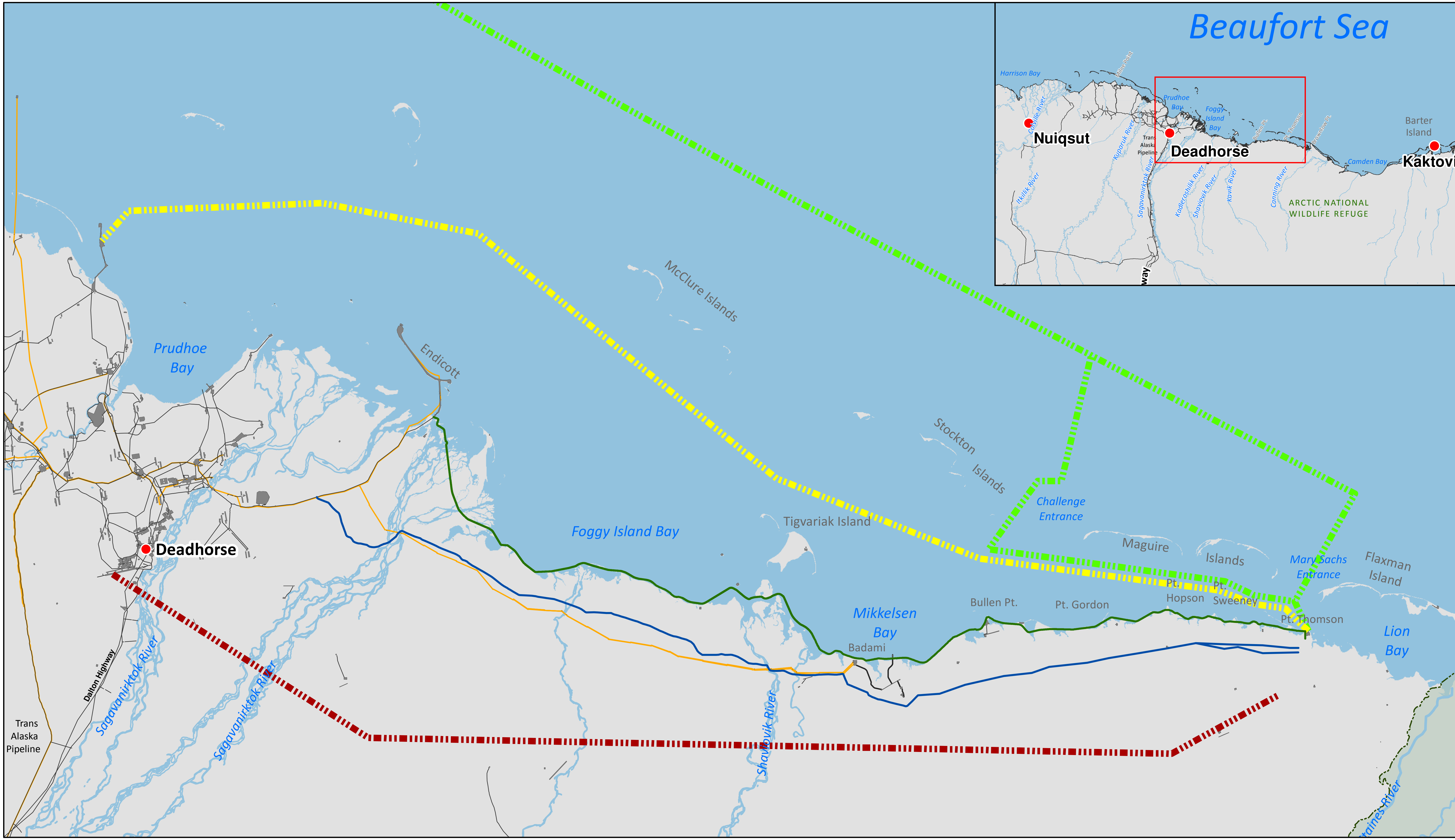
The only year-round access to the city of Kaktovik is air service to the Barter Island Airport. The airport is owned by the USAF and operated by the NSB. The ADOT&PF is considering constructing a new airport on higher ground to avoid flooding and low visibility caused by fog. Additional details on the proposed airport are available in the Final FAA Environmental Assessment (FAA 2009a) and the FAA Finding of No Significant Impact (FONSI; FAA 2009b) for Barter Island Airport Improvements.

3.17.12.2 Nuiqsut

Nuiqsut is located 110 miles west of Point Thomson. Nuiqsut has approximately 10 miles of roadways, which are generally constructed 24 feet wide within 100-foot rights-of-way, while a few streets lie within 60-foot rights-of-way. The community travels between residences, the post office, the Kuukpik store, the airport, medical facilities, the landfill, and the school. During the winter, Nuiqsut residents use a 17-mile ice road to access the existing Spine Road to reach Deadhorse and the Dalton Highway (ASCG 2005).

Nuiqsut is 35 miles south of the Beaufort Sea. The Nechelik channel runs by the village and accesses the Colville River, which is approximately 3 miles away. Nuiqsut residents use waterways primarily for fishing. Occasionally, residents will arrange to have goods delivered to Prudhoe Bay by barge, then transported by ice road or river to Nuiqsut (ASCG 2005). Small boats are used on the sea or rivers in the summer to travel to neighboring communities. Snowmachines are used on frozen land, seas, and rivers in the winter.

Air travel is the main year-round access to the Nuiqsut community via a 4,600-foot-long by 90-foot-wide gravel strip that is owned and operated by the NSB and used for passengers and other cargo. Each winter season, ice roads are built that connect the Nuiqsut community to the Dalton Highway and Deadhorse.



POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Oil and Gas Development Unit
- Existing Facilities
- Water Body
- Existing Pipeline
- Road - Primary
- Stream
- Town
- Aircraft Route
- Coastal Barge Route
- Sealift Barge Route
- Sea Ice Road
- Tundra Ice Road

0 2.5 5 Miles

N

Figure 3.17-4

Existing Transportation Systems

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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3.18 RECREATION

The study area for recreation is the area from which the proposed action may be seen or heard in clear weather. As such, the study area is defined in two parts: a primary study area encompassing a 20-mile radius around the proposed project site that represents the practical limits of visibility and a corridor along the proposed pipeline route; and a secondary study area from which lights from the project could be seen by people engaged in recreational activities, but from which structures would not be seen. The study area includes the lower end of the Canning River and the coastal corridors used by recreationalists. Recreation in the study area is principally a backcountry, wilderness recreation experience, and activities include river recreation, hunting, fishing, and hiking. A key feature of the recreation experience in the study area and surrounding areas is the notable lack of human development and presence.

3.18.1 Key Information About Recreation

There are two principal land owners in the study area: the State of Alaska and the U.S. Government/Arctic Refuge. The study area is generally undeveloped and, in the secondary study area, includes a portion of federally-designated Molly Beattie Wilderness of the Arctic Refuge. That portion of Arctic Refuge within the primary study area, known as the 1002 Area, is managed in part to preserve its wilderness qualities until such time that Congress either acts to open the area to oil and gas development or officially designate it as wilderness. The land managed by the State of Alaska is not specifically managed for recreation uses, but recreation activities like camping, hunting, and berry picking are allowed. The undeveloped and wild nature of the study area, with its associated opportunities for encountering wildlife and solitude, is generally what draws people to visit and recreate in the area. The project activities proposed could potentially disrupt these recreational characteristics of the study area.

Types of recreation that occur in the study area include hunting, river rafting, backpacking, wildlife viewing, camping, fishing, recreational flying, and ocean boating and kayaking. Most recreation occurs in the summer. The Arctic Refuge and adjacent state land provide vast areas of undeveloped land and wilderness where visitors can encounter scenery and wildlife with a high degree of isolation (with its associated challenges and risks). These qualities are primarily what motivate people to visit and recreate in the area.

The Arctic Refuge and State of Alaska have little quantitative data on recreational visits to the study area; information about the levels of recreational use is based on visitation figures for the broader area, as well as information from agency staff involved with management of the study area and surroundings. The Extrapolating from counts over a larger area, it is thought that no more than 100 nonlocal recreationists visit the primary study area in a year.

Subsistence harvest by local residents of the NSB has a recreational component. Counts of these users are not recorded, but the coastal corridor is important for fishing, hunting, and traveling by boat and snowmachine. Recreation occurring on state lands west of the Arctic Refuge is primarily hunting. Small numbers of sea kayakers use the nearshore waters of the study area. Occasional cruise ship visits occur in the study area, but these are infrequent.

3.18.2 Review and Adequacy of Information Sources for Recreation

Information specific to recreational use of the Point Thomson study area is very limited. Most of the information sources reviewed presented general information on the Arctic Refuge or on broad areas of state and federal land. In general, the information available is adequate to characterize the type of recreation that occurs, but does not provide counts of users or user days. Based on available data, the subsections that follow present a broad estimate to help characterize the low use levels in the study area. This Draft EIS does not attempt to break out count estimates by user group (e.g., hunters vs. rafters vs. coastal kayakers).

Table H-18 in Appendix H discusses the publications, reports, and data available for recreation related to the proposed project. Full references for the studies cited in this Draft EIS are in Chapter 9, References.

3.18.3 Recreation in the Study Area

Recreation in the study area is principally a backcountry and wilderness recreation experience. The nearest designated federal wilderness area is 30 miles from the coast, but the land throughout is essentially undeveloped and wild. The Canning River, which forms the boundary between state land and the Arctic Refuge, is one of the main recreation corridors for river floaters and float hunters. Those using the river corridor may camp, hike, or hunt on state or refuge land. Besides the Canning River corridor, there is a coastal corridor of indeterminate width in which local residents travel by snowmobile or boat and camp for hunting and fishing, and in which visitors sometimes kayak. Occasional boats from Kaktovik with touring visitors also use the coastal corridor and may occasionally travel to the Point Thomson area. For purposes of this Draft EIS, the coastal corridor is assumed to extend about 2 miles seaward and 2 miles inland but is acknowledged to vary. Figure 3.18-1 illustrates the area and the recreation corridors. All of these uses occur at low levels; there may be no more than about 100 individual nonlocal recreationists on the ground in the area in a given year, plus a variable but small number of local users, some of whom may transit the area and some of whom may camp for extended periods or visit several times per year. Recreationists in general likely are aware that the state land is managed differently and that oil and gas exploration activities have occurred or could occur even as most assume that they will not observe such activities.

Other recreational use occurs in and near the general area at low levels. Tourist ships occur offshore and flights occur overhead. On average these people are likely to be less sensitive to wilderness concerns and more interested in seeing North Slope oil and gas development or rural communities such as Kaktovik.

For this recreation discussion, the study area is considered to be the area from which the project might be heard or might be seen in clear weather by recreationists. The area is not distinctly defined by land management boundaries. For convenience, the primary study area is defined the same as the Visual Resources primary study area (Section 3.19). The primary study area is defined by the practical limits of visibility (a 20-mile radius around the proposed project site based on direct observation) and a broad corridor paralleling the coast and proposed export pipeline routes. A secondary study area, also defined in the Visual Resources discussion, is the area from which project lights, reflections, or plumes theoretically could be seen beyond the 20-mile primary study area, as shown on Figure 3.18-1. Because the ACP is mostly flat and not forested, the area from which the project might be seen is large, running from the mountains to waters several miles offshore (see Figure 3.18-1). Kaktovik residents reported informally at the time of the project scoping meetings that they had seen nighttime glow in the sky above the current project activities from Kaktovik, 60 miles away.

The ACP and adjacent ocean form a principally undeveloped and wild environment backed by the similarly undeveloped mountains of the Brooks Range. There are two principal land owners in the affected area—the State of Alaska and U.S. government/Arctic Refuge. Whether on state or federal land, the recreation environment is similarly undeveloped and wild without communities or buildings along the coast from Bullen Point to Kaktovik, a stretch of nearly 80 miles, and for much greater distances inland. There is no federally-designated wilderness land in the primary study area. The closest corner of the Molly Beattie Wilderness of the Arctic Refuge is 30 miles from the coast, measured from Point Thomson. The Arctic Refuge manages the 1002 Area, located between the wilderness boundary and the coast, in part to maintain its wilderness qualities until such time as Congress acts to open the area to oil and gas development or to officially designate it as part of the National Wilderness Preservation System. The State of Alaska lands are not designated for recreation, and the state does not have specific recreation management guidelines for its lands in the area, but generally allowed uses of state land include noncommercial recreation camping, foot travel, recreational hunting, berry-picking, airplane landings, and boat use. Overland motorized use is not allowed without a state permit, except for subsistence.

Those who use the area for recreation do so with the knowledge that it is not a developed recreational experience. There are no trails, designated camp sites, roads, signs, toilets, or lodgings, for example. Access in and out of these remote areas typically is by permitted air taxi landing small airplanes on tundra tires (large, low air pressure tires with no tread) on gravel bars or low, dense tundra vegetation. Although the Arctic Refuge and State of Alaska allow some uses of snowmobiles, motorboats, and airplanes on their lands, the recreational attraction is that the area is undeveloped, quiet, and wild. Visitors to this area have few encounters with other groups and a high likelihood for encounters with wildlife, including unusual species such as musk oxen and unusually large herds of migrating caribou. On the coastal plain, especially at higher elevations near the mountains, the views can be vast (see Section 3.19, Visual Aesthetics) although surveyed recreationists in the Arctic Refuge seem as interested in what they cannot see as in viewing wildlife (Christensen and Christensen 2009). Because the Arctic Refuge has these wild qualities and because ANILCA, in establishing the Arctic Refuge, set up a dichotomy for the coastal plain of the Arctic Refuge between the potential for development of oil and gas and the potential for maximum preservation as designated federal wilderness, the Arctic Refuge has garnered international attention and visitation (USFWS 2008d; see Sections 3.13, Land Ownership, Land Use, and Land Management, and 3.14, Arctic National Wildlife Refuge, for more information).

There is distinction between land management and land use for recreation. In the study area, lands are managed based on their status as part of the National Wilderness Preservation System (federal wilderness: the Molly Beattie Wilderness in the Arctic Refuge); areas managed for their wilderness values but not designated as wilderness (the 1002 Area in the Arctic Refuge); and areas managed principally for oil and gas leasing and development (State of Alaska lands) that are principally undeveloped and have "wilderness qualities and values" valued by some recreationists. This section focuses on the broad applicability of qualities and values of the land and land users that apply to recreation. Sections 3.13, Land Ownership, Land Use, and Land Management, and 3.14, Arctic National Wildlife Refuge, of this Draft EIS more specifically address management issues.

Because of the area's wilderness values, whether within the designated wilderness area or not, recreational users seeking these qualities may be highly sensitive to encounters with other recreational parties and to human development. This is particularly true of visitors who make a large commitment to travel hundreds or thousands of miles to visit the Arctic for a trip of many days. An Arctic Refuge visitor survey indicated 96 percent of visitors believe the Arctic Refuge's wilderness is very important and very high percentages indicated such qualities as remoteness and isolation, natural quiet, sacredness, and a place largely free of reminders of modern society were important. In this type of recreational environment, seeing human development, litter, artificial light, camp sites, or even footprints; hearing aircraft or other human-caused noise; or encountering other parties may be considered by many visitors to substantially detract from the wilderness recreation experience (Cole 2001, Christensen and Christensen 2009). For background on nationwide attitudes about wilderness, Alaska, and the Arctic Refuge in particular, see Section 3.14, Arctic National Wildlife Refuge, especially 3.14.4. Many wilderness-type recreationists see the Arctic Refuge as a particularly important destination (Christensen and Christensen 2009). Visitors to Kaktovik may consider themselves to be recreationists or tourists to the general area but may have much less sensitivity to these issues and have a higher interest in seeing all types of human activity in the area. These visitors may be more curious about seeing oil and gas facilities. Such visitors are most likely to fly over the study area and are not likely to recreate on the ground in or near the study area.

POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Existing Facilities
- Water Body
- Existing Pipeline
- Existing Road
- Stream
- Point Thomson Visibility Areas
- Canning River Corridor
- Coastal Corridor
- Canning River Main Channel
- Named Destinations/ Camping and Hunting Sites for Local Users
- Recreation Points of Interest

0 5 10 Miles

N

Figure 3.18-1

Recreation in the Point Thomson Area

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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3.18.4 Recreation as an Element of Local Resident Land Use

Although local residents typically do not label their activities in the general area as "recreation," there is in western cultural terms a recreation component to traditional subsistence activities and camps. The following paragraphs explain.

The Arctic Refuge encompasses the traditional homeland of Native Alaskans, such as the Iñupiat and Gwich'in peoples, and perpetuates the opportunity for continuing traditional subsistence uses, skills, and relationships with the land. As indicated in the Land Ownership, Land Use, and Land Management Section 3.13, part of the Arctic Refuge purpose set out by Congress is to provide continued opportunity for subsistence. Local residents also use state lands for subsistence, and subsistence use is given deference (for example, motorized uses require a state permit unless for subsistence).

The Arctic Refuge management plan indicates that "local residents interpreted recreation as use of the Arctic Refuge by people who lived outside the local area" (USFWS 1988). Similarly, an NSB summary of a 1982 book on Kaktovik subsistence addresses cultural definitions of recreation:

> "One reason these inner socioeconomic values have remained intact through times of rapid change is that the surrounding landscape has not changed appreciably, allowing families to return to traditional hunting, fishing, and camping sites year after year, taking part in the same activities in familiar surroundings, as they have always done. Outings at these places provide them with maximum cultural privacy away from the rules of modern village life and the outside world. Thus, the outings afford the opportunity to strengthen family and kinship ties and the community values of sharing and helping each other. Although the Iñupiat greatly enjoy these outings, they do not regard them as "outdoor recreation." For them, subsistence is serious work as well as a favorite way to spend time, for work and pleasure are not separated for them as in western societies." (NSB 1983)

Scoping meetings for this project and the 2002 effort did not generate comments from NSB residents about their own recreation, but did indicate that residents enjoy getting away from their usual home life for the quiet and change of pace of hunting and fishing camps and that there was an appreciation of aesthetics of the land.

NSB residents travel widely by snowmobile and boat for subsistence purposes. Kaktovik residents hunt well west of the Canning River and inland into the mountains. (NSB 1983, USFWS 1988) For Kaktovik residents, the concentration of land-based hunting and river fishing is along drainages coming off the Sadlerochit Mountains. Traditional camping sites and Native Allotments occur on Brownlow Point and Flaxman Island, within a few miles and within view of the project area, and named locations visited less commonly occur farther to the west. Disturbance of the pattern of hunting caribou and other wildlife along the coast was raised in scoping as an issue of concern (firing rifles in the direction of pipelines and other facilities proposed just inland from the coast). It can be assumed that there is a recreation component to local uses of the immediate project area and the broader ocean and inland area around it. Numbers of local users is not well known, but Kaktovik's total population is less than 300. Individual local residents who do visit the project area are likely to spend more days in the area or to visit more often than nonlocal recreational visitors.

3.18.5 Recreation by Nonresidents of the Area

The types of recreation that occur in the general area include: recreational hunting, river rafting, backpacking, camping, recreational flying, fishing, ocean kayaking and small boats, arctic cruise-boat tours, winter camping (epic snowmobile/ski/dogsled treks), and commercial recreation (guided hunts, floats, and boat trips with access by air from south of the Brooks Range, Deadhorse, or Kaktovik). As further indicated below, very little data is available on recreational use. The Arctic Refuge and ADF&G record some data, but none that is specific to the study area. Based on the data that is available, it is likely that total numbers of nonresidents recreating in the Canning River corridor and coastal corridor is fewer than 100 per year.

3.18.5.1 Recreation on the Arctic Refuge

The Arctic Refuge Web site highlights the primitive type of recreation available, capturing the romance and issuing a note of caution:

> "Perhaps more than anywhere in America, the Arctic Refuge is a place where the sense of the unknown, of horizons unexplored, of nameless valleys remains alive. These rare qualities place wilderness before the visitor not as an abstract concept but as a real place where decisions have consequences. Because the wild has not been taken out of the wilderness, there are risks. Freedom, discovery, and exploration prevail. Experience and self-reliance are required." (USFWS 2008f).

The Arctic Refuge plan helps to explain the primitive recreation that is characteristic of designated or undesignated backcountry or wilderness areas:

> "To experience primitive recreation, visitors should perceive a vastness of scale, feel they are part of the natural environment, and experience a high degree of isolation, challenge, and risk. Primitive recreation requires outdoor skills and meeting nature on its own terms without comfort and convenience facilities." (USFWS 1988).

The plan and a visitor survey (Christensen and Christensen 2009) indicate that solitude and experience of the wilderness values are primary motivators for recreational visitors. The plan states that hunting, river rafting, and hiking/backpacking are the primary recreational activities. Wildlife viewing and fishing as part of these activities are also important components.

The Canning River downstream to the Canning River take-out (informal airstrip) northwest of the Sadlerochit Mountains is listed in the 1988 plan as a high use corridor, and the north side of the western Sadlerochit Mountains is listed as a moderate recreational use area. These same areas are listed as high use (river) and moderate use (mountains) hunting areas. "High use (river)" is identified as "more than 8 groups" in the CCP; "moderate use" for hunting is identified as "2 to 7 groups" (USFWS 1988). The 1988 plan indicates other rivers and hiking areas farther east and south generally have somewhat more visitation; a 2008 visitor survey indicated the Canning River as the second-most-used entry and exit "point" for the Arctic Refuge (Christensen and Christensen 2009), although the questions do not allow for specifying which part of the 130-mile river system or whether recreationists were following the drainage during their trip. A 2010 Public Use Summary for the Arctic Refuge also lists the Canning River as the second-most-visited river in the Arctic Refuge, though the specific portions of the Canning River are not specified (USFWS 2010).

The Arctic Refuge plan indicates that the 1002 Area of the coastal plain (the portion of the Arctic Refuge nearest to the project area) is to be managed as a minimal management area until Congress acts to permit oil and gas activity or to designate the area as wilderness, options that were left open in ANILCA when the law was enacted that created the Arctic Refuge in its current form (see Section 3.14, Arctic National Wildlife Refuge).

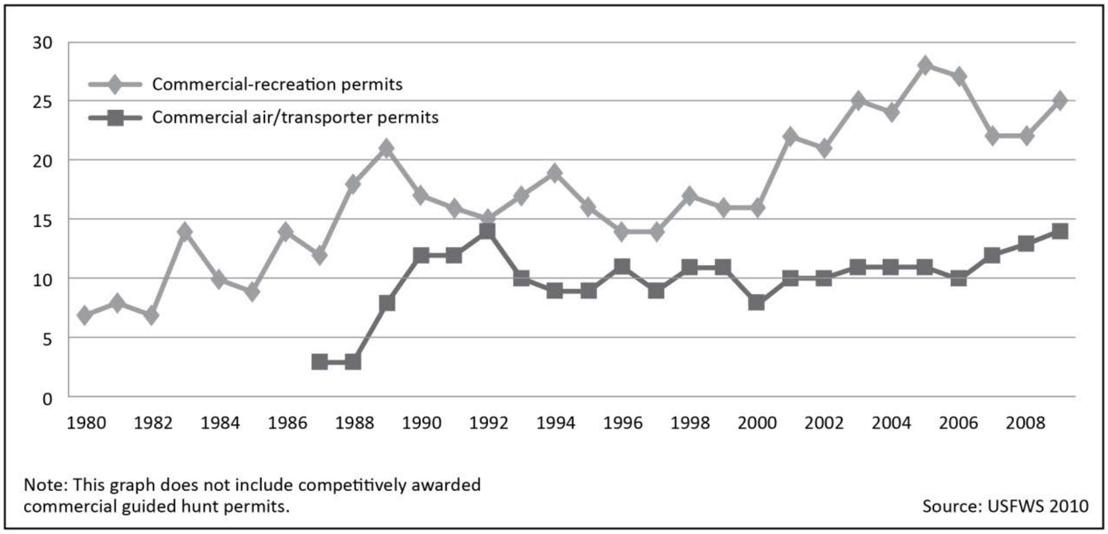
According to Arctic Refuge visitor services (HDR 2010j), people from around the state, the nation, and the world seek out the experience of visiting the Arctic Refuge. Besides the main activities of recreational hunting, river floating, and hiking, recreation includes camping, mountaineering, dog mushing, fishing, wildlife observation, and photography. Private pilots also fly into the Arctic Refuge for the scenery, or to land and camp. The visitor services staff indicated that, because it is remote and undeveloped, the Arctic Refuge offers wilderness qualities and opportunities that are hard to find in most other protected natural areas. These opportunities include the illusion of exploring areas for the first time and the potential of traveling for days or weeks at a time without seeing another person. The general considerations apply to the Canning-Staines River area of the refuge nearest to the project site.

Most recreational hunters (i.e., not subsistence hunters) come to the Arctic Refuge to hunt Dall sheep, caribou, moose, and brown bear. Although a large proportion of recreational visitors are believed to fish during their visits to the Arctic Refuge, fishing usually is not a primary reason for visiting (i.e., visitors usually come for some other purpose, but often fish while there).

With the intent of preserving the wilderness context of the visitor experience, Arctic Refuge management does not require registration of visitors. As a result, the Arctic Refuge staff has documented neither total visitation, nor the visitors' origins (USFWS 2010e). The Arctic Refuge tracks visitor use only for those who access the land via commercial pilots or guides, and not people who travel into the Arctic Refuge independently. Overall use of the Arctic Refuge averages somewhat more than 1,000 known recreational visitors per year. Average party size across the Arctic Refuge and across user types (not including commercial guided hunts, which are tracked separately) is five, and average length of stay is nine days (Reed 2010).

Figure 3.18-2 shows the number of commercial-recreation permits and commercial air/transporter permits awarded since the 1980s. There have been about 10-15 permitted air services each year and around 25 commercial-recreation permittees. These guides and pilots may operate across the Arctic Refuge, and there are no data on their specific uses near the project area. One permittee has, from year to year, consistently operated dog mushing trips identified as operating on the western border of the Arctic Refuge, likely on state and refuge land, between Kavik and the Canning River. Otherwise, these numbers indicate general activity levels in the Arctic Refuge.

Award Permits on the Refuge 1980-2009



Source: Reed 2010
Note: This graph does not include competitively awarded commercial guided hunt permits.

Figure 3.18-2: Permits Awarded to Commercial Recreation Guides and Pilots on the Refuge 1980–2009

Table 3.18-1 shows known visitor numbers for the Canning River drainage. The Canning River runs near the project site. Many of these users, but not all, float down the river to the coastal plain, where they are picked up by a pilot, often just north of the Sadlerochit Mountains or at the coast itself. The USFWS indicated this is the best data available and does not further break out those who end their trip before entering the coastal plain. Local and subsistence uses are in addition to these numbers and are not monitored. The Arctic Refuge is aware that others also use the Arctic Refuge for recreation, such as private pilots and those who travel overland. The Arctic Interagency Visitor Center along the Dalton Highway and the Toolik research camp south of Prudhoe Bay both report visitors who say they are going to the Arctic Refuge, but no accurate counts are known, and destinations within the Arctic Refuge are not known. The numbers reported in this section are considered by the Arctic Refuge to be the "absolute minimum number of visitors," and they likely underreport actual recreational use (HDR 2010j).

Table 3.18-1: Number of Commercially Supported Visitors by Year for the Canning River, Including the Marsh Fork

2001	2002	2003	2004	2005	2006	2007	2008	2009	Average
115	129	118	204 135		99	162	188	174	147

Source: Reed 2010

Note: The USFWS considers these data incomplete for commercially guided hunters, which are tracked separately. This table reports use for the entire Canning River system; only a portion of the reported users start or end their trips downstream in the Arctic Coastal Plain.

The Arctic Refuge reports that visitors to the Canning River drainage (the entire drainage, not necessarily the lower river near the project site) makes up about 14 percent of the Arctic Refuge's overall known visitation since 1999 (Reed 2010). Visitors to the Sadlerochit Mountains and Sadlerochit and Kaktakturuk River drainages make up an additional 3 percent of the known visitation of the Arctic Refuge, and portions of these areas are within view of the Point Thomson project area, although at such distances that only lights are likely to be evident, and even then likely only during nighttime darkness (autumn to spring).

The Arctic Refuge issues competitive exclusive permits for commercially guided hunting within its borders. There are four hunting guide units that may be within view of the project area. Unit No. 1 encompasses all of the Sadlerochit Mountains and the coastal plain between the lower Canning River and the Sadlerochit River, and a large proportion of this unit theoretically may be within view of the project area. The Arctic Refuge reports that 9 to 12 commercially guided hunters and guides used this unit each year between 2007 and 2009; likely to hunt sheep and grizzly bear in the mountain areas, and caribou on the coastal plain (HDR 2010k). On average, a similar number used each of the other three nearby units, but these units are located in rugged mountains, rather than on the expansive coastal plain, and at such distance that it is likely that even on a day with perfect visibility, hunters on certain ridge-tops and the northern flank of the Brooks Range would be within view of Beaufort Sea but would likely not be able to discern the project site. The Arctic Refuge compilation of visitor data is not yet complete. Because of overlap between these hunting areas and the Canning River area reported in Table 3.18-1, it is possible that some of the hunter numbers noted in this paragraph are also counted in the table.

3.18.5.2 Recreation on State Land

ADNR (HDR 2010c, d) indicated that off-road motorized use restrictions associated with the North Slope Special Use Area and Dalton Highway corridor restrictions combine to limit public access overland on the coastal plain. Subsistence uses are exempt from the motorized off-road use restriction, and ADNR indicated that local resident use of the area is generally considered “subsistence” use (even if the use at any given moment is transportation from one community to another by snowmobile), or that local residents perhaps should have a permit for certain nonsubsistence uses; however, the state does not actively enforce this permit requirement for local residents and is unaware of others outside the oil and gas industry seeking permits. Pilots are allowed to land on lakes and on old gravel airstrips on state land leftover from oil and gas exploration. ADNR indicated these uses occur, but at low levels.

The state and borough both require permits for commercial recreation in the area. ADNR (HDR 2010d) is not aware of any commercial guide or transporter (e.g., pilot) specifically permitted to operate on state lands on the coastal plain in the general area around the project. Similarly, the borough (Kittick-Atos 2010) does not have any permitted commercial-recreation in the area.

The only data available is associated with hunting. The ADF&G tracks hunter use by unified coding unit (UCU), which is a subdivision of a river drainage. By state policy, ADF&G is not able to provide hunter numbers for an individual UCU. ADF&G data is compiled from hunter reports that are much more likely to be filed from those who harvest an animal than from those who hunt but are not successful. As a result, the number of people reported to be hunting is considered by ADF&G to be the absolute minimum (HDR 2010l). Residents of a GMU are not required to report. GMU 26 encompasses all of northern Alaska, from the continental divide to the Arctic coast and from Canada to Cape Lisburne, an area some 650 miles east-west that includes 8 villages and more than 7,000 residents, most of whom depend on hunting as part of a subsistence-based lifestyle (Figure 3.10-1 shows GMUs in northern Alaska). Virtually all hunting reported here is by people who reside in southern parts of Alaska or outside the state (HDR 2010l).

Combining data from several UCUs for the nine years 2000-2008, ADF&G (HDR 2010l) reported the range of people who said they hunted caribou (not necessarily harvested caribou) was 45-89 per year. There were 15-46 people per year who reported hunting sheep. For grizzly bear, some years were zero, and some had one hunter. These UCUs together run from Canning River headwaters at the continental divide in the Brooks Range to the Beaufort Sea coast and include three closely-spaced drainages immediately west of the Canning on state land—the lower Juniper, lower Shaviovik, and lower Kavik Rivers. Together, these UCUs encompass a large area, no more than half of which might be within view of the project site on a day with perfect visibility (much less on hazier days), and it is not possible to pinpoint exactly which hunting occurs on state land versus refuge land. ADF&G reported, however, that the coastal plain adjacent to the lower Canning River is popular for caribou hunters. Sheep hunting all would occur in the Arctic Refuge, because sheep habitat (mountain habitat) does not extend farther north onto state lands of the coastal plain, but some points within the mountains would likely be within view of the project area on clear days.

In summary, many of the hunters reported by ADF&G likely hunt on refuge land and may also be counted in the Arctic Refuge use numbers reported above in Table 3.18-1, but there are small numbers of recreational hunters who use state lands west of the Canning River. Permitted commercial recreation does not occur on state land in this area. Minor use may occur by pilots and kayakers, in addition to local subsistence camping and hunting described in 3.18.4.

3.18.5.3 Other Recreation and Tourism Use

Employees of North Slope oil and gas developments in general are required to stay on developed gravel pads, gravel roads, or ice roads except for authorized tundra travel for work purposes. Recreation off these developed areas is not allowed (BPXA and ConocoPhillips 2005), and the Applicant prohibits hunting and fishing for all employees and contractors working at the Point Thomson site.

Occasional sea kayakers use nearshore waters of the Beaufort Sea, sometimes traveling between Kaktovik and Prudhoe Bay or Barrow in state and refuge waters and passing by the project area. Offshore, tour companies offer occasional cruises and icebreaker trips in the Arctic Ocean waters of Alaska and through the Northwest Passage. These cruises amount to no more than a handful of ships per season, based on a Web site search, although each ship may contain more people than typically float the Canning River in a year.

Recreational use mostly is in summer (USFWS 2010e); however, the Arctic Refuge reports that every year there are those who make long camping trips partially or entirely in the Arctic Refuge on snow, traversing over the Brooks Range or touring east-west along the coastal plain by snowmobile, skis, or dog sled. There are no specific counts of these expeditions, but the numbers are low (HDR 2010m).

3.19 VISUAL AESTHETICS

A visual assessment was conducted for the project and is included as Appendix N to the Draft EIS. This section summarizes background material from the appendix that characterizes the baseline conditions of the project area. The study area for visual resources is defined by visibility and includes primary and secondary study areas.

The primary study area is defined as about a 20-mile radius around the proposed project site, based on field observation (see Appendix N for detail). A general corridor between the project site and the Prudhoe Bay area also is part of the primary study area, following possible pipeline and access road routes. The corridor width is about 5 miles seaward from the coast and 10 to 12 miles inland to encompass potential pipeline and road routes and based on the 5-mile "foreground-middleground" distance zone in which they would be most likely to be seen. The western end of the primary study area ends where the pipeline and road routes would intersect existing permanent roads and pipelines near Deadhorse/Prudhoe Bay. ExxonMobil's staging pad in Deadhorse and other facilities are not included in this visual assessment study area because they were not an area of concern during scoping and are already industrialized where visual contrast of new structures would be quite low.

The secondary study area is based on the maximum theoretical area from which the project site at Point Thomson might be seen, with a focus especially on lights during dim and dark conditions, or perhaps daytime reflections or large plumes of exhaust. This includes views from rising terrain south of the primary study area, mountain slopes, and ridges up to 100 miles away. Structures are not expected to be visible with the naked eye in this secondary area. Figure 3.19-1 illustrates the primary and secondary study areas.

3.19.1 Key Information About Visual Aesthetic Resources

The project is located in an undeveloped and uninhabited area within a few miles of the Arctic Refuge. Proposed new industrial facilities, particularly drilling rigs, communications towers, flare stacks, support facilities, air traffic, and facility lights are expected to create strong "visual contrast" when compared to baseline conditions. By agreement of the lead and cooperating agencies, methods for preparing the visual assessment were based on published methods of the U.S. Department of the Interior, Bureau of Land Management (BLM) and the Corps, primarily BLM's Manual 8400 Visual Resource Assessment (BLM Manual 8400).

Although exploratory drilling has been underway since 2009 by the Applicant under state permits, the baseline condition for the visual assessment is the condition prior to 2009, without the exploratory drilling and associated drilling rig tower and other facilities and activities. The current activity has been a preliminary part of the project evaluated in this Draft EIS. The preliminary activity did not require federal approvals, and the applicant was able to proceed before completion of the Draft EIS. The No Action Alternative would return the area to approximately the pre-2009 condition, without structures, and it is thus the appropriate baseline.

The following key points characterize visual and aesthetic resources in the study area:

- The study area rated fairly high in visual quality based on seven characteristics such as landform, vegetation, and color.
- Sensitivity was rated high in the Arctic Refuge and medium on most state land in the study area because most users of the area, both local and visitors, are thought to be fairly sensitive to visual changes and because the refuge is considered a "special area" as defined by the BLM

methodology used for conducting the visual assessment (See Appendix N, Point Thomson Visual Assessment).

- State lands and the project site were classified as Visual Resource Inventory Class III, based primarily on the high visual quality rating. The 1002 Area was classified as Class I because it is managed in part for preservation of the natural landscape, including natural visual environment and natural darkness. The State of Alaska does not manage its lands in the study area for visual resources.
- Key observation points were selected within coastal and Canning River travel corridors and at graduated distances from the project site to provide a variety of views for inventory and eventual contrast (impact) rating.

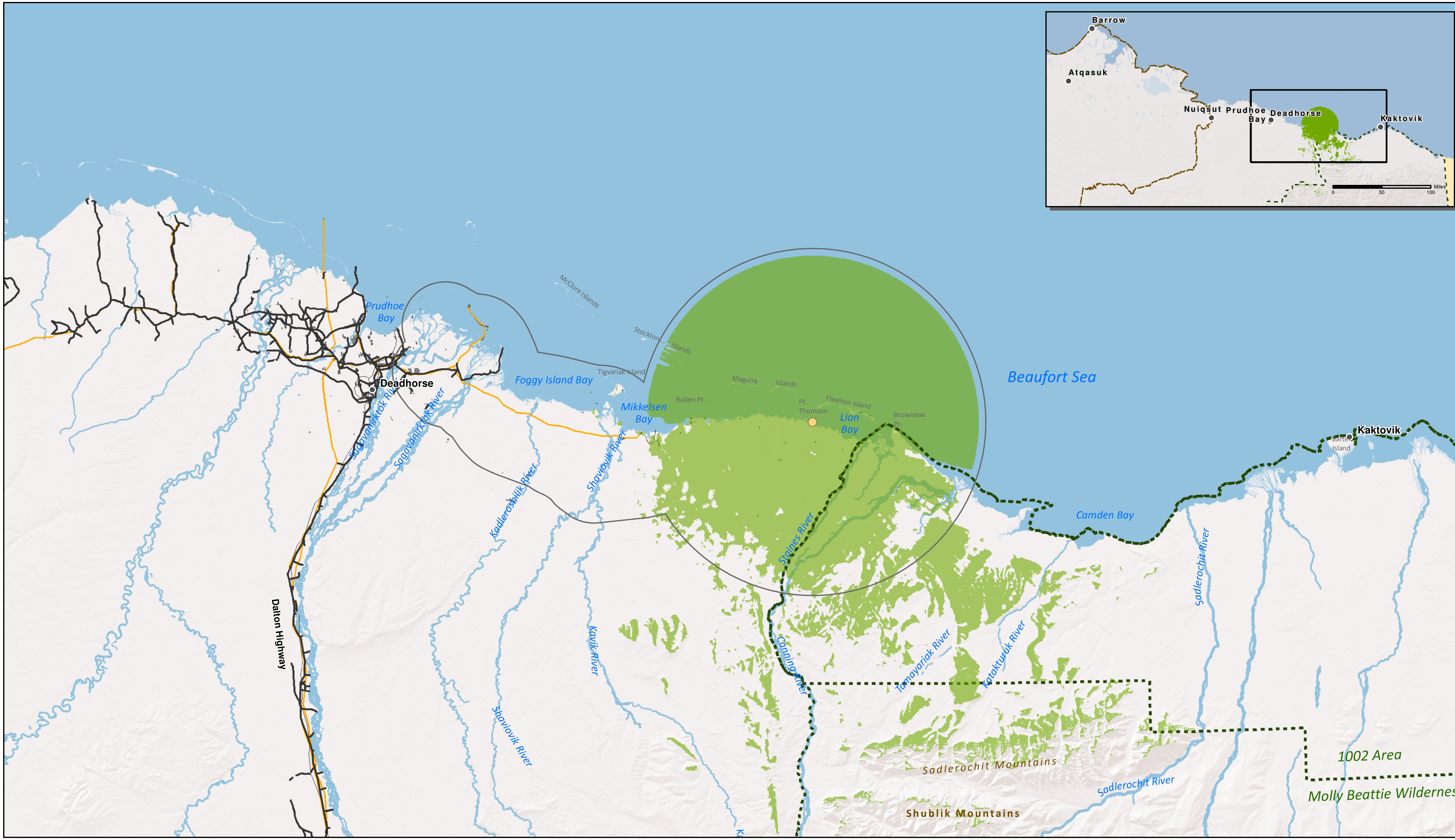
3.19.2 Review and Adequacy of Information Sources for Visual Aesthetics

The main information source for this section of the Draft EIS is the Visual Resource Assessment document that is appended to this Draft EIS (Appendix N). The Visual Resource Assessment was based on published methodologies, primarily BLM's Manual 8400 Visual Resource Assessment, and on data gathered specifically for the project: field photos and field notes taken in summer and winter, sources characterizing the coastal plain and adjacent physiographic provinces, and GIS data and GIS analyses of terrain, visibility distances, and so on. In addition, Arctic Refuge staff and state agency staff provided guidance about the characteristics of the area. The field visits provided the basis for visual resource inventory and the landscape unit characterizations. The methodology was designed by BLM primarily for its own lands and assumed visual resource management objectives are in place, which is not the case near Point Thomson. However, the method is generally adequate for characterizing and inventorying the visual resources in the study area. The data gathered in the field and via GIS and other means is adequate for these purposes as well. The GIS digital terrain model for the area generally is considered quite coarse but is a useful tool for use in conjunction with direct observation by field personnel. Table H-19 in Appendix H discusses the publications, reports, and data available for visual and aesthetic resources related to the proposed project. Full references for the studies cited in this Draft EIS are in Chapter 9, References.

3.19.3 Visual Resource Inventory

3.19.3.1 Regional Landscape Identification

The project site is located in the ACP physiographic province and adjacent to the Arctic Foothills physiographic province. The unifying visual characteristics of the regional landscape of the ACP are its essentially flat nature, expansive views, and very low vegetation (all evident year-round), as well as the many lakes and ponds, patterned ground, and vegetation influenced by permafrost. The coastal plain stretches across northern Alaska. Oil and gas development occurs principally in the center of the coastal plain, extending from Deadhorse and the Prudhoe Bay field, west to the Alpine development, and east to the Endicott and Badami developments. The western end of the project study area extends into this area. Roads and pipelines create a network that connects compact nodes of industrial development. In the less-developed areas of the coastal plain there are widely-scattered old gravel pads and airstrips that were created for military use or for oil and gas exploration, but currently are not in use. These may be visible from the air, but without substantial relief or structures built on them, they usually are not visible to viewers on the ground except when immediately upon them. East and west of the main oil and gas development area, the coastal plain is principally undeveloped, with natural elements dominating.



POINT THOMSON PROJECT EIS

Legend

- Existing Pipeline
- Existing Road
- Existing Facilities
- Arctic National Wildlife Refuge
- Point Thomson Visibility Areas
- Primary Study Area Boundary
- Town

Note: This image illustrates the theoretical areas from which lights, flares, reflections, or exhaust plumes at 150 feet above the ground surface at Point Thomson would be visible by an observer 5 ft above the ground surface, accounting for topographic obstructions and the curvature of the earth. This does not account for reductions in visibility based on atmospheric conditions. The digital elevation model in this area is considered "coarse," with elevation values assigned based on a cellsize of approximately 65m by 65m (i.e. no actual elevation change that may exist within 65m is noted). This is meant as a tool to help determine maximum visibility potential. See text.

0 5 10 Miles

Figure 3.19-1

Primary and Secondary Study Areas and Theoretical Maximum Visibility

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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3.19.3.2 Scenic Quality Evaluation

Following BLM methods, the visual assessment described a Point Thomson Scenic Quality Rating Unit based on the primary study area circle and gave the area an "A" rating for scenic quality in summer and a "B" rating in winter (on an A, B, or C scale). The ratings were based on the primarily unaltered nature of the area, its striking expansiveness, the visual variety in the coastal and Canning River delta areas, and the importance of the adjacent scenery of the Brooks Range and Beaufort Sea, including its coast, islands, and ice pack. The rating was lower in winter because the variety and visual interest generated by liquid water (lakes, ponds, streams, Lyon Bay, and Beaufort Sea) is mostly absent, and the color and variety of vegetation is covered by snow. Table 3.19-1 summarizes the ratings.

Table 3.19-1: Summary of Scenic Quality Rating for the Point Thomson Unit

Characteristics	Ratings*		Basis for Rating (from BLM methodology)
	Summer	Winter	
Landform	3	3	"Striking" in expansiveness of plain; "detail features interesting though not dominant or exceptional."
Vegetation	4	1	"A variety of vegetative types as expressed in interesting forms, textures, and patterns" but on a scale mostly visible in the close foreground. Vegetation not visible in winter.
Water	5	1	Ocean, large braided river, beaded streams, and extensive ponds create variety and interest in summer. Lack of liquid water in winter.
Color	4	3	Variety of color in combination of vegetation and water in summer. In winter, the changing quality of light as reflected in the snow.
Adjacent scenery	5	4	Adjacent Brooks Range and Beaufort Sea scenery greatly enhances visual quality. The sea is less visible in winter when frozen.
Scarcity	3	3	Area is "distinctive, but somewhat similar" to other areas of the coastal plain and unusual overall in the U.S.
Cultural Modification	0	0	"Modifications (structures, etc.) add little or no visual variety to the area, and introduce no discordant elements."
Total Score	24 (A)	15 (B)	

* BLM Manual 8410 indicates ratings as follows: A = 19+; B = 12-18; C = 11 or less. Appendix N provides additional information on the scenic quality ratings.

The visual assessment (Appendix N) addresses several other features common to the coastal plain that are not covered in the BLM methods, including:

- Atmospheric effects, such as arctic mirage, which can make objects appear larger than they actually are and can "lift" images from beyond the horizon, potentially increasing visibility of features under some conditions.
- Darkness and light, including the "midnight sun" and a mid-winter "day" that is a 5-hour period of twilight without direct sunlight. Between these extremes are long periods of slow sunrises and sunsets and low-angled sun in general, which colors the environment. With long winter nights, natural darkness is a common feature over much of the coastal plain, where moonlight, starlight, the aurora borealis all may be bright and visually dominating.

- Arctic haze, which is thought to be pollutants concentrated in the arctic from distant industrial sources and can reduce visibility.
- Fog and ice fog, which can obscure visibility but also can reflect artificial light and project it skyward where it may be visible even when the light source itself is not. Fog is common in the study area and can dramatically alter visibility when compared to the mostly-clear weather conditions during the on-site visual assessment work.
- Blowing snow, which is common in winter and creates sinuous patterns across the ground. Blowing snow can be severe and can limit visibility to only a few tens of feet, even on otherwise clear days.

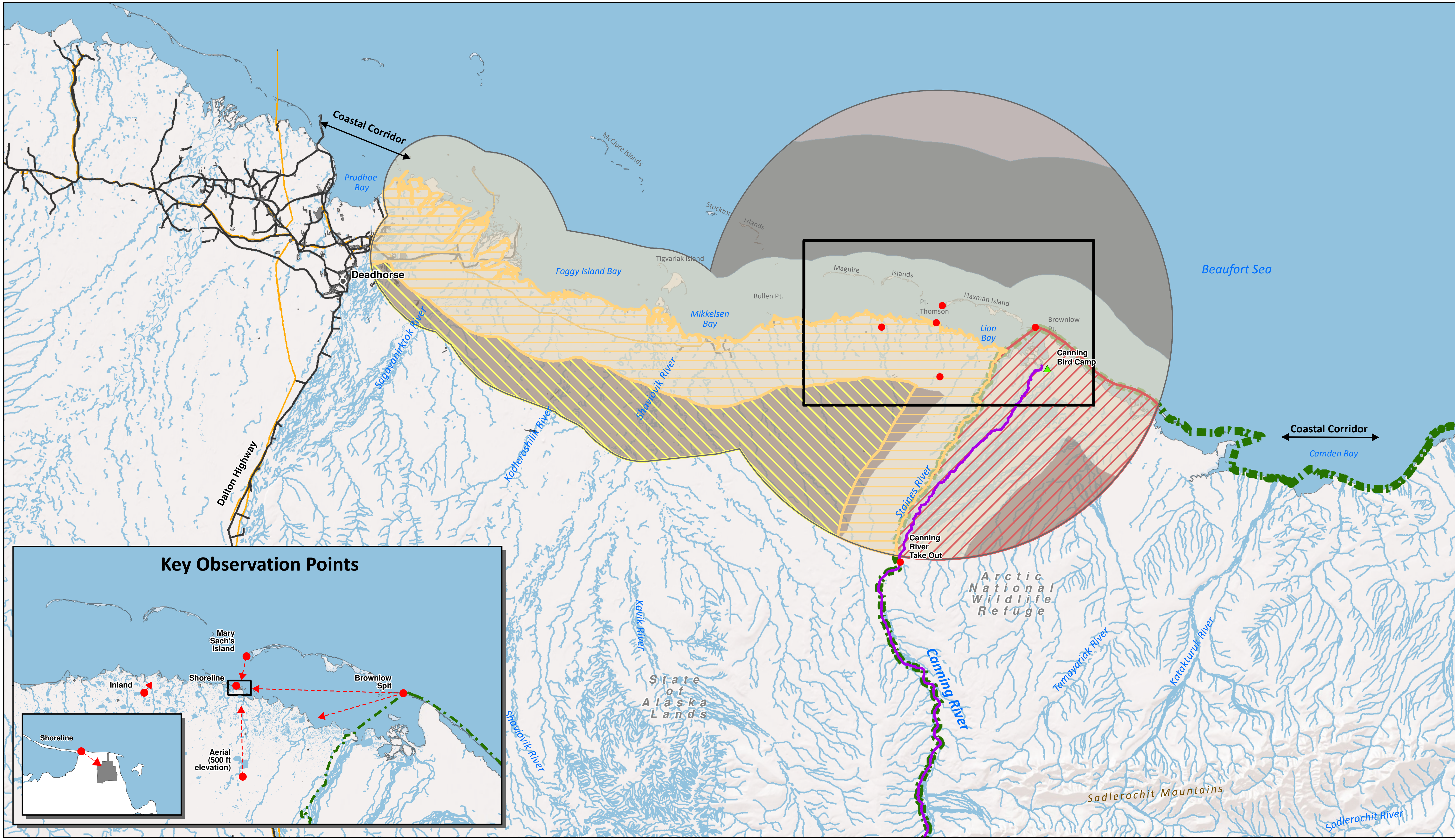
3.19.3.3 Sensitivity Level Analysis

The visual assessment describes "sensitivity level rating units." Sensitivity is based on types of users (primary users are local residents, visiting recreationists, and industrial workers), level of use (low, except at Prudhoe Bay; the visual assessment notes that low encounters with others is an expected condition in natural and wilderness environments), adjacent land uses (Arctic Refuge/state lands), and special areas (Arctic Refuge lands).

All Arctic Refuge lands in the primary study area are rated "high" sensitivity because Congress stipulated that those portions in the study area be managed for their potential future inclusion in the National Wilderness Preservation System (see Arctic National Wildlife Refuge, Section 3.14), and because the refuge manages the land, in part, for its wilderness values. State lands adjacent to the Arctic Refuge boundary and the coastal corridor are rated "medium." Although the appearance of the land itself is virtually identical on each side of the state-federal boundary, and although the study area has high wilderness and natural qualities, the sensitivity of the Arctic Refuge is higher because of its management status, the types of users attracted to it, and the public interest in the Arctic Refuge. Figure 3.19-2 illustrates sensitivity units. Public interest is lower for the state land. The state manages the area for oil and gas development (although this project would be the first long-term industrial development) and has no management guidelines for the visual environment. Similarly, lands along the coastal corridor are rated "medium" because of the use of a coastal corridor by local residents and by recreationists likely to be seeking a mostly natural experience (see Recreation, Section 3.18) in an area of state land otherwise not managed for its visual values. Other state lands in the primary study area but located farther inland are rated "low" sensitivity. The bands of sensitivity zones along the Arctic Refuge boundary and the coastal corridor are 5 miles wide, corresponding with the "foreground-middleground" distance zone explained in the next section.

3.19.3.4 Distance Zones

Distance zones are delineations of near and far views from the most commonly used areas. Distance zones were delineated based on a Canning River recreational use corridor and on a coastal corridor. The coastal corridor is used for local subsistence hunting and camping and for transportation by small boat and snowmobile, in addition to use by a few recreationists. A foreground-middleground zone is 5 miles wide on each side of these corridors. A background zone extends from 5 miles to 15 miles. A "seldom seen" zone is the area beyond 15 miles, but none of the land areas in the primary study area is more than 15 miles from the two corridors. Figure 3.19-2 illustrates the distance zones. The Visual Assessment technical report (Appendix N) provides further information on application of the distance zone definitions.



POINT THOMSON PROJECT EIS

Existing Facilities
Arctic National Wildlife Refuge
Water Body
Stream
Existing Road
Existing Pipeline

Primary Study Area Boundary
Canning River Corridor
Key Observation Point

Visual Sensitivity Level
High
Medium
Low

Distance Zones
Foreground-Middleground - 5 miles from Travel Corridors
Background Seen- 5-15 miles from Travel Corridors
Seldom Seen Zone - Remainder of Lands and Waters in Primary Study Area

Scenic Quality Rating Unit: The Point Thomson Scenic Quality Rating Unit is the all the land areas within the primary study area circle

Visual Resource Classification: Arctic Refuge lands in the primary project area are Class I, and all other lands in the primary study area are class III (see text)

N
0 5 10 Miles

Figure 3.19-2
Scenic Quality Inventory Mapping and Key Observation Points

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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3.19.3.5 Visual Resource Classes and Objectives

Based on the BLM methodology, the visual assessment team assigned Arctic Refuge lands within the primary study area as Visual Resource Inventory Class I, because Congress made an interim management decision in ANILCA to maintain the natural landscape. State lands are assigned Class III, based on a scenic quality rating of "A" in summer when virtually all of the highest sensitivity visitation occurs. These classifications break solely on land ownership/land management lines. Managers of lands in the study area do not have specific visual management objectives, although the Arctic Refuge has general guidance. The State of Alaska and NSB have no visual management objectives specific to the area. The Arctic Refuge Comprehensive Conservation Plan indicates the USFWS:

> "…will identify and maintain the scenic values of the refuge and minimize the visual impact of developments consistent with the constraints imposed by (the management plan as a whole). Refuge facilities and commercial use support facilities will be designed to blend into the landscape." -Arctic National Wildlife Refuge Comprehensive Conservation Plan, USFWS 1988

Arctic Refuge staff also pointed to the federal Wilderness Act, ANILCA, and USFWS's nationwide Wilderness Stewardship Policy (23 USC 23.1131, 16 USC 51, USFWS 2008e), all of which direct management of refuge lands within the study area for maintenance of the natural environment, including the visual environment. For example, the land is managed so that it appears "affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable" (23 USC 23.1131). See further discussion in Appendix N.

3.19.4 Key Observation Points

Lead and cooperating agencies approved key observation points (KOPs) for the project, principally in association with the coastal and Canning River corridors and at graduated distances from the project site. KOP locations were based on the existing Central Pad and East Pad sites and proposed West Pad and pipeline routes common to most alternatives. Table 3.19-2 indicates the KOPs and the key areas viewed from those points. Figure 3.19-2 illustrates the KOP locations. In addition to the KOPs listed in Table 3.19-2, agencies discussed assessing the visibility of the project from the northwest portion of the Molly Beattie Wilderness based on computer simulation without photographs; this site is discussed further in the visual assessment (Appendix N).

Table 3.19-2: Key Observation Points

Key Observation Point (KOP) (Land Ownership)	Primary Element Viewed (Distance from KOP)	Represents
Mary Sachs Island (state land)	Central Pad (1.8 mi.; FG-MG zone) Others: E. Pad 4.25 mi; W. Pad 5.25 mi	Views of local users and some recreationists in the coastal corridor, which has a medium sensitivity rating.
Brownlow Spit (state land near refuge boundary)	East Pad (5 mi.; FG-MG zone) Central Pad (8.2 mi.; BG zone)	Views local users and recreationists in both the coastal corridor and at the northern end of the Canning River corridor, both inside the Arctic Refuge (an area rated high sensitivity) and outside (rated medium sensitivity).
Shoreline West of Central Pad (state land)	Central Pad (0.16 mi.; FG-MG zone) Others: W. Pad (4 mi); Pipeline (1 mi)	Views of local users and some recreationists in the coastal corridor, which has a medium sensitivity rating.

Table 3.19-2: Key Observation Points

Key Observation Point (KOP) (Land Ownership)	Primary Element Viewed (Distance from KOP)	Represents
Bluff at Canning River Takeout (Arctic Refuge land)	Project Site (20 mi.); (SS zone)	Views recreationists and local users in the Canning River corridor, both inside the Arctic Refuge (an area rated high sensitivity) and outside it (rated medium sensitivity).
Aerial, at 500 Feet Above Ground Level at a Point South of Central Pad	Central Pad (4.7 mi.; FG-MG zone) Others: E. Pad 5 mi; W. Pad 7 mi	View of local users, recreationists, and industrial workers from the air.
Inland Southwest of West Pad (state land)	West Pad (0.8 mi.; FG-MG zone) Pipeline (225 ft.)	Views of local users and some recreationists in the coastal corridor, which has a medium sensitivity rating.

FG-MG=foreground-middleground distance zone; BG=background distance zone; SS=seldom seen distance zone.

The Visual Assessment (Appendix N) provides individual descriptions of the existing view from each KOP. The two following subsections present a generalized description.

3.19.4.1 Characteristic Landscape Description—Summer

Landform/Water

Refer to Figure 3.19-2 for names of landmarks in the following descriptions. The coastal plain is the dominant landform from most viewpoints. Views from Brownlow Spit and Mary Sachs Island include gravel island/coastline landforms, including a bluff on the eastern end of Flaxman Island. The plain is flat, without substantial topographic relief over expansive areas. The horizon over the ocean and sea ice is crisp. The Canning River takeout site, where river rafters often finish their trips and are flown out by aircraft landing on tundra and gravel, is located 20 miles upriver. The view from the river in the takeout area is within a wide floodplain on the coastal plain, with low bluffs on each side, and the bluffs obscure long distance views to either side. A short walk up the bluff at this location reveals a full coastal plain view similar to that of the inland site, with somewhat more rolling terrain and no ponds. From all locations, the Brooks Range mountains are visible at 35 to100 miles in the distance, usually as a hazy bluish silhouette. Some detail and texture within the mountains are visible under certain lighting conditions. There are no rock outcrops or geologic formations in the foreground-middleground. There are exposed sand and gravel bars within the Canning River floodplain and along the coast. From a distance these appear as various shades of gray and tan. Up close, individual pebbles have colors ranging from very light gray to brown, reddish, tan, and dark gray. Pingos (ice-core hills) do not appear to be prevalent within the study area as they are elsewhere on the coastal plain.

Water is an important element of the viewed landscape. From the spit, island, and shoreline locations, the marine waters of the Beaufort Sea are a dominant part of the view. The water reflects sky color and sunlight and ranges from white, to blue, to deep blue or black. Near the Canning River, marine waters can be colored a milky tan with sediment from the river. In summer, white ice chunks grounded on the beach and floating nearby contrast sharply with the darker water. The full ice pack commonly is visible to the north. The leading edge is a bright white line. The meeting of ocean waters and the shore creates curving lines that add visual interest. Inland, the coastal plain is dotted with ponds and lakes of various sizes, which add visual variety and interest. Small drainage ways meander between lakes and toward the coast. The Canning River is the only large river in the study area. Within the study area, it is substantially braided into many channels interspersed with gravel bars. In the upper parts of the study area, the river flows rapidly with small standing waves, but there are no waterfalls.

Vegetation

Coastal plain vegetation is arctic tundra. There are no trees or brush. During an early July field visit in 2010, grasses from the previous season dominated at the inland, shoreline, and Canning River takeout sites and were the yellow-tan color of straw. Wetter areas had new green vegetation. The Canning River takeout location had more green vegetation and a profusion of scattered small wildflowers in white, purple, and pale yellow colors. Remaining snow drifts also were visible, particularly along the river bluff. The coastal plain vegetation has the most variation in immediate foreground views; taken over a large area, the fine texture vegetation pattern appears the same and can be somewhat monotonous in views without the additional visual variety of water features, a shoreline, or topographic changes.

Structures

The viewed landscape appears almost entirely unaltered from each of the KOPs. No substantial structures are visible in the baseline condition. From the shoreline site, under the baseline condition, an existing gravel pad would be visible with a few large containers stored on it. At the Canning River takeout site, a USGS environmental monitoring unit is within the view: a human-sized metal structure on metal legs.

The baseline condition is without project-related structures and development. However, during the field visit, the Central Pad was in use for state-authorized exploratory drilling and was covered with a compact cluster of structures, including a tall drilling tower. The PTU-1 pad also was occupied by buildings that were visible from the Mary Sachs Island, shoreline, and inland sites as low silhouettes, distorted in some cases by heat waves in summer.

Other

Wildlife viewing is an important part of the experience for some who visit the ACP. Thousands of caribou were visible passing the inland site at the time of the field visit and visible at a distance from the shoreline site. At the inland site, caribou massed on the western horizon, antlers visible in a long line against the sky. Small numbers of caribou were visible at Brownlow Spit. Freshly worn caribou paths were evident at the Canning River takeout site. Some birds also were visible along the coast, and ground squirrels at the Canning River takeout site.

Some windblown or water-borne industrial litter was evident in beach gravel and at the inland site. Saw-cut driftwood also was evident, apparently the work of travelers along the coast.

3.19.4.2 Characteristic Landscape Description—Winter

Landform/Water

The snow-season winter field visit was conducted in late March 2010. As in summer, the coastal plain itself is the dominant landform in winter from most KOPs. In clear weather, as at the time of the field visit, the ocean and land horizon is a strikingly sharp, crisp, flat line. Views from Brownlow Spit and Mary Sachs Island include gravel island/coastline landforms, including a bluff on the eastern end of Flaxman Island, but the shoreline edges are indistinct compared to summer because the ocean surface is frozen and effectively continuous with the land. Still, they provide some visual variety. Liquid water is not visible in winter, reducing visual variety. The field observer did not visit the inland site in winter. The

Canning River takeout site was not precisely located in winter, but visits to the vicinity indicated massive snow drifts along the river bluffs. From all locations, the Brooks Range mountains are visible at 35 to 100 miles in the distance as a hazy bluish silhouette. Some detail and texture within the mountains is visible, including golden reflections off of snow slopes at certain angles. The mountains form a somewhat jagged line against the sky. Along the base of the mountains, a band of low fog often was visible at the time of the field visit.

Vegetation/Snow

Coastal plain vegetation principally is not visible in winter. Very low vegetation partially blown clear of snow is visible in small patches at Brownlow Spit and more extensively near the Canning River takeout site. Ground cover generally is shallow, wind-sculpted snow. A pattern of small drifts trending east-northeast to west-southwest with the prevailing winds extends to the horizon in all directions, appearing approximately the same across the frozen ocean surface, ponds and the river floodplain, and over land. Variations in drift depth and pattern occur at mainland and island shorelines, and it is generally possible to distinguish between the frozen ocean surface and the land. The pattern of wind-scoured drifts creates a coarse texture to the landscape in the foreground, fading to fine texture in the distance. Some larger lakes and river areas are blown free of snow so that ice is visible, colored slightly in yellow, red, and brown, apparently by vegetation leaching into the water. These are visible mostly from the air and not from individual viewpoints. Snow color generally reflects sunlight conditions and varies substantially throughout the day. Midday sunlight highlights drifts with almost fluorescent brightness, and drift shadows are shades of blue. Other small snow areas between drifts are a soft gold-white color. Late in the day, drift edges are highlighted pink, and shades of blue predominate across the landscape.

Structures

As in summer, under the baseline condition, the viewed landscape appears almost entirely unaltered from each of the KOPs.

Other

Winter site visits at night were conducted at the Shoreline, Mary Sachs Island, and Brownlow Spit KOPs at the time of spring equinox. Depending on time of day, a slight glow on the northwestern horizon is visible after sunset, but the southern and eastern horizons are dark, and the land runs together with the dark sky. During the site visits, ice crystals, wisps of fog, or low clouds in the air diffused some moonlight and starlight. The existing Point Thomson drilling rig was artificially lit, and other cleanup efforts were underway nearby and were lit and visible. No other artificial light was visible. Under baseline conditions, no artificial light would be directly visible. It is possible, under certain conditions of fog and low clouds over concentrations of artificial light, that light from Prudhoe Bay, the Badami development, or Kaktovik would be reflected off the clouds and visible from these KOPs.

3.20 NOISE

The resource study area for noise is a portion of the ACP centered on the proposed Central Pad. The study area extends approximately 20 miles east and southeast, north to Flaxman Island approximately 2 miles, south of the Central Pad approximately 10 miles, and west towards Badami.

3.20.1 Key Information About Noise

The broad coastal plain surrounding the project area is principally undeveloped, with low levels of noise from human activity. Subsistence uses in the area by North Slope residents and the project's proximity to the Arctic Refuge heighten sensitivity to noise effects compared to other North Slope developments. Key information regarding noise in the project area, on land and above the water, includes the assumptions used to conduct the noise analysis. The L_{eq} was used as a baseline metric to compare project-related noise levels and assess increases over existing conditions for areas outside of the Arctic Refuge. Data was collected at six sites in 2010 to characterize the baseline winter and summer acoustic environment in the study area. Existing sound levels during winter and summer conditions are dominated by natural sounds, atmospheric/meteorological phenomena, water features, and animals. Noise from human activities, other than currently permitted industrial activities, is largely absent from the ambient soundscape. Generally, sound levels in the coastal plains near surface water features are the loudest in the study area, while upland coastal plains without the influence of surface water features are the lowest.

For the underwater environment in the study area, most of the baseline acoustic and vibration measurements indicate that noise is primarily from physical (e.g., wind, waves, ice) and biological sources (e.g., whales, seals, fish).

3.20.2 Review and Adequacy of Information Sources for Noise

Studies performed to assess the ambient acoustic environment on the North Slope have been performed for various petroleum-related projects. However, data is somewhat limited and none exists for locations close to the Refuge. Therefore the Corps conducted additional noise monitoring to collect data that was representative of the Point Thomson study area. Proximity to the Arctic Refuge prompted USFWS to seek guidance from the National Park Service Natural Sounds Program and lead to the implementation of the Natural Sounds ambient noise monitoring protocol. This protocol was implemented in areas that were considered representative of the soundscapes identified in the study area which occur inside and outside of the Arctic Refuge.

A review of published reports was conducted to determine the availability of baseline underwater ambient noise measurements for the nearshore waters of Point Thomson. While ambient noise data specifically for Point Thomson do not exist, various acoustic monitoring efforts off the North Slope were identified. Discussions with acousticians involved in acoustic monitoring in the Beaufort Sea confirmed that the best available data for shallow water ambient noise measurements near Point Thomson are associated with acoustic monitoring of industrial sounds for BPXA's Northstar development project (Blackwell and Greene 2010, Thode 2010). The Liberty development project was also considered to be a suitable candidate for comparison because, like Northstar and Point Thomson, Liberty occurs in shallow waters (less than 66 feet in bottom depth).

Table H-20 in Appendix H discusses the publications, reports, and data available for noise related to the proposed project. Full references for the studies cited in this Draft EIS are in Chapter 9, References.

3.20.3 Introduction to Basic Acoustical Concepts

Sound is made up of tiny fluctuations in air pressure. Sound, within the range of human hearing, can vary in intensity by more than one million units; therefore, a logarithmic scale, known as the decibel scale (dB), is used to quantify sound intensity and compress the scale to a more manageable range.

Sound is characterized by both its amplitude (how loud it is) and frequency (or pitch) measured in Hertz (Hz). The human ear does not hear all frequencies equally. In fact, the human hearing organs of the inner ear deemphasize very low and very high frequencies. The A-weighted scale (dBA) is used to reflect this selective sensitivity of human hearing. This scale puts more weight on the range of frequencies where human hearing is most sensitive, and less weight on those frequencies we do not hear as well.

Noise is defined as unwanted sound. The human range of hearing extends from approximately 3 dBA to around 140 dBA. Table 3.20-1 presents common noise sources and their noise levels.

Table 3.20-1: Common Noise Sources and Noise Levels

Sound Pressure Level, dBA	Source
120	Jet aircraft takeoff at 100 feet
110	Same aircraft at 400 feet
90	Motorcycle at 25 feet Gas lawn mower at 3 feet
80	Garbage disposal
70	City street corner
60	Conversational speech
50	Typical office
40	Living room (without television)
30	Quiet bedroom at night

Source: Rau and Wooten 1980

Decibel levels from two or more sources are not arithmetically added together to determine the total sound level. Rather, the combination of two sounds with an equal decibel level yields an increase of 3 dB. On average, a 3 dB change in the A-weighted sound level is generally considered to be barely perceivable, whereas a 5 dB increase is clearly noticeable to a person with average auditory senses. A 10 dB change is perceived by most people as a doubling or halving of the perceived loudness.

Sound pressure waves travel (propagate) away from the noise source. Atmospheric and meteorological conditions affect the way sound propagates. Wind speed and direction can affect sound propagation. The ground surface can also affect the way sound propagates. Hard frozen snow and ice are two surface types that reflect sound, causing it to travel farther (propagate more efficiently). In the summer, soft tundra is more acoustically porous.

Environmental sound or noise is often expressed as a sound level occurring over a stated period of time, typically one hour. When the acoustic energy is averaged over the stated period of time, the resulting equivalent sound level represents the energy-based average sound level. This is called the equivalent level, or L_{eq}. Therefore, the L_{eq} represents a constant sound that, over the specified period, has the same acoustic energy as the time-varying sound.

Noise levels are also expressed using statistical acoustical descriptors including L_{10}, L_{50} and L_{90}. The L_{10} means the noise level exceeded 10 percent of the hour. The L_{50} is the median noise level (i.e., the level exceeded 50 percent of the hour). The L_{90} means the noise level exceeded 90 percent of the hour. These descriptors are used to describe the distribution of noise levels over a given time period.

3.20.4 Acoustic Monitoring Objectives

The noise measurement methodology was developed through coordination with the Corps, the NMFS, USFWS, NSB, and NPS. The primary considerations in the development of the measurement methods included identification of primary soundscapes within the study area, measurement in a wide range of conditions, and addressing noise concerns of participating and cooperating agencies.

The study area does not include any national park lands; however, USFWS relies on NPS expertise in the field of environmental acoustics. NPS recommended to USFWS that the study area soundscape be documented using NPS methods. During scoping, cooperating agencies and project stakeholders raised concerns regarding the potential for project-related noise to disturb polar bears, caribou, bowhead whale, and other animals in the area. Due to the unique natural soundscapes in the Arctic Refuge and concerns over noise-related disturbances to refuge wildlife, the USFWS accepted the NPS recommendation and requested that the NPS Natural Sounds Program, "Acoustics and Soundscape Studies in National Parks," be used for soundscape monitoring (NPS 2005). This methodology was subsequently adopted by the Corps for the project noise assessment within the Arctic Refuge. The following monitoring goals were recommended as part of the noise assessment:

- Measure and record the natural soundscape in winter and summer conditions,
- Collect useable data for a minimum of 23 days to clearly define the range of sound levels in the natural soundscape, and
- Use existing data to characterize underwater soundscapes (see Section 3.11, Marine Mammals).

From these initial goals, the objectives of the acoustical study were finalized as:

- Identify the primary airborne soundscapes within the project area,
- Measure sound levels in a wide range of conditions during winter and summer, and
- Collect adequate data to address noise concerns of participating and cooperating agencies.

3.20.5 Methodology

The L_{eq} metric, measured using NPS methods, was used as a baseline by which to compare project-related noise levels and assess increases over existing conditions for areas outside of the Arctic Refuge. Existing available underwater noise data from similar North Slope oil and gas development projects were used to assess potential impacts in the marine environment and therefore, were not measured as part of the baseline acoustic data collection.

3.20.5.1 Monitoring Locations

Sound data was collected at six sites in 2010 to characterize the baseline winter and summer acoustic environment in the project area (Figure 3.20-1). These sites and the environmental setting they represent are described below. This analysis assumes that each monitoring location is a soundscape that is representative of similar areas in the study area, both inside and outside of the Arctic Refuge. For example, the upland coastal plains monitoring location represents all upland coastal plain locations in the study area, both inside and outside the Arctic Refuge. Table 3.20-2 presents the types of data collected and the metrics calculated from that data.

Canning River West Bank (representing upland coastal plain near surface water features in the summer and winter). The Canning River West Bank site is close to a recreational camp site and landing strip used during summer. Measurements at the Canning River site are representative of the upland coastal plain soundscape near surface water features. This soundscape represents areas covered with tundra, and includes the sound associated with surface water features such as rivers and streams in the summer season. Sounds from animals that travel along rivers and streams and animals near small lakes are also a component of this soundscape. During wintertime, the surface water features are frozen, minimizing the noise associated with water movement.

Coastal Plain (representing upland coastal plain in the summer and winter). The Coastal Plain site was selected to be representative of the upland coastal plain soundscape in the project area without noise from currently permitted industrial activities at Point Thomson. This soundscape represents areas covered with tundra and is dominated by the sound of weather events. During summer it is dominated by sounds of animals, including caribou, bears, and insects. It is largely absent of noise associated with the interaction of waves and shoreline and animals that inhabit the seashore.

Mary Sachs Island (representing off-shore islands in winter). This soundscape represents off-shore islands where sounds associated with wave and shoreline interaction, weather, and animals dominate. However, during the winter the sea is frozen, so the sounds from waves are absent. Mary Sachs is representative of Flaxman Island, where polar bears den. The presence of polar bear dens on Flaxman Island precluded its use as a monitoring site during the winter; therefore, Mary Sachs Island was used.

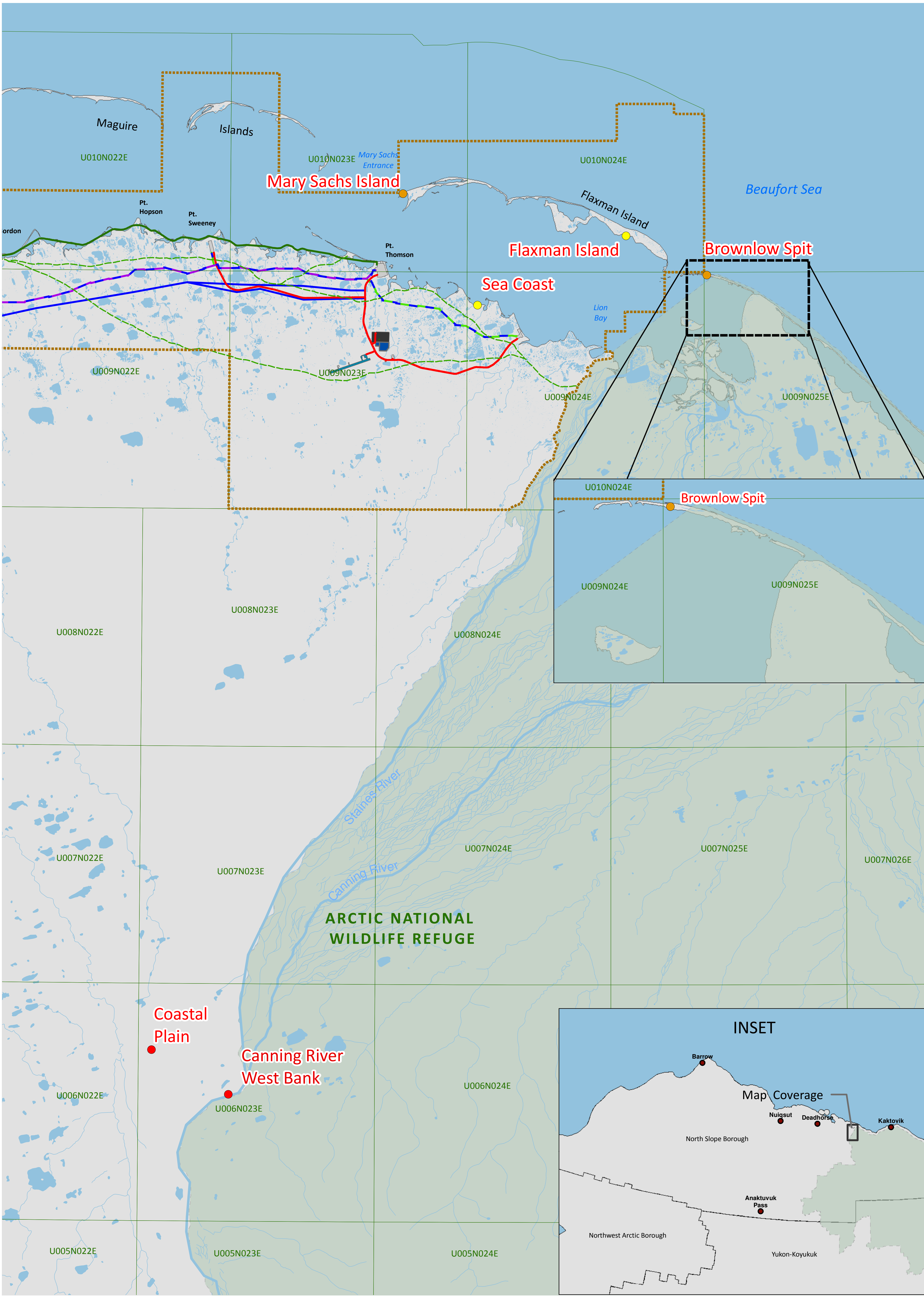
Flaxman Island (representing off-shore islands in summer). During the summer, the monitoring equipment was moved from a lower site on Mary Sachs Island to a higher site on Flaxman Island to avoid open water reaching the equipment on Mary Sachs Island.

Brownlow Spit (representing coastal shoreline in winter).The Brownlow Spit site is representative of the coastal shoreline soundscape. The soundscape is similar to the off-shore island soundscape, but because there is coastal shore on only one side, there may be somewhat less noise from wave and shoreline interaction during ice-free seasons than on the nearby islands. Brownlow Spit is a destination point for Kaktovik residents by boat and snowmobile and is used by other Arctic Refuge visitors.

Sea Coast (representing coastal shoreline in summer). An additional site, the Sea Coast, was added to represent the coastal shoreline in summertime. The Brownlow Spit site was not available during the summertime due to activities unrelated to this project.

Table 3.20-2: Types of Data Collected and the Metrics Calculated at the Study Sites

Types of Data	Calculated Metrics	
Meteorological (1- sec intervals)	Wind Speed and Direction	
Spectral Sound Pressure Level (1-sec intervals)	L_{10} L_{50} L_{90}	L_{eq} L_{max} and L_{min}
Audio Recordings	Time audible (nonnatural sources)	



POINT THOMSON PROJECT EIS

0 1 2 Miles

Legend

Sample Locations
- Noise - Winter and Summer
- Noise - Summer
- Noise - Winter
- Township Boundaries

- Arctic National Wildlife Refuge
- North Slope Borough
- PointThomson Oil and Gas Unit
- Bullen-Stains River Trail

Proposed Project
- Tundra Ice Road
- Sea Ice Road
- Gathering Pipelines
- Export Pipelines
- Road Centerline

- Airstrip
- Gravel Mine
- Gravel Pads
- Ice Pads

Figure 3.20.1

Noise Assessment Monitoring Locations

Date: 24 October 2010
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information

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3.20.5.2 Wind Speed and Direction

RM Young anemometers recorded wind speed and direction every second. Because high winds can mask other sounds, data collected during hours with wind speeds greater than 5 m/s (11 mi/hr) for more than 25 percent of the hour were excluded from the remainder of the noise analysis. This screening step is a component of the NPS Natural Sounds methodology. The effect of this screening step is to reduce the measurement data to periods with low winds and no man-made noise.

3.20.5.3 Sound Pressure Levels

Larson-Davis model 831 sound level meters measured broad-band and spectral sound pressure levels. The measurement data were stored every second throughout the duration of the monitoring events. Low-noise microphones were not used because they are not suited for use in arctic winter conditions. Based on these measurements, the hourly average L_{eq}, L_{10}, L_{50}, L_{90}, L_{min} and L_{max} was calculated for each study site.

3.20.5.4 Audio Recordings

Edirol R-09 units recorded continuous MP3-quality audio recordings at three of the monitoring sites. The audio recording device failed at the Canning River West Bank site; therefore, no audio data was recovered at that location.

Refer to the Noise Technical Report in Appendix O for further details concerning methods used for data collection, and data processing.

3.20.6 Existing Sound Levels in the Project Area during Winter Conditions

The ambient soundscape of the study area during the winter season is dominated by noise from nature: atmospheric/meteorological phenomena and animals. Noise from human activities is largely absent from the ambient soundscape in the project area. Data collection during winter and summer occurred at six locations represented by four principal soundscapes in the project area. These include upland coastal plains, upland coastal plains near surface waters, coastal shoreline, and off-shore islands. The following sections discuss monitoring activities at locations representative of these soundscapes.

The hourly L_{10}, L_{50}, and L_{90} were calculated at each site from all valid data (wind speeds greater than 5 m/s for less than 25 percent of the hour). In this regard, the values shown in the following figures are cumulative for the valid hours of data. Instrumentation noise (the noise an electrical system makes by itself) interfered with measurements of very low sound pressure levels at certain sites during certain conditions, as noted below. Each location where data collection occurred represents one of the four soundscapes present in the study area.

3.20.6.1 Canning River West Bank

Overall noise levels at the Canning River monitoring site ranged from approximately 21 to 54 dBA. Hourly mean (Leq) noise levels at the Canning River monitoring site range from 45 to 50 dBA. Hourly median noise (L_{50}) levels at the Canning River monitoring site ranged from 39 to 49 dBA (Figure 3.20-2), comparable to a quiet occupied room.

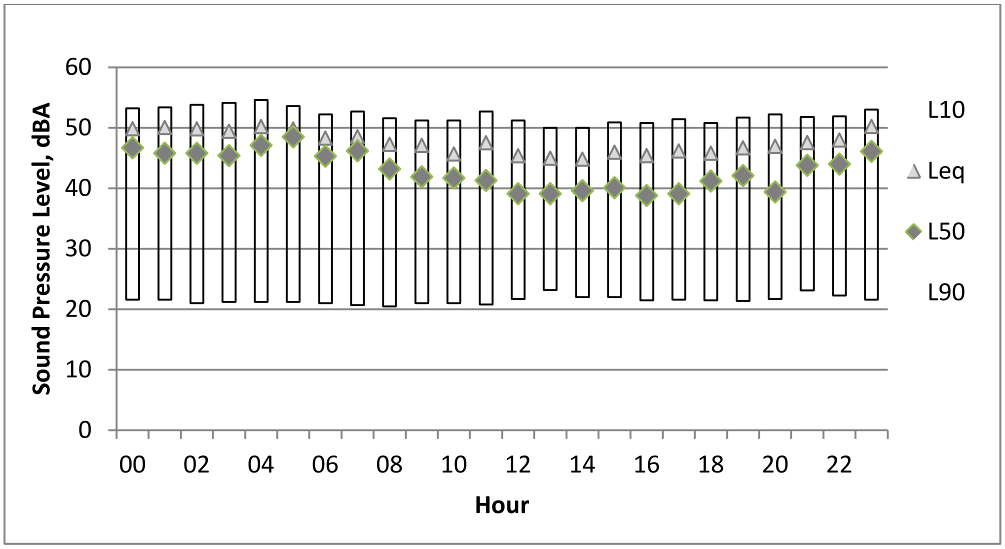


Figure 3.20-2: Canning River Winter Season Broadband Noise Levels

(Hourly averages of broadband sound levels from April 27 to June 8, 2010 during winter conditions. The top of the box represents the L10 and the bottom represents the L90.)

3.20.6.2 Coastal Plain

Overall broadband noise levels ranged from approximately 21 to 39 dBA. Hourly mean (Leq) noise levels at the Coastal Plains monitoring site range from 29 to 35 dBA, and the L_{50} levels at the Coastal Plain site ranged from 23 to 28 dBA (Figure 3.20-3) . Noise levels in this range are low and quieter than most unoccupied rooms.

Hourly median sound levels (L_{50}) in the Coastal Plain ranged from 23 to 28 dBA. Noise levels in this range are potentially influenced by instrument noise; therefore, it is possible that L_{50} levels at the Canning River site could have been lower than depicted. The narrow range of sound levels among all hours of the day indicates that sounds are fairly consistent, and that few loud events occurred during the measurement period.

The audible noise environment in the coastal plains during the winter season is dominated by natural sources such as wind and wildlife. Human-caused noise identified through audio review (i.e., aircraft overflight) ranged from 0 to 1 event per hour. Noises from current Central Pad operations were not audible during selective audio review, likely due to the distance from the pad (approximately 20 mi).

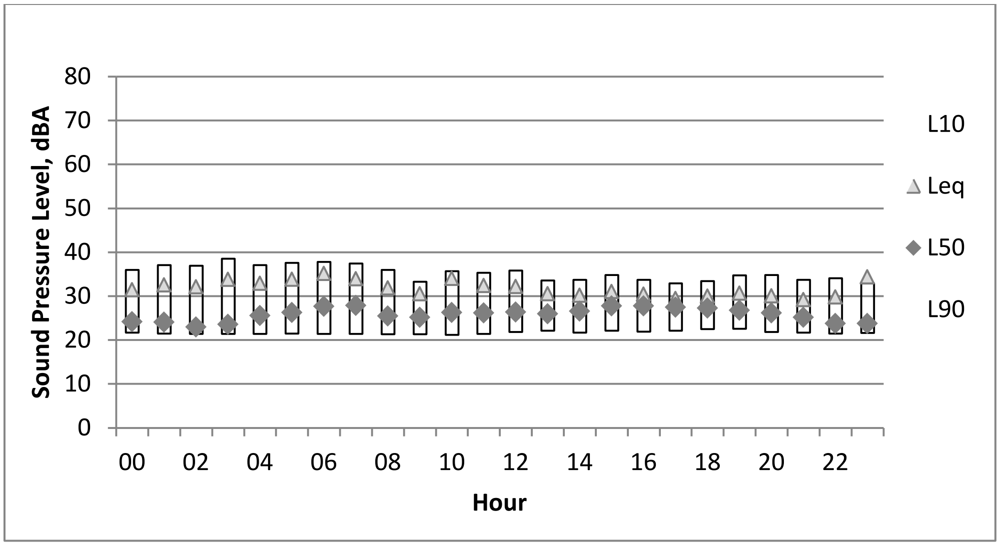


Figure 3.20-3: Coastal Plains Winter Season Broadband Noise Levels

(Hourly averages of broadband sound levels from April 27 to June 8, 2010 during winter conditions. The top of the box represents the L_{10} and the bottom represents the L_{90}.)

3.20.6.3 Mary Sachs Island

The acoustic environment at Mary Sachs Island during the winter season is influenced by both natural and human-caused sounds, including industrial activities at the Central Pad (less than 2 miles away). The range of noise levels recorded at Mary Sachs indicates that louder noise events occur intermittently (Figure 3.20-4). Human-caused noises included aircraft overflight, public address announcements, equipment backup alarms, and other industrial noises associated with the Central Pad. Equipment used at the Central Pad also influences the background noise levels by 20 decibels or more in the low and mid-range frequencies. During selective audio review, these human-caused noises were audible between 0 and 100 percent of any particular hour.

Overall broadband noise levels ranged from approximately 23 to 43 dBA. Hourly mean (Leq) noise levels at the Mary Sachs Island monitoring site range from 27 to 40 dBA. Hourly median (L_{50}) noise levels at the Mary Sachs Island monitoring site ranged from 24 to 30 dBA dependant on the hour. Noise levels in this range are low and quieter than most unoccupied rooms.

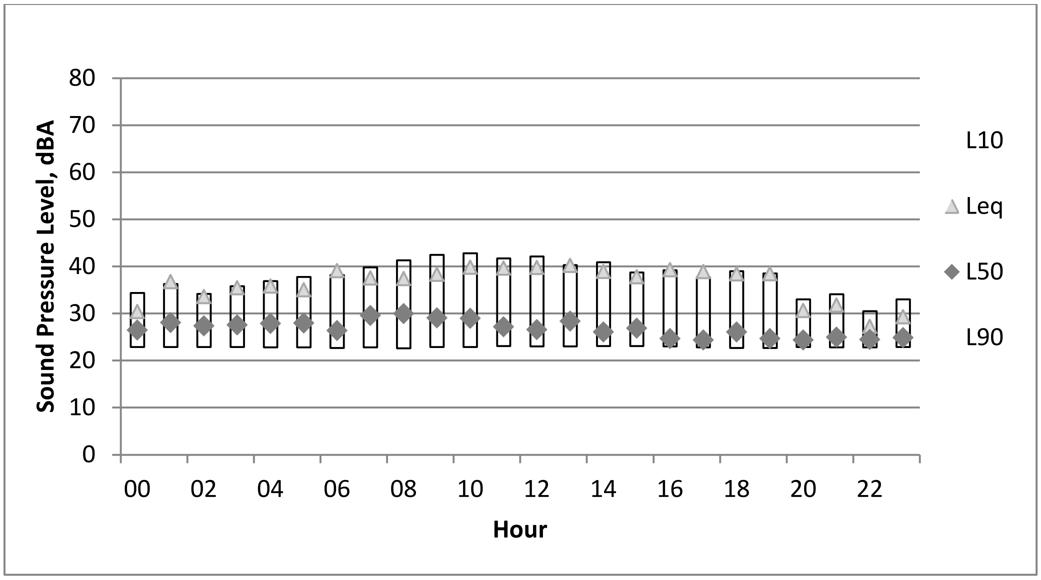


Figure 3.20-4: Mary Sachs Island Winter Season Broadband Noise Levels

(Hourly averages of broadband sound levels from April 27 to June 8, 2010 during winter conditions. The top of the box represents the L_{10} and the bottom represents the L_{90}.)

3.20.6.4 Brownlow Spit

Overall broadband noise levels ranged from approximately 20 to 43 dBA. Hourly mean (L_{eq}) noise levels at the Brownlow Spit monitoring site range from 22 to 40 dBA. L_{50} levels ranged from 21 to 23 dBA, noise levels in this range are very low and quieter than most unoccupied rooms (Figure 3.20-5). Sound levels in this range could have been influenced by instrument noise, so it is possible levels were lower than 20 dBA. The range of noise levels among all hours of the day was fairly narrow, with the exception of hour 0900 (for unknown reasons). Other than this exception, the narrow range of noise levels indicates that the ambient sounds are fairly constant and there are few loud noise events in the area.

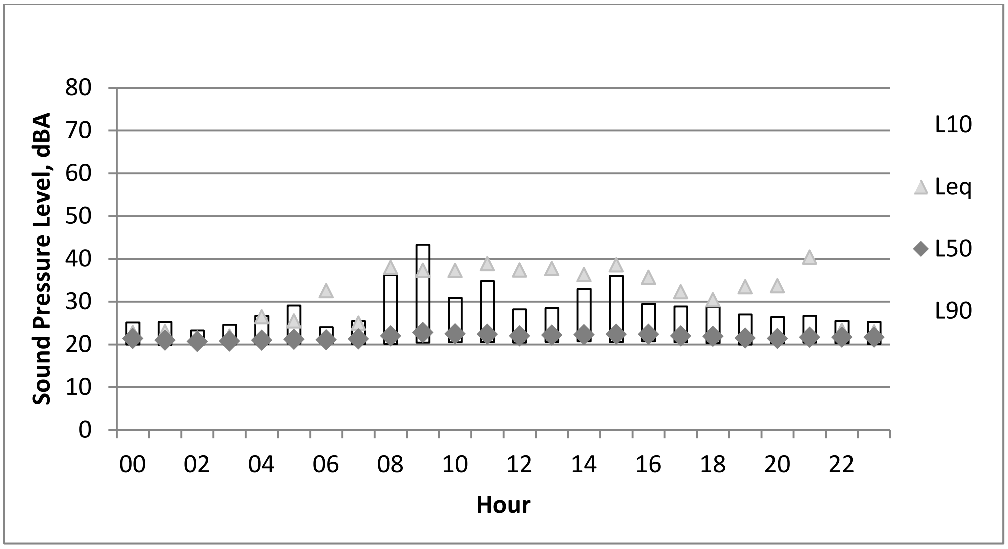


Figure 3.20-5: Brownlow Spit Winter Season Broadband Noise Levels
(Hourly averages of broadband sound levels from April 27 to June 8, 2010 during winter conditions. The top of the box represents the L_{10} and the bottom represents the L_{90}.)

3.20.7 Existing Sound Levels in the Project Area during Summer Conditions

The ambient soundscape of the study area during the summer season is dominated by noise from nature: atmospheric/meteorological phenomena, water features and animal.

3.20.7.1 Canning River West Bank

Overall broadband noise levels ranged from approximately 28 to 68 dBA. Hourly mean (L_{eq}) noise levels at the Canning River monitoring site range from 38 to 44 dBA, with one spike to 68 dBA (likely due to aircraft noise). Hourly median noise (L_{50}) levels at the Canning River monitoring site ranged from 33 to 42 dBA (Figure 3.20-6), comparable to a quiet occupied room.

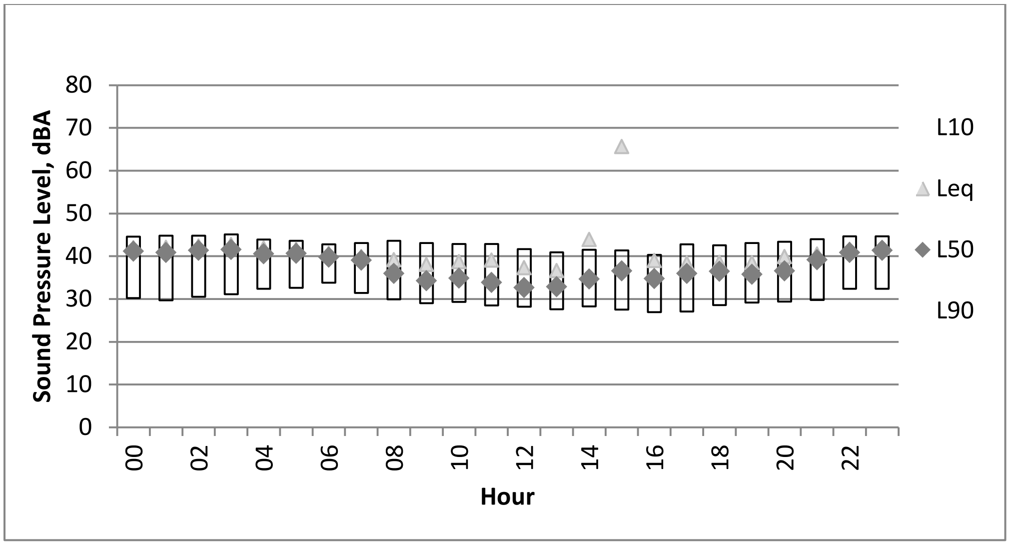


Figure 3.20-6: Canning River Summer Season Broadband Noise Levels

(Hourly averages of broadband sound levels from July 12 to August 12, 2010 during summer conditions. The top of the box represents the L_{10} and the bottom represents the L_{90}.)

3.20.7.2 Coastal Plain

Overall broadband noise levels ranged from approximately 24 to 40 dBA. Hourly mean (L_{eq}) noise levels at the Coastal Plain monitoring site range from 26 to 40 dBA. L_{50} levels at the Coastal Plain site ranged from 24 to 26 dBA (Figure 3.20-7). Noise levels in this range are low and quieter than most unoccupied rooms. Noise levels in this range are potentially influenced by instrument noise; therefore it is possible that L_{50} levels at the Coastal Plain site could have been lower than depicted. The narrow range of sound levels among all hours of the day indicates that sounds are fairly consistent, and that few loud events occurred during the measurement period.

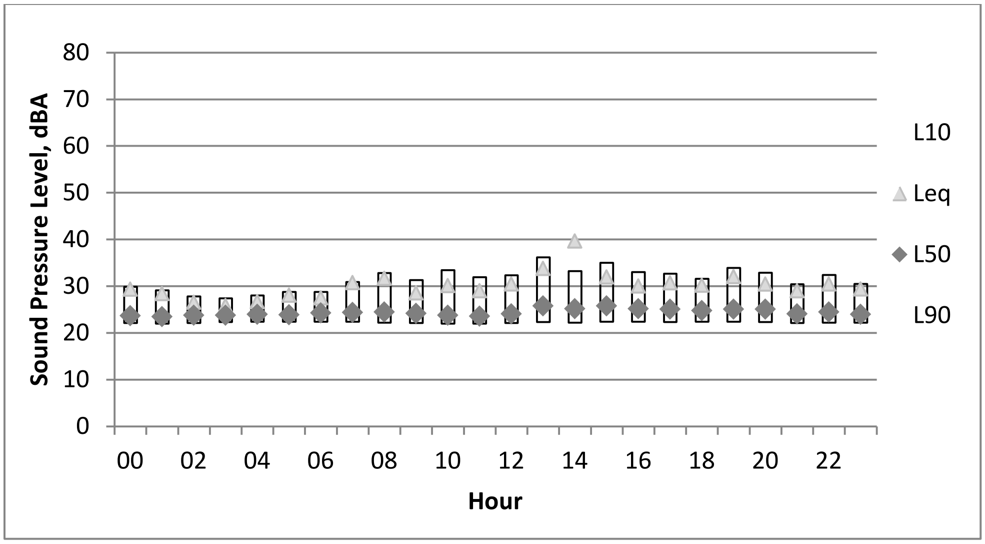


Figure 3.20-7: Coastal Plain Summer Season Broadband Noise Levels

(Hourly averages of broadband sound levels from July 12 to August 12, 2010 during summer conditions. The top of the box represents the L_{10} and the bottom represents the L_{90}.)

3.20.7.3 Flaxman Island

The acoustic environment at Flaxman Island during the summer season is influenced by both natural and human-caused sounds, including industrial activities at the Central Pad. The range of noise levels recorded at Flaxman Island indicates that louder noise events occur intermittently (Figure 3.20-8). Human-caused noises included aircraft overflight, equipment backup alarms, and other industrial noises associated with the Central Pad. During selective audio review, these human-caused noises were audible between 0 and 100 percent of any particular hour.

Overall broadband noise levels ranged from approximately 26 to 50 dBA. Hourly mean (L_{eq}) noise levels at the Flaxman Island monitoring site range from 41 to 50 dBA. Hourly median (L_{50}) noise levels at the Flaxman Island monitoring site ranged from 37 to 41 dBA dependant on the hour. Noise levels in this range are comparable to an unoccupied room or a very quiet room at night.

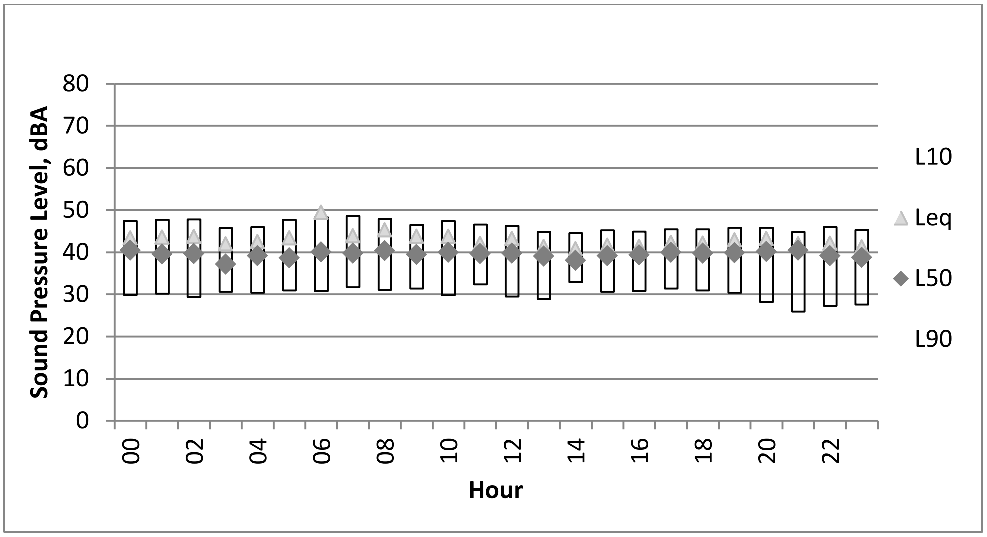


Figure 3.20-8: Flaxman Island Summer Season Broadband Noise Levels

(Hourly averages of broadband sound levels from July 27 to August 30, 2010 during summer conditions. The top of the box represents the L_{10} and the bottom represents the L_{90}.)

3.20.7.4 Sea Coast

Overall broadband noise levels ranged from approximately 25 to 52 dBA. Hourly mean (L_{eq}) noise levels at the Sea Coast monitoring site range from 40 to 48 dBA. L_{50} levels ranged from 34 to 43 dBA, comparable to a quiet occupied room (Figure 3.20-9).

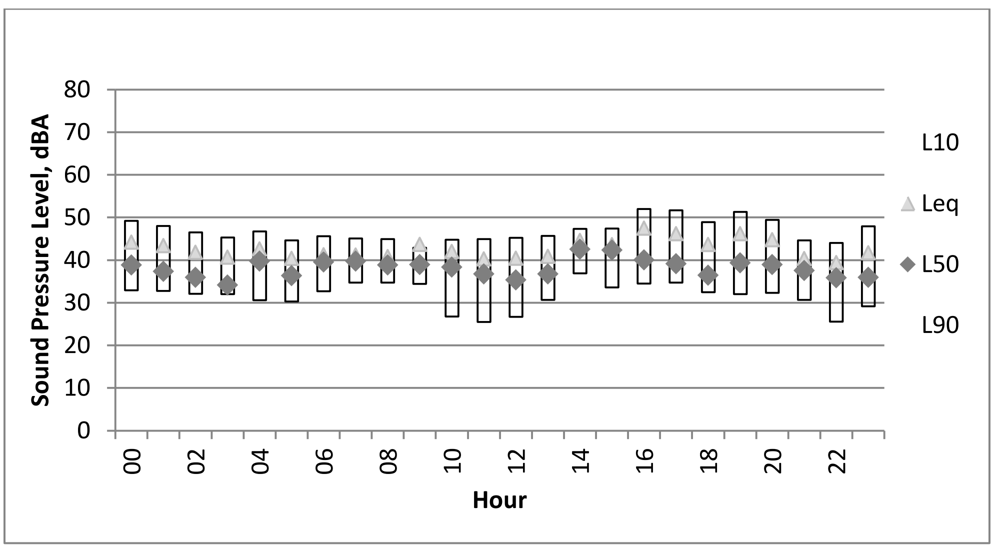


Figure 3.20-9: Sea Coast Summer Season Broadband Noise Levels

(Hourly averages of broadband sound levels from July 29 to August 12, 2010 during summer conditions. The top of the box represents the L_{10} and the bottom represents the L_{90}.)

3.20.7.5 Comparisons Among Monitoring Locations

The ambient soundscape in the project area is influenced by both human and natural sound sources. As described in Section 3.20.6, six monitoring locations were used, but are represented by four different soundscapes in the study area: upland coastal plains, upland coastal plains near surface waters, coastal shoreline, and offshore islands. These four soundscapes varied somewhat in sound level, distribution of sounds throughout the day, and range of sound levels. Generally the natural ambient soundscape of the study area during the summer and winter is dominated by natural sounds such as weather events and animals. Noise from human activities, other than currently permitted industrial activities, are largely absent from the ambient soundscape in the project area.

Average existing sound levels in the project study area can vary up to 20 dB dependant on the soundscape and season (Figure 3.20-10). Data in the figure represent all data collected during this study. With the exception of the upland coastal plain soundscape, noise levels generally increased during the summer season due to increased human activity and the influence of moving water.

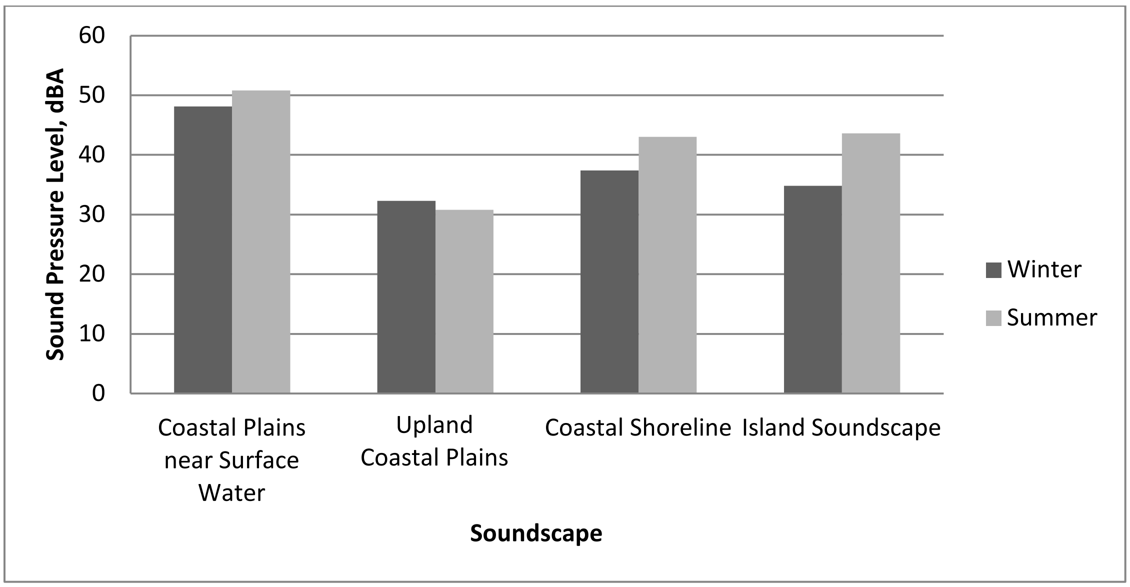


Figure 3.20-10: Equivalent Sound Level Comparison

(L_{eq} averages at four soundscapes recorded during summer and winter conditions)

Generally sound levels in the coastal plains near surface water features include the loudest in the study area, while upland coastal plains without the influence of surface water features are the lowest. Equivalent sound levels at the coastal shoreline and island soundscape are influenced heavily by both natural and human created sound, as determined in selective audio review.

3.20.8 Underwater Ambient Noise in the Study Area

Because marine mammals can be affected by changes in noise levels within their underwater environment, the following sections provide a baseline for understanding the principles of underwater acoustics and the existing underwater noise condition in the study area. Hearing ranges for marine mammal species expected to occur in the study area are presented in Section 3.11, Marine Mammals, while the discussion on the range of impacts and influence of noise on marine mammals in the study area is provided in Section 5.11, Marine Mammals.

3.20.8.1 Some Principles of Underwater Acoustics

Similar to sound in air, underwater sound consists of changes in pressure transmitted through a medium, in this case, water. When quantifying an underwater sound, the same units of in-air measurements apply although some differences exist. The density of saltwater is about 770 to 890 times the density of air at sea level (Denny 1993) and sound travels five times faster in water than in air. The speed of sound depends on the physical properties of the specific medium where sound is transmitted (e.g. water temperature, salinity, and depth).

Because the ocean is highly conducive to sound transmission, marine mammals are exposed to noise both from their local environment and from far away. Underwater noise can be intermittent and local or prevailing (constantly present and originating nearby or from far away), and can come from a variety of sources (Bradley and Stern 2008). Noise sources in the ocean include earthquakes and explosions, shipping and industrial activity, precipitation, ice, water turbulence, and molecular agitation creating sound that is usually imperceptible to humans (Bradley and Stern 2008).

Sound propagation will not only depend on the speed of sound and the physical properties of the medium, but also on absorption, scattering, and reflection specific to the environment. In the open ocean, particles in the water column can affect how sound propagates. Sounds also vary in the nature of their frequency content; low frequency (or pitch) sounds (below 1 kHz) tend to travel further while high frequency (above 10 kHz) will tend to dissipate much faster and are usually of less concern for marine species. Underwater sounds range from very low frequencies (below 1Hz) to over 100,000 Hz (Bradley and Stern 2008). Low frequency sounds have long wavelengths and will tend to be less subject to reflection, scattering, or absorption caused by small particles and localized changed in temperature or salinity. This is particularly true in the open ocean where the bottom will cause limited scattering and reflection of sound. With limited energy loss, long wavelengths or low frequency sounds will tend to travel further, and some sounds can be detected as far as 2,000 miles away.

The amplitude of an underwater sound is measured similarly to in-air measurements using the decibel scale. Hydrophones (underwater microphones) are usually positioned at a given depth and distance from a sound source to directly measure sound waves. Sound pressure levels (SPLs) are of primary importance as they indicate how loud a sound is at a given distance and can help predict if a specific sound is likely to affect a particular species. SPLs are calculated using a logarithmic scale to accommodate for large changes in pressure and are shown as the ratio of the pressure of interest over a reference pressure, both usually measured in microPascals (μPa). In air the reference pressure is 20 μPa (re 20 μPa), while it is only 1 μPa underwater (re 1 μPa). Because underwater SPLs are calculated using a logarithmic scale, a doubling in pressure translates by adding only 6 dB.

Comparisons between in-air and underwater sounds are often difficult because of the different references used to express sound intensity, as well as the very different properties of sound such as speed of sound and density in the two media (Chapman and Ellis 1998). While the range of impacts on marine mammals can vary greatly depending on the species and the nature of the noise, it is important to be able to predict or quantify what sounds might impact to the marine species present in the study area.

When measuring sound, whether it is ambient noise or manmade construction sounds, the noise levels are usually expressed as the total energy across frequencies in dB re 1 μPa (which means that the SPL is evaluated using 1 μPa as a reference; Greene 1995) and are presented as a sound spectrum, which is a graphical representation of the distribution of energy of a sound across different frequencies.

A common concern about anthropogenic noise (noise from manmade activity) is the impact of vibration transmitted through ice or land. Vibrations are usually measured using geophones which are accelerometers that measure particle velocity (PPV) of a movement or the point of maximum velocity in a medium such as tundra, ice or snow. Vibrations are usually expressed in mm/s, but can also be expressed as vibration levels in dB re 1 pm/s (where 1 pm/s is the reference velocity). Vibrations transmitted through the ground or ice can travel faster than airborne sound and cumulative effects of all sounds (in air, in water and vibrational) can potentially disturb animals, particularly in enclosed spaces such as denning polar bears.

3.20.8.2 Underwater Ambient Noise in the Study Area

Ambient noise refers to all sound sources including environmental and anthropogenic sources (Green 1995). Sources of ambient noise include both physical (e.g., ice, waves) and biological (e.g., whales, seals, fish) sounds and anthropogenic sounds can range from boat traffic to construction-associated activities. Important sources of underwater ambient noise off the North Slope are wind, waves, and ice as well as sounds of biological origins (e.g., bearded seals, ringed seals, bowhead whales, and beluga whales; Davis 1981). Shallow-water ambient noise, particularly in the high arctic, is known to be highly variable (Greene 1995). Wind is considered to be the primary factor on shallow water ambient noise level in the absence of human activities, directly and through its effects on ice and waves (Wille and Geyer 1983). The following sections provide an overview of ambient noise levels and construction noise measured in the Beaufort Sea, both in terms of underwater noise and vibrations.

Baseline underwater noise monitoring

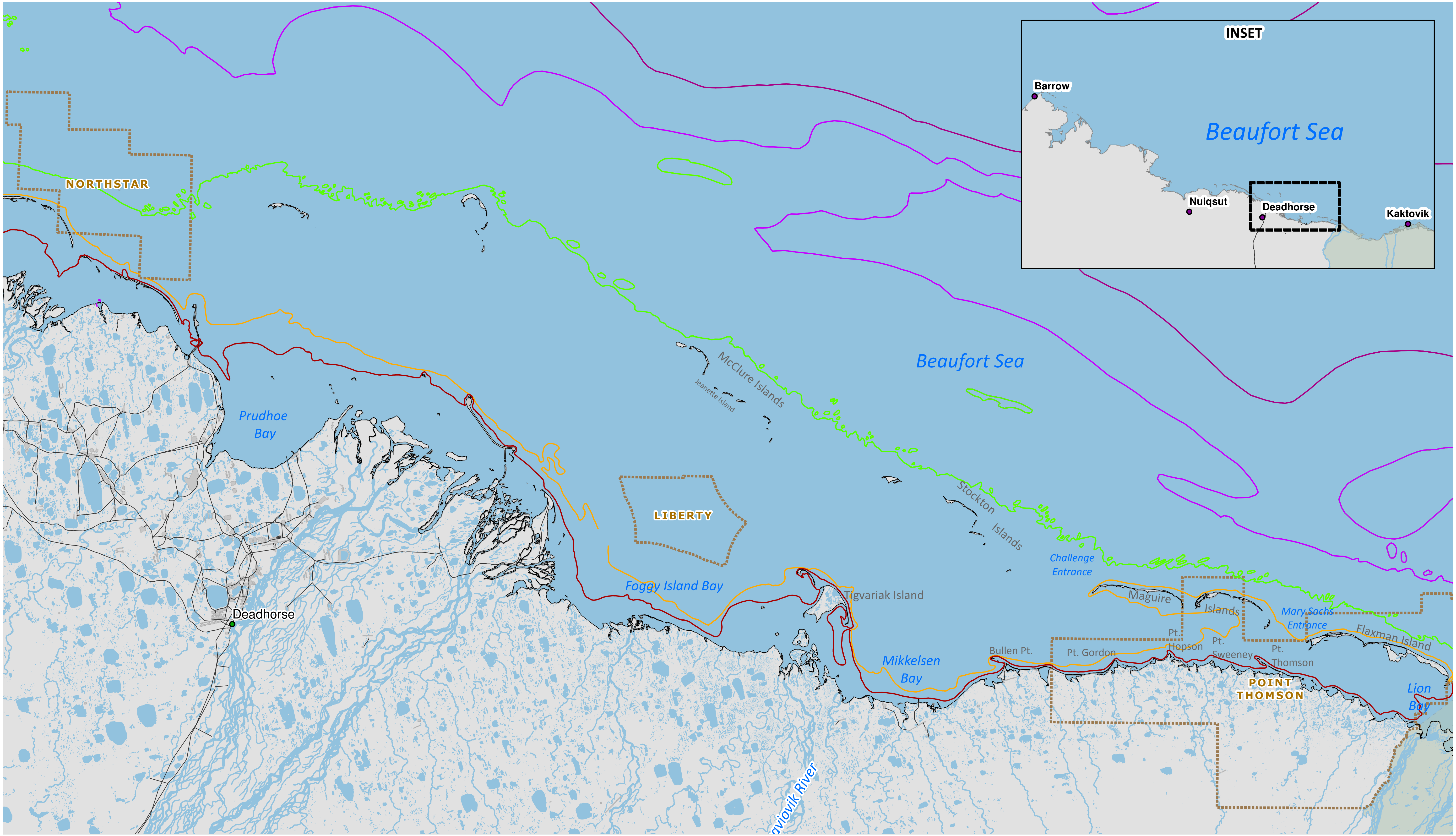
Currently, no underwater ambient noise data has been measured for the study area; however, there are abundant data from the Northstar Island and the Liberty site. (For a discussion of the availability and suitability of data on underwater noise in the Beaufort Sea, see Section 3.20.2).While there are major differences between these sites (primarily in terms of depth, topography, sediment composition, and the presence of barrier islands), the comprehensive ambient noise acoustic monitoring conducted on the North Slope provides (especially in areas with limited human activities)baseline data for comparison purposes in the case of Point Thomson. All three sites (Northstar, Liberty, and Point Thomson) are located within 60 miles of each other (see

Figure 3.20-11) and are all situated in shallow waters with a low bathymetry gradient. Additionally, both Liberty and Point Thomson are located within barrier islands.

Northstar is approximately 60 miles northwest of the Prudhoe Bay industrial complex and approximately 3 miles seaward of the closest barrier island. The 5-acre island is situated in shallow water (approximately 33 feet in bottom depth). The Liberty development project is connected to the mainland by a gravel causeway and is an extension of the Endicott Development project. Liberty is connected about 5.5 miles offshore in about 20 feet of water. The current working area is approximately 11 acres with a future pad extension adding 20 acres of working surface. The Liberty site is approximately 40 miles west of the Point Thomson study site. In contrast to Northstar and Liberty, Point Thomson would be constructed entirely onshore with bottom hole drilling targets located offshore. Point Thomson is approximately 2 miles east of the Badami Development and 6 miles west of the Arctic Refuge.

The North Slope region is known to have limited human activity and most of the baseline acoustic and vibration measurements indicate that noise is primarily from physical and biological sources. Moulton et al. (2003) collected underwater ambient noise measurements at the Northstar site (from 10 to 10,000 Hz) and indicated that received levels were around 85 dB re 1μPa. Blackwell et al. (2007) used Directional Autonomous Seafloor acoustic recorders (DASARs) to monitor the presence of bowhead whales (*Balaena mysticetus*) in the vicinity of the Northstar island near Prudhoe Bay in September for 4 years and found low background noise (<25 percentile) at 87.8 dB, medium background noise (>75 percentile) at 99.1 dB and loud ambient noise (>90 percentile) at 101.6 dB.

Additional underwater measurements of ambient noise in the Prudhoe Bay during the open water (i.e., when no ice was present) season yielded a median ambient noise of 95 dB re 1 μPa (LGL and Greeneridge 1996) and these results are summarized in Table 3.20-3 where 5th, 50th, and 95th percentiles indicate the variations in ambient noise levels and are usually used as standard reference degrees of quiet, median, and loud ambient noise variations for a given study site.



POINT THOMSON
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Legend

Bathymetry - Feet			
5	49	Road	
10	82	Arctic National Wildlife Refuge	
16	115	Oil and Gas Development Units (Used for Underwater Noise Comparison)	
	Towns		

0 5 10 Miles

N

Figure 3.20-11

Oil and Gas Units Along the North Slope
Used for Baseline Data Comparison

Date: 24 August 2011
Map Author: HDR Alaska Inc.
Source: See References chapter for map source information
Uneven contour intervals due to multiple bathymetry sources

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The Liberty site was quieter than Northstar, with the median ambient noise being 82 dB re 1 μPa and ranging from 70 to 100 dB re 1 μPa. Ambient noise measurements were consistently 10 dB less than Northstar in the absence of any man-made activity. Aerts et al. (2008) investigated the degree to which the barrier islands on the offshore side of Foggy Island Bay (near Liberty) attenuate sounds. This is likely the explanation for the observed differences in ambient noise between Liberty and Northstar. During Foggy Island Bay noise measurements, seismic exploration signals were recorded from three different locations within the bay just landward of Jeanette Island, at the main exit from the bay, and on the seaward side of Jeanette Island. Considerable attenuation was noted at the most distant hydrophone offshore of Jeanette Island. This attenuation was greater than expected from spreading loss and was believed to be due to the barrier islands affecting sound propagation and therefore ambient noise levels (Aerts et al. 2008).

Table 3.20-3: Ambient Underwater Noise Levels
(No Human Activity **Observed) in dB re 1 μPa)**

Percentiles*	Prudhoe Bay
5	77
50	95
95	104

*: Airborne sound percentiles are expressed as the level exceeded a given percentage of levels, whereas underwater percentiles are the level *not* exceeded a given percentage of levels. Noise is usually described with the 5% percentile representing quiet, the 50th percentile representing median noise level, and the 95% percentile representing loud.

Source: LGL and Greeneridge 1996

During the ice covered season (winter and spring), fast ice covers the area and underwater ambient noise levels drop dramatically as most physical factors such as wind and wave actions decrease (Greene and Buck 1964, Milne and Ganton 1964) and the presence of marine mammals is also limited (see Section 3.11, Marine Mammals).

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3.21 CULTURAL RESOURCES

This section includes a discussion of cultural resources of the ACP, with particular emphasis on the Point Thomson area. Cultural resources include sites and materials of prehistoric Native American, historic European and Euro-American, and historic Iñupiaq origin (e.g., traditional cabin sites, camp sites, burial grounds, traditional subsistence harvest sites, and other traditional land use areas, landscapes, and place names).

This section incorporates information from the following sources: ADNR Office of History and Archaeology (OHA) Alaska Heritage Resources Survey (AHRS; OHA 2010a), NSB Traditional Land Use Inventory (TLUI; IHLC 2010), cultural resource section from the *Point Thomson Environmental Report* (Exxon Mobil 2009b), a review of available, relevant literature regarding cultural resources in the Point Thomson area, and the U.S. Department of Interior (USDOI) MMS historic shipwreck database (MMS 2000).

The study area for cultural resources includes an area extending from Endicott in the west to Brownlow Point in the east, and from the barrier islands (e.g., Flaxman Island, Maguire Islands) in the north to the area several miles south of Point Thomson. Figure 3.21-1 shows the location of AHRS, TLUI, and shipwreck sites in relation to the study area (for project effects the term “project area” is used and encompasses the APE as described in Appendix P, Section 106 Process Documentation). The site-location information contained in the AHRS, TLUI, or MMS shipwreck database is not available to the public; thus, sites depicted in Figure 3.21-1 have been generalized to ensure confidentiality. Cultural resources in Alaska are recorded in the AHRS files with a trigraph that includes a state code, a coded reference to the USGS 1:250,000 quadrangle (e.g., Beechey Point [XBP]) in which the resources are located and a number for each resource reported to the OHA, who maintain the list. The TLUI site list is maintained by the NSB and includes sites of cultural importance to borough residents using a bigraph code that includes the USGS quadrangle code and a site number. These two data sources can, but do not always, overlap.

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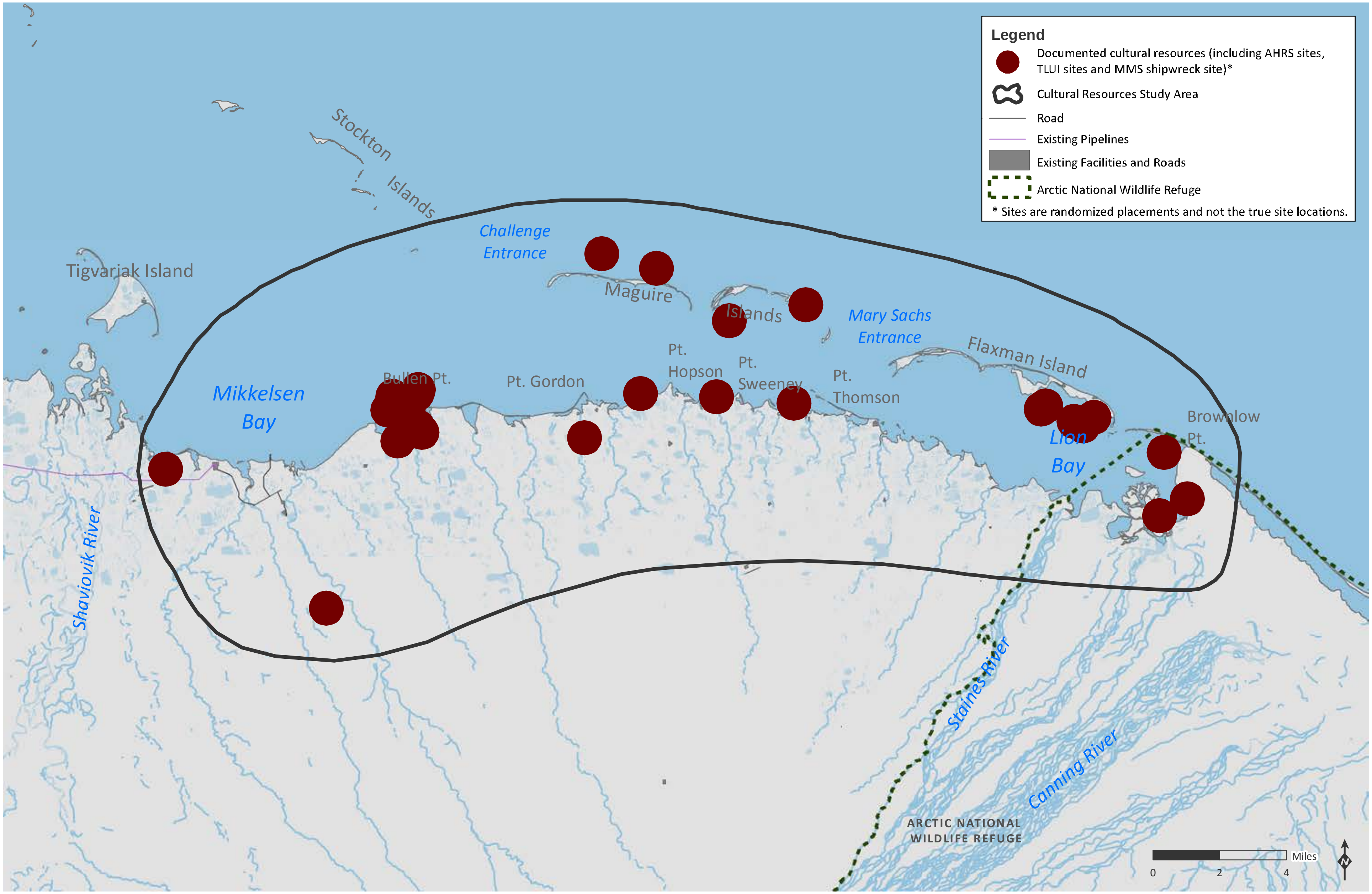

Figure 3-21.1

POINT THOMSON PROJECT EIS

Documented Cultural Resources within the Point Thomson Cultural Resources Study Area

Date: 05/18/2010
Map Author: Stephen R. Braund and Associates

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3.21.1 Key Information About Cultural Resources

In order to properly take into account the potential effects of the undertaking on cultural resources, information has been gathered through several means. Archaeological field surveys were undertaken at different times (see Table 3.21-1) to identify, record, and evaluate the condition and characteristics of cultural resources in the study area. AHRS, TLUI, and MMS databases of documented sites of archaeological, historic, and traditional significance were consulted. Stakeholders, including governmental and nongovernmental entities, as well as former residents of the study area and their descendants, were consulted. In some cases, former residences were revisited with tribal members and archaeologists (CCRS and NLUR 2010). Besides the North Slope Borough's TLUI program, surveys and research to identify and document potential sacred sites, traditional cultural properties (TCPs), historic landscapes, or districts have not been completed to date. Further cultural resource efforts under the project will be addressed through the development of a Programmatic Agreement (PA) under the provisions of Section 106.

Comments made in the scoping process expressed the importance of, investigating the traditional cultural properties and/or cultural landscapes in the study area, and an emphasis on the importance of consultation with local tribal governments and organizations, nongovernmental agencies and other interested parties (Corps 2010, Scoping Comment 10044). General comments were made regarding a desire to maintain the integrity of the landscape as part of the tradition of subsistence, and the continuation of longstanding ties to the landscape through hunting and fishing (Corps 2010, Scoping Comment 10000, 10011, 10012, 10020).

Between Endicott and Brownlow Point, there are 60 recorded cultural resources located in the proposed study area. Archaeologists have assumed that the location of prehistoric and early historic sites are constrained by the availability of elevated, dry ground and proximity to fresh water, sources of fuel and materials for housing and heat, and access to areas where food may be obtained in different seasons (Reanier 2007, NLUR 2008, CCRS and NLUR 2010). Finding these sites is complicated by the active nature of the landscape; coastal and stream erosion, freeze and thaw processes, and vegetation and wildlife constantly affect known and unknown sites (Reanier 2007, CCRS and NLUR 2010). Seasonally and permanently wet or frozen tundra has the potential to harbor cultural resources; however these landforms are generally subject to helicopter surveys if considered at all, as the impacts of excavation in wet tundra, improbability of locating material (besides historically recent winter camp sites), and inherent difficulty in excavation in wet and frozen material preclude such a pursuit (Lobdell and Lobdell 2000).

There are two main locations where cultural resources have been documented in the study area: on barrier islands and protected coasts of the Beaufort Sea, and inland on elevated dry ground landforms such as pingos, river terraces, and bluffs. Sites of greatest antiquity are found inland, as these landforms appear to have long periods of relative stability. Documented coastal sites are mainly historic, as the dynamic coastal environment appears to cause rapid displacement of sediments and soils through erosion, thawing of underlying permafrost and elevated sea levels, and the likely destruction of ancient shoreline sites (CCRS and NLUR 2010). Many Iñupiat TLUI sites documented in the study area are historic sites, and all Euro-American sites in the study area are historic-era sites located along the coast and barrier islands.

3.21.2 Review and Adequacy of Sources for Cultural Resources

The Point Thomson area was examined for historic and prehistoric sites by scientists from as early as 1906, when geologist Ernest Leffingwell began conducting multiyear geological and topographic surveys for the USGS (NLUR 2008). Direct archaeological, historical and ethnohistorical research was conducted by archaeologists on behalf of proponents of hydrocarbon exploration in the study area beginning in 1974 (NLUR 2008) and as early as 1947 in other areas (Reanier 2007). Recent studies specific to Point Thomson development include the cultural resource management plan report by Chumis Cultural Resource Services and NLUR (2010), which summarizes the history of research activity in the study area, efforts to monitor identified resources, makes recommendations for preservation of documented resources, and records the authors' consultations with local stakeholders. NLUR (2008) provides a detailed narrative of the history of site surveys in the study area, including surveys conducted for the proposed project which recovered prehistoric material inland. Reanier (2007) discusses the history of archaeological methodology on the North Slope and examines the proposed rights of way for the Bullen Point Road, which would travel east from the existing road system on a route located away from the coast, avoiding pingos, terraces and bluffs discovered in earlier surveys which harbored prehistoric sites. Lobdell and Lobdell (2000) provide a description of archaeological survey methodology to date on the North Slope, a succinct model of cultural phases, and descriptions of then-known cultural resources and their preservation status. Bacon (1982a, b, 1985) and Lobdell (1980) address in site report form cultural resources in the study area and represent pioneering archaeological survey work on the North Slope of Alaska. Although these reports are comprehensive, they are limited in being site-specific, representing relatively small survey areas focused on project components such as gravel pads, airstrips, borrow pits, road and pipeline routes and barge landings. Additionally, surveys of road and pipeline routes are often conducted from helicopters with little on-foot verification in areas designated as wet tundra. Most cultural resources investigations are expended on resources in the coastal zone, which focuses the surveys towards younger and more plentiful resources such as historic houses and graves, and against older materials that are found in more geologically stable inland locations.

For cultural resources, OHA maintains the AHRS database, an inventory of all reported historic and prehistoric sites within the State of Alaska (OHA 2010a, b). The inventory includes objects, structures, buildings, sites, districts, and travel ways, with the general provision that they are over 50 years old. The AHRS is primarily a map-based system currently in transition to a computerized geographic information system (GIS) database. The AHRS database provides a broad overview of documented resources; however, it has several limitations. Most of the data were compiled before precise GPS location systems were available so locations and extents of cultural resources are often imprecise. Sites in the database are also not frequently updated, and may have been removed or destroyed since being reported, may not resemble the descriptions provided, and may not be described in accurately or in any detail. Additionally, the information in the AHRS database may not be up to date due to more recent data entry delays. Thus, the AHRS is not representative of the actual number and extent of prehistoric, historic and traditional cultural properties present on the landscape. Reports of field surveys used to create AHRS data may be based on varying levels of effort from fixed-wing flyover surveys to intensive, systematic pedestrian survey with extensive subsurface testing. Also, archaeological reports rarely address cultural resources that are nonartifactual, such as traditional cultural properties and cultural landscapes. Despite these limitations, the AHRS files, including the GIS and map based data, archived documents, and reports, represent the best available information for archaeological and historic site locations and extents for the study area.

The Iñupiat History, Language, and Culture Division (IHLC) division of the NSB created the TLUI database to document place names, landmarks, traditional land use sites, travel routes, and important locations remembered by the Iñupiat people to protect these sites from disturbance or destruction due to development activities on the North Slope. A series of reports started in the 1970s document material evidence, recorded history and oral history accounts of Iñupiat and Athapaskan land use in the NSB. The IHLC commissioned these reports as parts of the NPR-A field studies, the NSB Coastal Zone Management Plan, and establishment of the Arctic Refuge and Gates of the Arctic National Park following passage of ANILCA. Information from these reports became the basis for the TLUI database. Because the reports covered overlapping areas, however, single sites received different numbers in each report, with different Iñupiat spellings and different locations and associations based on the recollections of the sources interviewed. Some of these discrepancies were resolved in a pair of reports commissioned by the MMS documenting Nuiqsut and Kaktovik subsistence harvest use patterns (IAI 1990a, b), which resolved the location of significant places from the IHLC reports, clarified site identifications , and associated sites with the families who used them. IHLC is in the process of transferring this information to a GIS-based system. Ongoing efforts by the IHLC to update and document continued use of Iñupiat cultural properties in the NSB reflect the continuity of use of historic and prehistoric sites by contemporary people. The TLUI database represents the best effort at integrating history, oral history and archaeology to understand the late prehistoric and historic period use of lands by the Iñupiat.

Traditional knowledge (TK) is included in the oral history and ethnography used for the TLUI database. Additional TK includes information gathered from public sources such as scoping testimony for EA/EIS documents and other literature (SRB&A 2003a). TK derived from public testimony related to cultural resources can be both general (e.g., testimony regarding long standing use of the Arctic environment) or very specific (e.g., testimony about use of a specific family subsistence camp). TK in public testimony must be broad as those speaking are specialists in the Arctic landscape, conveying their knowledge to nonlocal individuals and agencies. Other aspects of TK are very specific to the area of the scoped projects, many of which are distant from the Point Thomson study area or in the nearshore and offshore lease areas. TK information from local experts in archaeological site visits, subsistence resource interviews, and public scoping and outreach efforts was incorporated and considered where appropriate in both the cultural resources and subsistence sections.

These diverse sources outlined above provide a sound basis for a review of potential effects from the proposed undertaking on documented cultural resources because they are directed at the study area; corroborate previous discoveries; integrate decades of research activity; include perspectives from local stakeholders; and indicate a continuity of content based on multidecadal monitoring of documented cultural resources in the study area (Table H-21 in Appendix H). Limitations in the data include limited ground and subsurface surveys of project areas outside the footprints of project components and the focus of archaeological research efforts towards the barrier island and coastal beach ridge areas. Additionally, limited TK research has been done on the North Slope and there is a lack of TK research focused in the study area. Additionally, the assessment of nonartifactual cultural resources individually, or in related groups as historic districts, cultural landscapes, or traditional cultural properties is under-represented in the study area. The following discussion is based on the existing information; additional information. Investigations, consultation and mitigation will be addressed through provisions developed under the PA. Full references for the studies cited in the following text are included in Chapter 9, References.

3.21.3 Regulatory Framework

The relevant regulations for the evaluation of effects to cultural resources are NEPA and Section 106 of National Historic Preservation Act (NHPA) and its implementing regulations in 36 CFR Part 800. Federal agencies are encouraged to coordinate compliance with Section 106 with any steps taken to meet the requirements of NEPA and should consider their Section 106 responsibilities as early as possible in the NEPA process (36 CFR 800.8a).

Cultural aspects of the environment to be analyzed include historic properties, other culturally valued places, cultural use of biophysical environment (e.g., religious, subsistence), and sociocultural attributes (e.g., social cohesion, social institutions, lifeways, religious practices, and/or other cultural institutions; NPI 2010).

Section 106 of the NHPA (as outlined in 36 CFR Part 800) and Alaska Historic Preservation Act (AS 41.35.010 through AS 41.35.240) protects cultural resources in cases where effects to historic properties may occur as a result of proposed federal undertakings. Compliance with these state and federal laws is required when the project location is under the purview of federal or state stewardship, in cases where federal or state funds support or partially support the project, or if there is a federal permit involved. Federal and state agencies follow the Section 106 process in reviewing project activities and determining appropriate actions to meet the requirements of compliance. Other relevant legislation that applies to the management of cultural resources include the Antiquities Act of 1906 (16 USC 431 et seq.); the Archaeological Resources Protection Act (ARPA) of 1979 (16 USC 470 et seq.); the Abandoned Shipwreck Act of 1987 (P.L. 100-298); the American Indian Religious Freedom Act (AIRFA); Section 4(f) of the DOT Act (49 USC 303); the Archaeological and Historic Preservation Act of 1974 ("Moss-Bennett" Act); the Abandoned Shipwrecks Act; Executive order 13007 ("Indian Sacred Sites"); and the Native American Graves Protection and Repatriation Act (NAGPRA; 25 USC 3001-3013).

The NHPA defines "historic properties" as prehistoric and historic districts, sites, buildings, structures, and objects listed or eligible for inclusion in the National Register of Historic Places (NRHP), including artifacts, records, and material remains related to such properties (NHPA, 16 USC 470w, Sec. 301.5). Criteria used in determining the significance of "historic properties" for the purposes of Section 106 are the same as the criteria used in determining the eligibility of the resource for listing in the NRHP (36 CFR 60.41). For a cultural resource (e.g., districts, sites, buildings, structures and objects) to be eligible for the NRHP, it must possess integrity of location, design, setting, materials, workmanship, feeling, and/or association.

3.21.4 Prehistoric Environment

The period before 11,000 years Before Present (BP) was one of continental glaciation and variable sea levels. Vegetation was likely comprised of cold steppe species, and the climate was colder and dryer than current conditions. Large mammals, most of which are now extinct in the area (e.g., mammoth, horse, bison, lion), dominated the landscape. The last glacial retreat (approximately 9,000 years BP) brought the extinction of Pleistocene megafauna and resulted in climatological conditions similar to those found today. Plant communities and general climatic patterns had stabilized by around 6,500 years BP, but fluctuations in temperatures and environmental shifts of smaller magnitudes nevertheless affected the human inhabitants of the region to some degree. Although warming and cooling episodes since approximately 10,000 years BP are well documented in northern regions, their effects on the different stages of prehistory are not well known and are the subject of continuing research.

3.21.4.1 Regional Prehistory

Human prehistory on the coast of northern Alaska is represented by isolated sites along the coast of the Beaufort Sea, from Point Barrow to the Canadian border near Demarcation Point. The oldest cultural tradition documented on the northern coast of Alaska, the Northern Archaic, is approximately 6,000 years in age. Despite the absence of earlier documented cultures in the area, the potential does exist for future discoveries of prehistoric remains.

Table 3.21-1 summarizes the known prehistoric traditions from the North Slope of the Brooks Range to the Beaufort Sea coast.

Table 3.21-1: Correspondence Between Environmental Zones and Documented Prehistoric Cultures

Environmental Zone	Prehistoric Cultures	Age Ranges Before Present
Arctic Coastal Plain	Northern Archaic Denbigh Flint Complex Western Thule Historic Eskimo	6,000 4,000—3,500 1,000—150 150—100
Arctic Foothills	Denbigh Flint Complex Choris Western Thule	2,500 2,700 1,000—150
Brooks Range, North Slope, and Passes	Paleoarctic Paleoindian Northern Archaic Denbigh Flint Complex Choris Ipiutak Western Thule Kavik Historic Eskimo	10,000—9,000 11,700—9,000 6,500 3,700—2,500 2,700 1,350—550 1,000—150 1,850 150—100

3.21.4.2 Paleoindian and Paleoarctic Traditions

The earliest known inhabitants on the North Slope occupied sites dating to the terminal Pleistocene and early Holocene (12,000 to 9,000 years BP) and can be placed in two ***traditions***: Paleoindian and Paleoarctic. Archaeological investigations have identified Paleoindian sites on the North Slope of the Brooks Range (e.g., Mesa [KIR-00102] and Putu/Bedwell [PSM-00027] dating between 12,000 and 9,000 years BP; Kunz and Reanier 1996; Reanier 1996). While Paleoindian material seems to be absent from the North Slope's archaeological record after 9,800 years BP, the Old World-affiliated Paleoarctic tradition does not. The Paleoarctic tradition is generally defined as a stone tool industry that utilized a core and blade technology to produce unifacial tools such as burins, scrapers, and drills on blades; the latter is a common trait among late Pleistocene Siberian cultures (Dikov 1977, 1979, 1996, 1997).

Other sites near the study area have also yielded evidence of Paleoindian or Paleoarctic activity. These include artifacts from the Putuligayuk River Delta Overlook Site (XBP-00007) located near Prudhoe Bay, as well as other isolated artifacts in the area. Sites from Paleoindian and Paleoarctic traditions have the potential to shed considerable light on the ways in which humans adapted to the high latitude environments of North America, as well as a better understanding of the migration of humans in the region at the Pleistocene-Holocene boundary (approximately 10,000 years BP).

3.21.4.3 Northern Archaic Tradition

As the Holocene era progressed, cultural changes that occurred in the region include the initial appearance of the Northern Archaic tradition at around 6,000 years BP in many areas of Alaska. Prehistorians generally believe that Northern Archaic groups were primarily hunters of large terrestrial animals.

Northern Archaic artifacts typically consist of surface finds and are found throughout the Arctic Foothills and the Brooks Range. Such remains have been found near Prudhoe Bay and the Beaufort Sea, and suggest that Northern Archaic people were present near Prudhoe Bay approximately 6,000 years BP; a Northern Archaic side-notched point and microblades, for example, were found at the Putuligayuk River Delta Overlook (XBP-00007) located near the Putuligayuk River mouth at Prudhoe Bay (Lobdell and Lobdell 2000). Additional Northern Archaic cultural remains are located approximately 30 miles west of Putuligayuk River at the Kuparuk pingo site (XBP-00033). The Kuparuk pingo site is unusual because such ice core hill features on the ACP were not believed to persist for more than a "few millennia" from the time of their initial development, until they submerged into the plain (Lobdell 1995). However, the important evidence recovered on the Kuparuk pingo indicates that the landform has been in existence for at least 6,000 years, based on a radiometric age determination (Lobdell 1995). The location of the site adjacent to the north Alaska coast indicates that Northern Archaic people possibly used coastal resources, in addition to the terrestrial fauna long believed to be the primary focus of their subsistence.

3.21.4.4 Arctic Small Tool Tradition

The Arctic Small Tool tradition (ASTt), or Denbigh, dates to approximately 4,000 years BP. Archaeological investigations have located ASTt sites in the northern Arctic Foothills and Canada. Denbigh sites near the study area have been documented in coastal areas ranging to the Arctic Foothills and passes through the Brooks Range (Lobdell 1995). Denbigh-related sites occur near Prudhoe Bay in locations along the shore, such as the Putulagayuk River Delta Overlook site (XBP-00007; Lobdell and Lobdell 2000). A Denbigh-related site is also located on the Central Creek pingo (XBP-00008), an ancient ice core mound on the ACP approximately 3 miles from Prudhoe Bay and a mile inland from the Beaufort Sea coast (Lobdell and Lobdell 2000). Radiocarbon dates from this location indicate a Denbigh presence in the area dating to between 4,000 and 3,500 years BP (Lobdell and Lobdell 2000).

3.21.4.5 Late Holocene

Beginning approximately 2,000 years BP, ancestral materials of modern Native cultures have been documented; antecedents of the cultures that were first encountered by European explorers in the 19th century.

From the Birnirk phase (approximately 1,600 to 1,100 years BP) onward, the cultural continuity of Arctic peoples is clearly documented. The Birnirk phase appears in the Bering Strait by 1,600 years BP and is a direct ancestor of the historic Thule culture (Ackerman 1984, Anderson 1984). Birnirk peoples engaged in the harvest of marine (e.g., whales and seals) and land mammals (e.g., caribou), birds, and fish. Birnirk type-sites are located in the Barrow vicinity west of the study area, and have been found from northeastern Siberia to northwestern Canada, indicating a large trade network reminiscent of the extensive Iñupiaq trade network in place in the 19th century. Birnirk people were characterized by their use of ground slate tools and weapons, multiple spur harpoon heads, chipped chert implements, and clay pots and lamps (Anderson 1984)

At approximately 1,000 years BP, a favorable climate, coupled with technological innovations such as the *umiaq* (a large skin boat), the *qataq* (cold trap door for winter houses), and the *uniat* (sled), resulted in the rapid expansion of Thule populations from the Bering Strait along the shores of the Beaufort Sea to Greenland, and southeast around the shores of the Bering Sea ultimately to Kodiak Island and Prince William Sound. When early European explorers and whalers arrived on the Beaufort Sea coast in 1826, they encountered the Thule culture. Thule people hunted sea mammals, including whales, as well as terrestrial game such as caribou, and utilized a variety of marine, freshwater, and anadromous fishes. Thule sites at Barrow include Nuvuk (BAR-00011) and Utkiagvik (BAR-00002). Lobdell (1980) notes that little is known archaeologically about the coastline east of the Colville River, and that documented sites in the area between the coast and the Arctic Foothills are limited to historic archaeological remains along the major rivers. However, because of theories on the spread of Thule culture from the Bering Strait across the Arctic to Greenland, and the lack of systematic surveys of the coastline, the coast is considered to have substantial potential for late prehistoric Thule sites of the last 1,000 years.

3.21.5 European/Euro-American Exploration (A.D. 1827 to Present)

The climate on the North Slope of Alaska is harsh, with sub-zero temperatures for at least seven months of the year, with strong winds and slight precipitation. The majority of the ACP is flat and poorly drained, especially within the study area. Exceptions to this include pingos and well-drained riverbank or drained lake-basin shoreline terraces. Tundra drainages have resulted in low, well-drained terraces that provide thoroughfares for both people and animals. A variety of plant and animal life sustains the inhabitants of the region. Some parts of the coastal zone are eroding at an average of three meters per annum (Lobdell and Lobdell 2000).

Exploration of the North Slope began in 1825 with the first Franklin expedition. Sir John Franklin and his crew members spent 1825 and 1826 at Herschel and Barter islands. Franklin, as well as other early explorers, noted that the presence of European trade goods (e.g., tobacco and metal) preceded their arrival among the Iñupiat on the North Slope (Beechey 1832; Murdoch 1888, 1892).

Between 1847 and 1854, contact between Europeans and the Iñupiat increased due to the influx of whalers to the region, and as exploration of the region increased while ships searched for the lost Franklin expedition. Richard Collinson, a captain on one of the search ships looking for Franklin’s lost expedition, documented Iñupiaq place names along the coast, from Barrow to the Mackenzie River (e.g., Flaxman Island [*Kapagillok*], and between Point Barrow and Flaxman Island [*Chegea*]) while wintered off the ice of Camden Bay between 1853 and 1854 (Libbey 1983).

During the last quarter of the nineteenth century, epidemic diseases caused a severe population decline among the North Slope Iñupiat. Beginning in 1881, John Murdoch and Lt. Patrick Henry Ray, members of the International Polar Expedition, collected ethnographic information over the course of 2 years at Point Barrow. Captain Stockton, who visited the area in 1889, stated

> “…There are no permanent settlements here or elsewhere between the vicinity of Herschel Island and Barrow. The country is sterile, affording but little upon which to live, the sea also having little or no animal life in its waters. The Eskimo give to this part of the Arctic Ocean a native name which signifies “the sea where there is always ice”… (Stockton 1890 in Libbey 1983).

3.21.5.1 Missionary Efforts, Trading Posts, and Reindeer Herding

The establishment of mission schools in the North Slope region occurred between 1890 and 1910 at Wales, Point Hope, and Barrow, as well as in other places that were previously only seasonally occupied. Eventually, the original mission schools split into separate entities: government schools and church-operated missions. Trading posts were also established near missions and schools; these areas became focal points for the Native population, and settlements became established around each one.

The first commercial whaling vessel passed through Bering Strait to the arctic coast in 1848, and Yankee whaling flourished until the beginning of the twentieth century, when whale oil and baleen decreased in commercial value and importance. The fur trade filled some of the economic gap left by the demise of commercial whaling in the first decade of the twentieth century. In addition, Sheldon Jackson, a Presbyterian missionary, introduced reindeer herding to Natives. Reindeer herds were subsequently maintained by Iñupiat in the vicinity of Wainwright, Barrow, and Nuiqsut, as well as other settlements on the North Slope (Jackson 1906). The area between Brownlow Point and Demarcation Bay was divided into reindeer herding areas: Beechey Point to Brownlow Point was the herding area for James Taakpaaq, a well-known whaling captain from Barrow; and Brownlow Point to the Sadlerochit was Richmond Ologak's herding area. Three families (Ologak, Akootchook, and Gordon) maintained reindeer herds at Camden Bay, Barter Island, and Demarcation Bay. A hard winter betewen 1935 and 1936 resulted in a depletion of available game, and Gordon's trading post ran out of supplies. The Bureau of Indian Affairs (BIA) later performed a survey to determine if more reindeer should be imported to the area, but attempts to bring in additional reindeer failed. Reindeer herding ended in the region in 1938, to be briefly revived by a program of loaning reindeer from Wainwright to Barrow and finally ended at Barrow in 1952 (Chance n.d., 1990).

In 1915, the Barrow whaler and trader Charles Brower ceased commercial whaling operations to begin fur trading operations. In 1917, Charles Brower sent his associate, Tom Gordon, from Barrow to Demarcation Point, to establish a fur trading outpost for the H.B. Liebes Company of San Francisco. Gordon's wife moved with him, as well as several of her family members. After a year, Gordon's brother-in-law and his family moved to Barter Island and spent the winter trapping. In 1923, Gordon established a trading post at Barter Island (Jacobson and Wentworth 1982); however, Gordon died in 1938, and no one replaced him in managing the Barter Island trading post. Between 1923 and 1943, Henry Chamberlain operated a trading post at Brownlow Point. Most of the trading posts closed in the 1940s. The trader at Humphrey Point, located east of Kaktovik (*Imaignaurak*) died in 1942, and the trader at Brownlow Point (*Agliguagruk*) left in 1943, forcing people to look elsewhere for supplies and trade (e.g., Barrow, Coldfoot, and Aklavik, Canada). The lack of trading posts and other economic opportunities caused several Kaktovik families to move to Herschel Island or to Barrow (Jacobson and Wentworth 1982). Many historic archaeological sites from the fur trading period are still visible along the Beaufort Sea coast and in the study area in the form of sod house ruins, other structural remains, and graves.

3.21.5.2 Military Presence/DEW Line Sites

Known DEW line facilities in the vicinity of the project area include those at Bullen Point and Brownlow Point. While located outside of the project area, the Barter Island DEW line facility played a role in the history of Kaktovik and the land use patterns of its residents. Barter Island Long Range Radar Site (BAR-MAIN; BRL-00023) is a 647-acre facility located on a 4,500 acre military reserve near Kaktovik, Alaska (Jacobson and Wentworth 1982, Chance 1990). The Department of Defense (DOD) activated the Barter Island installation in 1957 as a DEW line site and used contractors to staff and maintain the facilities. The

DEW line equipment was removed in 1987. A minimally-attended radar (MAR) was installed at the Barter Island facilities in 1990. The facilities remaining at the Barter Island site today include an airfield, fuel storage area, 4,280-foot runway, and a terminal building (USAF 1999).

The Brownlow Point (POW-D) DEW line facility, located within 100 feet of an historic Iñupiaq settlement (XFI-00009, TLUIXFI-008), is located approximately 65 miles east of Prudhoe Bay in the Arctic Refuge, and supported the Intermediate station at Collinson Point that was operational from 1957 to 1963.

The Bullen Point (POW-3) short range radar site (SRRS; XFI-00001, XFI-00021-29, TLUIXFI-002) is a 605-acre facility located approximately 35 miles east of Deadhorse, Alaska. The DOD activated the Bullen Point facility in 1953 as a DEW line intermediate station. The DEW line system was deactivated in 1971 and closed in 1972. The construction of the unattended radar (UAR) facility began in 1992 and the facility was activated in 1993. The radar system is still active, but the site has been unmanned since 1995 and is only visited periodically for maintenance. The UAR site includes a radar structure, support building, fuel tanks, and a helicopter landing area. Inactive facilities include a 3,500-foot gravel airstrip, one 25-module train, a warehouse, two pump houses, a 250,000-gallon water storage tank, four communications antennas, fixed petroleum, oils, and lubricant tanks, and associated roads and gravel pads. The Bullen Point SRRS Road System (XFI-00027) and the Bullen Point SRRS Airfield (XFI-00028) have been determined eligible for inclusion on the NRHP (OHA 2010a).

3.21.5.3 Ethnographic and Cultural Resources Studies

Interest in geology and early cultural history of the area began in earnest at the beginning of the twentieth century, but was limited by access to coastal areas. Vilhjalmur Stefansson (1921) conducted ethnographic studies along the coast east of Barrow between 1906 and 1907, 1908 and 1912, and 1913 and 1918 (accompanied by Diamond Jenness on the 1913 expedition). Between 1906 and 1914, Ernest Leffingwell conducted geographical place name research in the Arctic. Leffingwell spent nine summers and six winters on Flaxman Island living in a cabin made from the pilot house of the ship that brought him there, the *Duchess Bedford*. Leffingwell's camp (XFI-00002) is currently listed on the NRHP. Between 1917 and 1918, Hudson Stuck (1920) recorded his expedition as he traveled by dog team along the entire arctic coast from Kotzebue Sound to Herschel Island. As an extension of the fifth Thule expedition, Knud Rasmussen crossed into Alaska from Canada in 1924. He compiled ethnographic data on the Alaskan Iñupiat and their camps, and recorded place names on the Utuqqaq (*Utukok*) River. In 1952, Robert Spencer (1959) investigated the ecological relationship between inland and coastal Iñupiaq groups. Various researchers investigated the Nunamuit (or inland Iñupiat), including Robert Rausch (1951), Helga Ingstad (1954), Nicholas Gubser (1965), and Lewis Binford (1978). The initiation of petroleum development has led to intensive investigations of cultural resources on the North Slope; Ralph Solecki accompanied USGS geologists working in the NPR-A in 1949 (Solecki 1950), and the first surveys for the Trans Alaska Pipeline were completed in the early 1970's (e.g., Cook 1970, 1971, 1977). Following the ratification of the NHPA of 1966 and NEPA of 1970, both federal agencies and private entities were required to conduct archaeological surveys to manage historic properties that could be adversely affected by activities falling under federal jurisdiction. The NSB Commission on History and Culture began a TLUI database in the 1970s.

3.21.6 Kaktovik Community History

The proposed study area is currently used primarily by Kaktovik residents. Prehistorically and historically, Kaktovik, located on the north shore of Barter Island, was a "seasonal home for the nomadic ancestors of present-day Kaktovik residents, who traveled the area in pursuit of caribou, sheep, sea mammals, fish, and fowl" (NSB 1979). Archaeological evidence indicates that Kaktovik was a place where people used and possibly hunted whales. The name Kaktovik means "seining place." Barter Island has been a subsistence base and trading center for centuries. Historically, Iñupiat from Canada often stopped in Kaktovik on the way to Nigliq on the Colville River, and Barrow residents (and others) often stopped in Kaktovik on their way to Herschel Island and the MacKenzie River Delta in Canada, while Athabaskans from south of the Brooks Range visited Kaktovik occasionally. In 1826, Sir John Franklin observed 54 adults on Barter Island with "a collection of tents planted on a low island with many *oomiacks* (umiaks), *kaiyacks* (kayaks) and dogs around them" (Franklin 1828 in Pedersen et al. 1985). In 1914, Jenness reported 30 to 40 house sites on Barter Island, and speculated that the location was once likely a prehistoric village site (Leffingwell 1919 in Pedersen et al. 1985).

Kaktovik was an important stop for commercial whalers during the 1890s into the early 1900s. In 1923, Tom Gordon established a trading post at Barter Island marking the beginning of Kaktovik as a permanent year-round settlement. Prior to the establishment of the DEW line, and subsequent wage employment opportunities in the early 1950s, people in Kaktovik lived a more nomadic lifestyle, living in such places as Camden Bay, Hulahula River, Griffin Point, Demarcation Bay and Herschel Island, and other places within 75 miles east and west of the island (NSB 1979).

Kaktovik relocated in 1947 when the existing site at Barter Island was chosen as a radar site for the DEW line system. In 1951, the entire area around Kaktovik was made a military reserve. Changes in the DEW line layout and new road construction forced the village of Kaktovik to relocate again in 1953. An expansion of the DEW line facility in 1964 forced the village to relocate for a third time; however, Kaktovik received title to the present location, a 280-acre village townsite plat located on the east shore of the island facing Kaktovik Lagoon (NSB 1979). Kaktovik was incorporated in 1971. The passage of the ANCSA in 1971, and the creation of the NSB in 1972, brought further wage employment opportunities (e.g., NSB, Borough-funded village housing and public building construction) to Kaktovik. In 1979, 99 percent of the population of Kaktovik was related by blood or marriage to three families. Kaktovik residents continue to return to traditional subsistence use area and engage in subsistence activities that reflect their long standing sociocultural traditions and ties to the Kaktovik area (see IAI 1990a, Pedersen and Linn 2005, SRB&A 2010). Additional information on current subsistence practices is included in Section 3.15, Socioeconomics.

3.21.7 Documented AHRS/TLUI Sites in Proposed Point Thomson Study Area

In general, coastal Iñupiat from the prehistoric period into the present have settled on peninsulas or points of land where conditions are ideal for hunting sea mammals and waterfowl and have traveled inland on the river systems for harvesting caribou and other terrestrial mammals, waterfowl, birds, and a variety of fish including several species of whitefish. The relationship of the Iñupiat to their natural environment remains a cornerstone of their personal and group identity (NSB 1979). Signs of past occupation (e.g., remains of camps/houses) generally mark historical places of significance. Old occupation sites are not regarded by the Iñupiat as being truly abandoned; they are valued as the living and dying places of ancestors "no longer recalled but still somehow a part of the surrounding world" (NSB 1979), and may have supernatural associations that affect the way they are viewed by modern populations. Cultural associations with the land may be contained in recollections of the recent past, stories of remote history or "folklore," and in supernatural beliefs (NSB 1979). Oral traditions and supernatural beliefs are connected to specific features of the landscape or "connected to locations where remote historical events involving the people, the animals and the landforms took place" (NSB 1979). The Iñupiat believe that "each place is entirely unique and imbued with its own importance" (NSB 1979).

Cultural resources investigations within and near the study area began in the 1970s (Campbell 1974). In the 1980s, several archaeological surveys for oil and gas exploration were conducted in the proposed study area by Lobdell (Lobdell 1980, 1981, 1992a, b, c, d, 1997a, b, 1998; Dames & Moore and Lobdell 1986; Lobdell and Lobdell 2000, Lobdell et al. 2000). Bacon (1982a, b, 1983, 1985) also assisted in surveys in the study area and Flaxman Island. In 2007, Reanier completed site condition assessments at sites XFI-00001, XFI-00004, and XFI-00005 during a cultural resources reconnaissance for the Bullen Point road project. A recent investigation of the project area for a Cultural Resource Management Plan occurred in the summer of 2009, which identified a new prehistoric archaeological site (Exxon Mobil 2009b).

One previous cultural resource investigation within one mile of the study area is recorded in the OHA citation database (OHA 2010b). The cultural resource investigation, conducted by NLUR (2008) for the Point Thomson Drilling Program, consisted of a literature search and reconnaissance level survey, and reported negative findings.

Between Endicott and Brownlow Point, there are 60 recorded cultural resources located in the proposed study area. In addition, there is one recorded shipwreck located in the study area: the *Duchess of Bedford* was caught and crushed in ice off Flaxman Island in 1907; although elements of the ship were salvaged by Leffingwell and reused, the ruins of the vessel remain (MMS 2000).

The 60 listed AHRS and TLUI sites located in the study area are listed in Table 3.21-2. For each cultural resource, the table lists the available AHRS site number, AHRS site name, AHRS site type, TLUI ID number, TLUI place name and TLUI site legend. Not all AHRS sites have corresponding TLUI ID numbers, and vice versa. In addition, some AHRS and TLUI site locations do not match between the databases (e.g., Mikkelson Bay Village). The table also indicates if a site has been destroyed, if there is a description of significance for known TLUI sites, and provides a TLUI legend code for the TLUI site type.

Table 3.21-2: AHRS and TLUI Listed Sites in the Cultural Resources Study Area

AHRS No.	AHRS Site Name	AHRS Site Type	TLUI ID No.	TLUI Place Name	TLUI Site Legend[a]
XFI-00001	POW-3 (Bullen, Savaguik, Flaxman Island DEW Line Station)	Road System, Airfield, Gravel Pad System (WACS, AC&W)	TLUIXFI-002	Savagvik	3, 4
XFI-00002	Leffingwell Camp	Iñupiat/Euro-American Historic	—	—	—
XFI-00004	Point Gordon	Iñupiat, Historic	TLUIXFI-003	Point Gordon	2,10
XFI-00005	Point Hopson	Iñupiat, Historic	TLUIXFI-004	Point Hopson	3,10
XFI-00006[b]	Point Thomson	Iñupiat, Historic	TLUIXFI-006	Kunuatchiam Inaa	3
XFI-00007[b, c]	Flaxman Island Graves	Iñupiat, Historic	TLUIXFI-007	Tikigaq	1,2,3,4,5,6,8, 9,10
XFI-00008	East Flaxman Island	Iñupiat, Historic	TLUIXFI-026	Flaxman Island	3,7
XFI-00009	Brownlow Point (Agilguagruk)	Iñupiat/Euro-American, Historic	TLUIXFI-008	Agliguagruk	2,3,4,6,10
XFI-00021	Bullen Point LRRS (POW-3) DEW Line Facilities	Road System, Airfield, Gravel Pad System (WACS, AC&W)	TLUIXFI-002	Savagvik	3,4
XFI-00022[e]	Bullen Point LRRS (POW-3) DEW Line Facilities	Road System, Airfield, Gravel Pad System (WACS, AC&W)	TLUIXFI-002	Savagvik	3,4
XFI-00023	Warehouse Supply and Equipment Building at Bullen Point DEW (XFI-00001)	Road System, Airfield, Gravel Pad System (WACS, AC&W)	TLUIXFI-002	Savagvik	3,4
XFI-00024	Bullen Point LRRS (POW-3) DEW Line Facilities	Road System, Airfield, Gravel Pad System (WACS, AC&W)	TLUIXFI-002	Savagvik	3,4
XFI-00025	Bullen Point LRRS (POW-3) DEW Line Facilities	Road System, Airfield, Gravel Pad System (WACS, AC&W)	TLUIXFI-002	Savagvik	3,4
XFI-00026	Bullen Point LRRS (POW-3) DEW Line Facilities	Road System, Airfield, Gravel Pad System (WACS, AC&W)	TLUIXFI-002	Savagvik	3,4
XFI-00027	Bullen Point SRRS Road System [WACS, AC&W]	Road System, Airfield, Gravel Pad System (WACS, AC&W)	TLUIXFI-002	Savagvik	3,4

Table 3.21-2: AHRS and TLUI Listed Sites in the Cultural Resources Study Area

AHRS No.	AHRS Site Name	AHRS Site Type	TLUI ID No.	TLUI Place Name	TLUI Site Legend[a]
XFI-00028	Bullen Point SRRS Airfield [WACS, AC&W]	Road System, Airfield, Gravel Pad System (WACS, AC&W)	TLUIXFI-002	Savagvik	3,4
XFI-00029	Bullen Point SRRS Gravel Pad System [WACS, AC&W]	Road System, Airfield, Gravel Pad System (WACS, AC&W)	TLUIXFI-002	Savagvik	3,4
XFI-00030	Flaxman Island - Brownlow Point H.D.	—	—	—	—
XFI-00031	A2 Pingo	Flake on a Pingo	—	—	—
XFI-00032[e]	Badami River Flake Scatter	—	—	—	—
XFI-00033[e]	Brownlow Cemetery	—	—	—	—
XFI-00034[e]	Brownlow Southern Grave	—	—	—	—
XFI-00035	Brownlow Point Prehistoric Surface Artifacts	—	—	—	—
XBP-00028	Mikkelson Bay Village	Iñupiat, Historic (late AD 1800s)	TLUIXFI-001, TLUIXBP0028	Mikkelson Bay Village	3,7
—	—	—	TLUIXFI-005[b]	Ikpikpauraq	3
—	—	—	TLUIXFI-022[d]	Maguire Island	—
—	—	—	TLUIXFI-023[d]	Maguire Island	—
—	—	—	TLUIXFI-024[d]	Maguire Island	—
—	—	—	TLUIXFI-025[d]	Maguire Island	—
XBP-00001[c]	Anxiety Point	Historic	—	—	—
XBP-00020	Sagavanirktok River, Main Channel	Iñupiat, Historic	—	—	—
XBP-00021	Small Boat #1	Historic	—	—	—
XBP-00022[b]	Point Brower	Iñupiat, Historic	TLUIXBP-005	Aglibuabruk	2,3,5,8
XBP-00023	Foggy Island Bay House Ruin	Iñupiat, Prehistoric/Historic	—	—	—
XBP-00024	Foggy Island Bay #2	Iñupiat, Historic	—	—	—
XBP-00025	Kadleroshilik River	Iñupiat, Historic	—	—	—
XBP-00026	Foggy Island Bay #3 (Ekoolook Inaat)	Iñupiat, Historic	—	Ekoolook Inaat	—
XBP-00027[c]	Shaviovik River Delta Site	Iñupiat, Historic	TLUIXBP-039	Savviubvik	—
XBP-00031	Tigvariak Island	Iñupiat, Historic	—	Tigvagiak Island	—

Table 3.21-2: AHRS and TLUI Listed Sites in the Cultural Resources Study Area

AHRS No.	AHRS Site Name	AHRS Site Type	TLUI ID No.	TLUI Place Name	TLUI Site Legend[a]
XBP-00032	Shaviovik River Camp	Iñupiat, Historic	—	—	—
XBP-00042	XBP-00042	Iñupiat, Prehistoric	—	—	—
XBP-00060	Foggy Island Bay Burial	Iñupiat, Historic	—	—	—
XBP-00062[b]	Foggy Island Bay House Ruin 2	Iñupiat, Prehistoric/Historic	TLUIXBP-034	Kisim inaat	6,10
XBP-00067	Shaviovik River Tent Rings	Iñupiat, Historic	—	—	—
XBP-00068[b]	Shaviovik River Cache	Iñupiat, Prehistoric/Historic	TLUIXBP-010	Kakianaam inaat	2,5,6,10
XBP-00069[b]	Tigvariak Island Graves	Iñupiat, Historic	TLUIXBP-011	Tigvabiaq (Point Lookout)	2,3,4,6
XBP-00072	Possible Grave	—	—	—	—
XBP-00076	XBP-00076	Iñupiat, Historic	—	—	—
XBP-00081	Sako	Euro-American, Prehistoric/Historic	—	—	—
XBP-00082	Shav	Euro-American, Historic	—	—	—
XBP-00083	William Ekolook Grave	Iñupiat, Historic	—	—	—
XBP-00084	XBP-00084	Prehistoric	—	—	—
XBP-00085	XBP-00085	Prehistoric	—	—	—
XBP-00086	XBP-00086	ASTt, Prehistoric	—	—	—
—	—	—	TLUIXBP-006	Aglibuabruk(Pt. Brower)	—
—	—	—	TLUIXBP-007	Koganak Inaat	2,6
—	—	—	TLUIXBP-008	Ekoolook Inaat	—
—	—	—	TLUIXBP-035[d]	Tigvabiaq	2,3,4,6
—	—	—	TLUIXBP-038	Tigvabiaq	3,4,6
—	—	—	TLUIXBP-040	Sikiabrum inaat	4,6,10

Source: NSB 1977, 1980; ExxonMobil 2009b, Table 3-32; IHLC 2010; OHA 2010a.

[a] TLUI Legend: 1) Cabins/Shelter Cabins Today; 2) Graves/Cemetery; 3) Ruins/Sod Houses/Bones; 4) Fishing; 5) Trapping Area; 6) Hunting/Camping Area; 7) Cellars; 8) Other/Nesting Area, Seals, Roots; 9) Whaling Settlement; 10) Important Event/Old Site

[b] AHRS and TLUI locations do not match

[c] Site destroyed

[d] No known description of significance in the TLUI database but at one point was determined a TLUI by elders of the NSB

[e] No location data available

3.21.7.1 Description of Historic Sites located in the proposed Study Area

Bullen Point (*Savagvik, Shavugavik, Savviugvik*): XFI-00001; TLUIXFI-001-2

Leffingwell reported in 1913 that the name *Shavugavik* the Iñupiaq name for Bullen Point, means "working place" (1919 in Orth 1971). Porter (1991) stated that the Iñupiat spelling is *Savviugvik* which means "where one works on metal." Sir John Franklin named this area Bullen Point in 1826 (Porter 1991). Cultural features at Bullen Point include sod house ruins that are described as being amongst the DEW line facilities (Gallagher and Weed 1981b as cited in Lobdell 1998). Reanier (2007) used GIS software and aerial photographs to locate sod houses buried by the gravel pads built for the DEW Line site. The DEW line station may have impacted other historic remains in the area (Lobdell 1998). Porter (1991) stated that the remains of a fish camp are located at Bullen Point. The area is currently used as a fishing area (Oldham n.d.). This site is also designated as TLUI #177 (Lobdell 1998).

Point Gordon: XFI-00004; TLUIXFI-003

Point Gordon was named in honor of trader Tom Gordon, then resident at Demarcation Point, by geologist and cartographer Ernest Leffingwell (Stuck 1920). The site recorded at this location consists of the remains of an Iñupiaq sod house (NSB 1980, Lobdell and Lobdell 2000, Lobdell 1998) and graves (NSB 1980). The remains are still visible from upright support timbers and a surrounding sod mound (Lobdell and Lobdell 2000, Lobdell 1998). It is also reported that one family ran their trapline to Point Gordon from Flaxman Island (NSB 1980); however, there is no Iñupiaq place name recorded for Point Gordon specifically. Other sources of information for this location are found in Pedersen et al. (1985) and Orth (1971), where Point Gordon is identified as site #43. The site located at Point Gordon is also designated as TLUI #26 (Lobdell 1998).

Point Hopson: XFI-00005; TLUIXFI-004

The site recorded at Point Hopson consists of the remains of three rectangular Iñupiaq sod houses and one meat cellar located adjacent to the coast (NSB 1980, Nielson 1977; Pedersen et al. 1985 [site #25], Orth 1971, Lobdell 1998). These remains are visible as sod mounds, sod removal areas, and posts or tethers (Lobdell and Lobdell 2000). There is no Iñupiaq place name recorded for Point Hopson specifically. The site located at Point Hopson is also designated as TLUI #25 (Lobdell 1998).

Mikkelson Bay Village (*Ikpikpauraq*): XBP-00028; TLUIXFI-005

The name *Ikpikpauraq* means "little bank (bluff)." The TLUI database states that TLUIXFI-005 consists of two groups of sod houses, and a cabin representing Mikkelson Bay Village. According to the AHRS (OHA 2010a) eight cultural features at this site include five sod house remains, a small wooden building, a small rack, and a collapsed ice cellar. The AHRS site for Mikkelson Bay Village (XBP-00028) is located west of the recorded TLUI location, and more closely fits with the location description for TLUIXFI-001, located on the east point of the entrance into Mikkelson Bay (Orth 1971).

Point Thomson: XFI-00006; TLUIXFI-006

The place name for this site as reported in the TLUI database is *Kunuatchiam Inaa* (NSB, IHLC 2010). Sir John Franklin (1828 in Orth 1971) gave Point Thomson its English name in 1826. Structures located at the site, located 1.5 miles west of the point proper, include three connected historic Iñupiaq sod houses used in the 1920s (NSB 1980; Nielson 1977). These sod house remains are in varying stages of disrepair;

two of the houses appear to have arctic entrances (surface type), and axe and saw-cut wood is evident (Lobdell and Lobdell 2000).

Flaxman Island (*Qikiqtaq, Sirak, Kuugruak*): XFI-00002, XFI-00007, XFI-00008; TLUIXFI-007, TLUIXFI-026

One of the Iñupiaq names for Flaxman Island is *Sigak* (commonly spelled *Sirak*), which means "animal den" or "place where polar bears go to get covered up with snow and have their cubs" (Jacobson and Wentworth 1982). Leffingwell reported that the name *Sidrak* meant "foxhole" (1919 in Orth 1971). Other names include *Qikiqtaq* ("big island") and *Kuugruaq* ("Canning River"; Jacobson and Wentworth 1982). The TLUI database reports the place name of *Tikigaq* for TLUIXFI-007 (NSB, IHLC 2010). Sir John Franklin gave the island its English name during his 1826 expedition, for the English sculptor and artist John Flaxman (Jacobson and Wentworth 1982).

Flaxman Island is historically important both for its continuous usage by Iñupiat for hunting, fishing and trading, and historically as explorer/geologist Ernest Leffingwell's former campsite. Leffingwell's former campsite, located on the southwestern shore of Flaxman Island, was listed in the NRHP in 1971, and was recognized as a National Historic Landmark (NHL) in 1978. Located near Leffingwell's former campsite is an Iñupiaq dwelling that has been occupied since 1924, and was moved to its current location in 1934. Site consists of two unoccupied sod house ruins, ice cellar, and tent platform (CCRS and NLUR 2010). This Iñupiaq dwelling bears the Leffingwell Camp NHL plaque.

Habitation of Flaxman Island was first recorded in 1850, when Stefansson and Leffingwell referred to annual trade fairs at Flaxman Island (Libbey 1981). Many families lived on Flaxman Island between the 1920s and the 1950s. The population at Flaxman Island in 1938 was 10 (BIA 1938 in Jacobson and Wentworth 1982, Table 1). Many residents of Flaxman Island died during the flu epidemic of 1945 (NSB 1980, Libbey 1981, Jacobson and Wentworth 1982). In 1973, a Nuiqsut whaler butchered a whale at Flaxman Island (Libbey 1981). As of 1982, residents of Kaktovik continue to use Flaxman Island for the harvest of caribou, waterfowl, seal, and fish (Jacobson and Wentworth 1982). The island serves as a "caribou corral" during summer months, as caribou often go to Flaxman Island to escape the heat and the mosquitoes (Jacobson and Wentworth 1982).

Libbey (1981) describes cultural resources at Flaxman Island at two locations: Leffingwell's Camp and East Point. Leffingwell's Camp consists of the following historic structures: a house built in 1923, still used in 1981; a large iron tank; a house foundation (original foundation of the house) with a partially standing framework at one end; two iron tanks; a cache and drying rack; the house foundation for Leffingwell's house built between 1907 and 1914 (later moved to Brownlow Point); a concrete column for a now missing sundial; a sod foundation for a house built in 1940; a plank floor for a wall tent; and a wood rack for storing and drying driftwood. A part of Leffingwell's original house was made from the remains salvaged from the wreckage of the *Duchess of Bedford* that sank off Flaxman Island in 1907 (Stuck 1920; Stefansson 1921).

East Point consists of five sod house ruins (two of the structures may have been entrances to ice cellars or small houses) and a possible cache/drying rack. Ejnar Mikkelson, a Danish sea captain and explorer who lived on the island with Leffingwell, reported that there were house ruins and graves located on the extreme west end of the island (Mikkelson 1909 in Libbey 1981). Graves were located on the eastern end of Flaxman Island, but have since eroded away. An exploratory oil rig was removed from the island in 1979; however, a gravel landing strip was left in the center of the island (Libbey 1981).

Brownlow Point (*Agliguagruk*): XFI-00009; TLUIXFI-008

The Iñupiaq name for Brownlow Point is *Agliguagruk*, which means “a person’s jaw” or “big jawbone.” Brownlow Point is historically and currently important as a summer and early fall fishing area (esp. arctic cisco [*qaaktaq*]), and as a caribou and seal hunting area, camping/stopover place, and trapping area (Oldham n.d.). Residents of Flaxman Island often went to Brownlow Point for fishing and hunting (caribou and waterfowl) in the summer. Henry Chamberlain had a store here from 1923 to 1943. In the 1930s, Chamberlain disassembled Leffingwell’s house on Flaxman Island and moved it to Brownlow Point, where he used it as a warehouse for his trading post (Libbey 1981). In 1933, Isobel Hutchinson, a Scottish botanist, described Brownlow Point as the site of a small Native village and store. The population at Brownlow Point in 1938 was 36 (BIA 1938 in Jacobson and Wentworth 1982, Table 1). After Chamberlain closed the trading post at Brownlow Point, most residents left the area and started trading at Herschel Island or Aklavik, Canada.

Historic remains reported at the location included several structures along the northeast side, a Teledyne tower and abandoned DEW line building at the tip, and graves of 11 former residents on the west side. Libbey (1981) stated that historic structures included five sites: 1) two sod house ruins; 2) a wood frame house with metal roof (originally Leffingwell’s house on Flaxman Island that was later moved by Henry Chamberlain to Brownlow Point in the 1930s for use as a warehouse; 3) a wood and sod house built by Chamberlain in the 1920s; 4) three sod house foundations; and 5) a graveyard on the west side of the point that has several wooden grave markers/tombstones enclosed by a picket fence and two graves with similar markers outside of the fenced area (Orth 1971, Nielson 1977, NSB 1977, Pedersen et al. 1985 [site #51]). Erosion has removed the nonmilitary structures and the military dump site, and the DEW line structures were removed as part of environmental remediation in 2000 leaving only the native cemetery and DEW line structure foundations and pads (Grover 2011, ADEC 2011). Many of the remaining resources have been adversely affected by frost heaves, erosion, and weather. The Brownlow Point cemetery has few standing elements intact, and some coffins with human remains have been frost heaved to the surface (CCRS and NLUR 2010).

Shaviovik River

The Shaviovik River Delta Site (XBP-00027) was a small sod-covered subterranean structure located at the north end of the largest island in the Shaviovik River delta. The site was reported as completely destroyed by erosion in 2007. Savviubvik (TLUIXBP-039), which is the remains of a sod house, may be associated with the Shaviovik River Delta Site. An AHRS card for Tigvariak Island (XBP-00031) includes Savviagvik as one of a group of locations in the vicinity with shared historical significance and continued use and importance. The Shaviovik River Camp (XBP-00032), Shaviovik River Tent Rings (XBP-00067), and the Shaviovik River Cache (XBP-00068) appear to be historic era Iñupiat sites in relative proximity to each other that may likewise share contemporaneous use and continued significance to North Slope residents. XBP-00068 may correspond to *Kakianaam Inaat* (TLUIXBP-010), Kakianaaq’s camp. The nearby *Sikiabrum Inaat* (TLUIXBP-040) is the location of the Sikiagruk family site.

Additional TLUI information about the Shaviovik River area not contained in the AHRS and current NSB TLUI database is found in IAI (1990a, b), which inventoried Kaktovik and Nuiqsut subsistence resource harvest patterns sites in a special report for the MMS. According to these reports, three cabins owned by local families and a sod house are reported to have been located on the Shaviovik River (IAI 1990b). A TLUI site called Putoligayak is the burial place for a local man and possibly others, located 6 miles upstream from the mouth of the Shaviovik River (IAI 1990a). A fishing site that may feature a sod house and other facilities is also located on or near the river (IAI 1990a).

Tigvariak Island

Tigvariak (local spelling: *Tigvagiak*) was a residential location that was used year-round before people were consolidated into present villages, and was the site of a trade fair held in the winter with people to the east (IAI 1990b). Several AHRS and TLUI sites are located on Tigvariak Island. Graves reported to exist on the island include those of local families. The AHRS card for Tigvariak Island (XBP-00031) reports a number of sod houses, ice cellars, an umiaq frame, and at least five graves. The Tigvariak Island Graves site (XBP-00069) corresponds to Tigvabiaq (TLUIXBP-035) or Lookout Point (TLUIXBP-011) in the TLUI database, which records up to four graves. According to the AHRS card, they are likely related to the Tigvariak Island site (XBP-00031). Located on the northwest shore of the island, XBP-00076 is a set of house ruins, which were used beginning in 1932.

The historic era of the island includes its use in 1949 as a base for U.S. Coast and Geodetic Survey exploration and mapping of the arctic coast (Nygren 2001). Nygren, who retired as an admiral at NOAA, described how locally-hired Native people lived with their entire families in tents near the camp, and used the location for subsistence resource harvesting while men worked on the survey (2001). The AHRS card for the Tigvariak Island site (XBP-00031) also mentions the presence of a former Arco oil well, which reflects a more recent use of the region.

Tigvariak West Base

The Tigvariak West Base is a U.S. Coast and Geodetic Survey marker in Foggy Island Bay with several AHRS and TLUI sites located nearby. There is some confusion about the locations of actual sites in the TLUI listings for a number of reasons, such as the age and recollections of different groups of elders interviewed, and the span of time since many sites were actively used (IAI 1990b). Nonetheless, two TLUI sites are located in the area of Foggy Island Bay between the Kadleroshilik and Shaviovik Rivers: *Kisim Inaat* (TLUIXBP-034) and *Ekoolook Inaat* (TLUIXBP-008). The AHRS lists Foggy Island Bay No. 3 as XBP-00026 (parenthesized as *Ekoolook Inaat*), as being located east of the Tigvariak West Base marker; the site is comprised of three historic winter houses and a grave. Slightly further away from the Tigvariak West Base mark is *Kisim Inaat* (TLUIXBP-034); this site is associated with Foggy Island Bay House Ruin No. 2 (XBP-00062). Foggy Island Bay Burial (XBP-00060) is a grave site located to the east, along the coast.

A pingo recorded as Shav (XBP-00082) is located between Tigvariak West Base and the Kadleroshilik River, and was used by Ernest Leffingwell during his 7-year expedition to map the Canning River region (Leffingwell 1919). His description of the depressions at the site indicates the likelihood that Iñupiat use of the location had occurred:

> "Shav. - A station on top of a conspicuous mound about 5 miles from the coast southwest of Tig. There are three depressions and four elevations which trend about east-northeast across the more or less flat top. The station is on the elevation south of the central depression. A yellow metal spike was placed about half a foot underground and cobblestones were piled over it to mark the station."

Kadleroshilik River

On the west side of the mouth of the Kadleroshilik River, the AHRS records site XBP-00025 as comprising a sod house, collapsed ice cellar, tent ring, sod quarry, and two racks. Another site west of XBP-00025, Foggy Island Bay No. 2 (XBP-00024), contains two sod house ruins, one of which has since eroded (see discussion above). East of the river is the Ekolook Grave site (XBP-00083), which may be the same as *Ekoolook Inaat* (IAI 1990b); however, this location may also refer to the grave of another Ekoolook family member. Between Kadleroshilik River and Sagavanirktok River was the site of *Koganak Inaat*, or Koganak's Place (TLUIXBP-007; IAI 1990b). The site contains the ruins of a sod house and graves. A local family lived here in the 1920s, and the site is linked to people who now live in Kaktovik (IAI 1990b).

Additional traditional use information about the Kadleroshilik River area not contained in the AHRS and current NSB TLUI database is found in Impact Assessment, Inc. 1990b. Two traditional use sites, *Qalgusilik* and *Sikiagruum Inaa*, are either very closely collocated or possibly different names for the same site (IAI 1990b). Qalgusilik was a former habitation site that is listed as having the ruins of a sod house and unidentified graves (IAI 1990b); Sikiagruk's Place was a family camp associated with local residents (IAI 1990b).

Sagavanirktok River

AHRS sites on the Sagavanirktok River include two possibly related sites: the Main Channel site (XBP-00020) and Small Boat No. 1 (XBP-00021). The Sagavanirktok River Main Channel site consists of a winter house from the historic period, which was reported as washed away in 2003, and two nearby surface depressions. Six hundred fifty meters downstream from the Main Channel site on a sand bar is the inverted Small Boat No. 1 site. On the east side of the Sagavanirktok River delta is the Foggy Island Bay House Ruin (XBP-00023), which is a semisubterranean house ruin with a possible nearby storage shelter.

Leffingwell placed another survey point, called Sako (XBP-00081), on a 30-foot-tall mound near the eastern mouth of the Sagavanirktok River about 1 mile in from the coast; there he buried a few small stones 1.5 feet below the surface (Leffingwell 1919).

Foggy Island/Point Brower

Point Brower (TLUIXBP-005 and XBP-00022) includes three historic houses at risk of destruction by wave erosion. The site, *Aglivurak* or *Aglibuabruk*, was a habitation site in the 1930s and the site of a trading post owned by Jack Smith and operated by Henry Chamberlain. A local family is associated with a residence at the site (IAI 1990b). A nearby site (TLUIXBP-006) was used by several local families. There are graves located in the area and the location was also used as a whaling site.

Anxiety Point

Site XBP-00001 includes a recent hunting site and what appears to have been a seismic testing camp. The point was occupied at least three times by Leffingwell (1919) during his survey of the coast, and he describes the point, ANX, from which he triangulated to neighboring stations as follows:

> "Anx. - A station at the north end of Foggy Island, which was thought to be Anxiety Point. The Station is near the west bank, near a low grassy mound. Half a dozen fish-net weights of horn were placed about 2 feet underground."

Leffingwell (1919)later corrected this by placing a station called Howe on the real Anxiety Point:

> "Howe. - A station at Anxiety Point, the eastern and highest part of Howe Island. The station is on the highest spot, close-to the bank at the southeast corner. It is marked with a 15-foot beacon; no subsurface mark ."

3.21.7.2 Additional Sites in the Study Area

In addition to the sites discussed in the previous section, there are 11 AHRS sites in the proposed study area (XFI-00030, XFI-00031, XFI-00032, XFI-00033, XFI-00034, XFI-00035, XBP-00042, XBP-00072, XBP-00084, XBP-00085, and XBP-00086) that are not associated with TLUI sites, and are lacking any additional site descriptions. Available information on these AHRS sites is limited to AHRS site names and/or types and consists of seven prehistoric lithic sites, three gravesites, and one site with no description (Table 3.21-2). No further site information is currently available from the OHA AHRS database. The TLUI sites with no known description of significance in the TLUI database include TLUIXFI-022, TLUIXFI-023, TLUIXFI-024, TLUIXFI-025, and TLUIXBP-035.

3.22 SUBSISTENCE AND TRADITIONAL LAND USE PATTERNS

This section describes the affected environment for subsistence resources and traditional land use in communities that either hunt in and/or rely on resources in the vicinity of Point Thomson. This section includes a general overview of subsistence-use patterns for Kaktovik and Nuiqsut, including the importance of subsistence, the seasonal round, harvest estimates, and subsistence-use areas. An in-depth description of Kaktovik and Nuiqsut subsistence uses, including additional maps, figures, and tables, is provided in the Subsistence and Traditional Land Use Technical Report in Appendix Q. In addition to a description of Kaktovik and Nuiqsut subsistence patterns, this section provides a brief description of Anaktuvuk Pass that will include a description of sharing patterns between that community and residents from Kaktovik and Nuiqsut.

3.22.1 Key Information About Subsistence and Traditional Land Use Patterns

Subsistence is a central aspect of North Slope culture and life, which is rooted in the traditional relationship of the Iñupiaq people with their environment. Residents of the North Slope of Alaska rely on subsistence harvests of plant and animal resources for nutritional sustenance and cultural and social well-being. Subsistence is not only a source of food for North Slope residents, but the activities associated with subsistence strengthen community and family social ties; reinforce community and individual cultural identity; and provide a link between contemporary Iñupiat and their ancestors.

The two communities closest to the Point Thomson Project, Kaktovik and Nuiqsut, use areas in or adjacent to the Point Thomson project area for subsistence purposes; residents from these communities also harvest subsistence resources, such as caribou and waterfowl, which may migrate through the project area. Direct uses of the project area by Nuiqsut residents are limited; however, Nuiqsut whaling crews hunt for whales offshore from the project area, primarily to the west in an area surrounding Cross Island. Kaktovik residents use the project area primarily for the harvests of caribou, although subsistence harvests of other resources such as seals, waterfowl, and fish occur at a minimal level in the project area primarily in conjunction with the summer caribou hunt.

Of the various subsistence resources harvested by Kaktovik and Nuiqsut residents, the primary resources of concern for impact from the development of the Point Thomson Project are caribou hunting, bowhead whale hunting, seal hunting, waterfowl hunting, and fish harvesting (see Table 3.22-1). Data show Kaktovik hunters using the project area (Bullen Point to Point Thomson) to hunt for caribou and harvesting caribou along the coast in the project area during certain years. Bowhead whale hunting by Nuiqsut residents occurs offshore from the Point Thomson project area (although primarily west of Bullen Point). While Kaktovik bowhead whale hunting does not occur in the project area, bowhead whale hunting is of special concern because bowhead whales are known to be particularly sensitive to noise, they provide a substantial percentage of each community's yearly subsistence harvest, and they are a key element in the cultural identity of the Iñupiat in both communities. Years with unsuccessful bowhead whale harvests (Kaleak 1996, Long 1996, Pedersen et al. 2000) have caused hardships (e.g., decreased subsistence foods, increased risks to safety) for the study communities and remain in their collective memory. Kaktovik harvesters have reported fishing along the coast in the project area vicinity and Nuiqsut residents harvest fish (primarily arctic cisco) that migrate past the project area on their way to the Collville River delta. Other subsistence uses (seal and waterfowl hunting) have been reported in or near the project area to a lesser extent. Residents from both communities expressed concerns about impacts on subsistence uses of these resources (caribou, bowhead whales, seals, waterfowl, and fish) during Point Thomson Project EIS public scoping meetings.

Table 3.22-1: Subsistence and Traditional Land Use Resources of Concern for the Point Thomson Project	
Subsistence Activity/Use	Reason For Concern
Caribou Hunting	Caribou hunting by Kaktovik residents is the most commonly reported subsistence activity in the project area. Kaktovik residents expressed concerns about impacts on access to and availability of caribou during public scoping meetings. Nuiqsut residents also expressed concerns about potential impacts on caribou health and availability during public scoping meetings.
Bowhead Whale Hunting	Bowhead whales are hunted offshore from the project area by Nuiqsut residents. Nuiqsut residents expressed concerns about potential impacts on bowhead whales from drilling and other activities associated with the Point Thomson Project. While Kaktovik hunters hunt bowhead whales east of the project area during the whales' east to west fall migration, residents expressed concerns about potential contamination of marine resources resulting from the project; bowhead whales are a key resource for both the communities of Kaktovik and Nuiqsut.
Seal Hunting	Residents of Kaktovik and Nuiqsut have reported subsistence use areas for seals offshore from the project area. Uses of this area for these activities are low compared to areas closer to Kaktovik and Nuiqsut and generally occur as secondary activities during caribou or bowhead whale hunting. However, residents from both communities expressed concerns about impacts on seals and on hunter access to these resources in the project area resulting from the Point Thomson Project.
Fish Harvesting	Kaktovik harvesters have reported subsistence uses of coastal area to Bullen Point for harvests of fish including Dolly Varden and whitefish. While uses of the project area are limited compared to areas closer to Kaktovik, a number of residents have identified Bullen Point as a good fishing location. Nuiqsut residents rely heavily on their yearly harvests of arctic cisco, which migrate past the project area each year on their way to the Colville River delta. Residents of both communities expressed concerns about impacts on fish availability (including impacts on migrating fish) resulting from the Point Thomson Project.
Waterfowl Harvesting	Kaktovik and Nuiqsut harvesters have reported subsistence uses of the coastal and offshore areas in the vicinity of the Point Thomson Project. Uses of this area for these activities are low compared to areas closer to Kaktovik and Nuiqsut and generally occur as secondary activities during caribou or bowhead whale hunting. Residents of both communities expressed concerns about the effects of the Point Thomson Project on migrating waterfowl.

3.22.2 Review and Adequacy of Sources for Subsistence and Traditional Land Use Patterns

Various sources provide data on traditional land use patterns for Kaktovik and Nuiqsut. The identification and discussion of traditional land use patterns is relevant because contemporary subsistence activities are rooted in and closely linked to traditional subsistence activities. Traditional knowledge associated with subsistence, including key hunting and harvest locations, the timing of subsistence activities, and the methods of hunting, harvesting, processing, and sharing subsistence resources, has been passed down through generations. Even if residents infrequently access certain harvest locations for various reasons, they often maintain cultural ties to those places. A number of reports provide data on traditional land use patterns including traditional harvest locations, TLUI sites, and descriptions of traditional subsistence activities through first-hand accounts from community elders (Brown 1978; Libbey et al. 1979; Pedersen 1979; Spearman et al. 1979; Wentworth 1979; Jacobson and Wentworth 1982; Hall et al. 1985; Hoffman et al. 1988; Rausch 1988; IAI 1990a, b; HRAF 1992).

The primary sources of data on contemporary subsistence uses are harvest data and subsistence use area data. Harvest data for the study communities are available through ADF&G and through the NSB

(Pedersen and Coffing 1984, Coffing and Pedersen 1985, Pedersen 1990, Fuller and George 1999, Bacon et al. 2009, ADF&G 2011b). Harvest data provide quantitative estimates of the amount of fish and game harvested by each study community, by subsistence species. They are useful for analyzing community harvests and uses (e.g., household participation and sharing) over time, for determining community harvest levels by species, and for comparing subsistence resources to one another in terms of household uses and harvests. Harvest data are not exact and their accuracy depends on various factors, including survey sample sizes and the accuracy of harvester recall. However, they are generally the only source of information for quantitative community-wide harvests for all resources. The most recent all-resources harvest data for Kaktovik are from 2002 to 2003; the most recent all-resources harvest data for Nuiqsut are from 2000 to 2001. More recent resource-specific (e.g., bowhead whale and caribou) harvest data are available for both communities.

Harvest data typically do not provide spatial information but focus on harvest amounts, sharing, and participation. However, both the ADF&G and NSB have also collected Kaktovik harvest amounts by harvest placename locations, primarily for caribou, adding a geographic layer to harvest data (ADF&G 2003a; NSB 2003, 2006, 2010b). These data show harvest numbers grouped by harvest placename location; while they do not record exact harvest locations, they show the general vicinity where the harvests occurred. Harvest by location data only represent reported harvests and not community totals, because harvests by location have not been generalized for the community as a whole. Therefore, for years when harvest amounts by location are the only available data, these numbers should not be used as a replacement for community harvest estimates. Harvest location by placename data are useful for understanding interannual variations in harvest activities and resource availability and for determining which areas generally provide a greater percentage of a community's harvests. Similar to harvest data, the accuracy and reliability of harvest placename location data depends on sample sizes and harvester recall. Harvest amounts by placename location data are available only for Kaktovik and are limited to caribou. The most recent year of harvest by placename location data for Kaktovik is 2007. In addition, bowhead whale harvest locations for Nuiqsut and Kaktovik are available as recently as 2010 through various sources (Suydam et al. n.d. a, b, c; Suydam and George n.d. NSB 2010b).

Subsistence use area data primarily measure the geographic extent of residents' use of their environment to harvest subsistence resources. Subsistence use areas for Kaktovik and Nuiqsut are available through various sources including SRB&A (2003b, c, 2010a), Brown (1978), Galginaitis (2006, 2008a, b, 2009a, b, c, 2010), Galginaitis and Funk (2004a, b, c, 2005), Hall et al. (1985), Pedersen (1979, 1986), and Pedersen and Linn (2005). There are various methods of representing subsistence use area data. The most common method is to show one polygon representing the extent of a community's use area during a certain time period. This method does not differentiate between areas used periodically or by one harvester and areas used by multiple harvesters on a regular basis. Another method is to track harvesters' activities using GPS units (Galginaitis 2006, 2008a, b, 2009a, b, c, 2010; Galginaitis and Funk 2004a, b, c, 2005); this method has provided a more exact depiction of where bowhead whale hunters travel by boat, but for Nuiqsut is currently limited to one resource.

A third method (SRB&A 2010a) maps subsistence use areas on separate acetate overlays during individual interviews with active harvesters and creates subsistence use area maps differentiating between areas where only a small number of use areas were reported and areas where a higher number of use areas were reported. This is achieved by converting polygons (use areas) to a grid with each pixel being assigned a value of one. Then, the number of overlapping pixels are summed and assigned a color, with the darkest color (red) representing the highest density (or number) of overlapping pixels. This method provides a measure of harvest effort in terms of the number of respondents reporting subsistence activities within geographic areas and, in the case of multiresource maps, includes the number of species targeted. For some resources (e.g., Kaktovik moose and walrus), maps show sharply defined ranges between high and low colors; this generally occurs for resource maps representing a small number of use areas or respondents where the transition from yellow (low numbers of use areas) to red (high numbers of use areas) is less gradual. The overlapping use area method does not represent harvest success or intensity of use in terms of frequency or duration of trips. It also does not represent all harvesters in the community, but rather a subset of harvesters systematically selected as particularly active and knowledgeable subsistence users. Stephen R. Braund & Associates (SRB&A) employed a social network method based on the one described in Johnson (1990) to create a sample of active and knowledgeable subsistence harvesters for each community (Kaktovik, Nuiqsut, and Barrow) and used this to select respondents for the mapping study. Subsistence use areas for each respondent were mapped on an acetate sheet positioned over a 1:250,000 USGS map. Each recorded use area represented the area where the respondent reported having searched for a specific resource during the 10 years prior to each interview. Use areas depict active search areas and not areas used en route to subsistence use areas; non-hunting travel routes to subsistence use areas were mapped separately. A more detailed description of the methods associated with the SRB&A overlapping use area method is provided in SRB&A (2010a). The overlapping use areas documented by SRB&A are the primary source of subsistence use area data used to analyze potential impacts in this Draft EIS, in addition to the harvest location by placename data provided by ADF&G and NSB. The most recent time period available for subsistence use area data is from 1996 to 2006 (for Kaktovik) and from 1995 to 2006 (for Nuiqsut). Bowhead whale hunting tracks for Nuiqsut are available as recently as 2009 and are included in the Subsistence and Traditional Land Use technical report (Appendix Q).

The two primary methods of spatially documenting subsistence uses used in this report (harvest by placename location and overlapping subsistence use area data) both provide relevant information about subsistence uses. Harvest location data are useful for identifying where harvests have occurred during specific events and/or years, and if one has time series data, for measuring the importance of an area by identifying recurring harvests at that location. Subsistence use area data are useful for representing where community residents identify as their current subsistence hunting and harvesting area and, in the case of overlapping use areas, measuring the importance of an area in terms of the number of individuals who use the area and the number of resources targeted in an area (for multi-resource maps). Neither method fully measures the cultural or traditional importance of an area or resource to a community.

Subsistence seasonal round data are available in the form of ethnographic descriptions, harvest amount or level by month data, and subsistence use area by month data. This Draft EIS incorporates all three types of seasonal round data. It is important to note that harvest amount by month data represent seasonal round in terms of harvest success, while subsistence use area by month data represent seasonal round in terms of harvest effort. Although these two data sets (month by use area and month by harvest amount) are not directly comparable, there is generally a high correlation between harvest effort (represented by numbers of reported use areas) and harvest success (represented by harvest amounts; see the Contemporary Seasonal Round discussions, Section 3.22.4.1).

Another primary source of subsistence data cited in this Draft EIS is related to impacts on subsistence and culture. The sources used in this document primarily focus on impacts related to oil and gas development (Haynes and Pedersen 1989, Pedersen et al. 2000, SRB&A 2009). In general, North Slope literature addressing impacts on subsistence and culture rely directly on observations and reports by local hunters as well as evidence of impacts through harvest location and subsistence use area documentation. Biological studies also provide measures of impacts on subsistence resources, which also inform impacts on subsistence users.

Table H-22 in Appendix H discusses the publications, reports, and data available for subsistence and traditional land use that are cited in this Draft EIS and their relevance to the proposed project. Full references for the studies cited in the following text are in Chapter 9, References.

3.22.3 Subsistence Definition and Relevant Legislation

Subsistence hunting and fishing are regulated under a dual management system by the State of Alaska and the federal government. Federal subsistence law regulates federal subsistence uses; state law regulates state subsistence uses. The federal government recognizes subsistence priorities for rural residents on federal public lands or in certain waters with a federal reserved water right. The state of Alaska considers all Alaskan residents to have an equal right to participate in subsistence hunting and fishing activities when resource abundance and harvestable surpluses are sufficient to meet the demand for all subsistence and other uses.

The Point Thomson Project is located on state lands. State regulations governing subsistence are based on Title 16 of Alaska Statutes (AS 16) and Title 5 of Alaska Administrative Code (05 AAC 01, 02, 85, 92, and 99). The State distinguishes subsistence harvests from personal use, sport, or commercial harvests based on where the harvest occurs, not where the harvester resides (as is the case under federal law). More specifically, state law provides for subsistence hunting and fishing regulations in areas outside the boundaries of "nonsubsistence areas," as defined in state regulations (5 AAC 99.015). According to these regulations, a nonsubsistence area is "an area or community where dependence upon subsistence is not a principal characteristic of the economy, culture, and way of life of the area or community" (5 AAC 99.016). Under state law "subsistence uses means the noncommercial, customary and traditional uses of wild, renewable resources by a resident domiciled in a rural [sic] area of the state for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of non-edible by-products of the fish and wildlife resources taken for personal or family consumption, and for customary trade, barter, or sharing for personal or family consumption" (A.S. 16.05.940[33]).

Federal subsistence law is based on Title VIII of the 1980 ANILCA and regulations found in 36 CFR 242.1 and 50 CFR 100.1. Federal regulations recognize subsistence activities based on a person's residence in Alaska, defined as either rural or nonrural. Only individuals who permanently reside outside federally designated nonrural areas are considered rural residents and qualify for subsistence harvesting on federal lands under federal subsistence regulations. Nonrural residents may harvest fish and game on most federal lands (unless the lands are closed to non-federally qualified subsistence uses); however these harvests occur under state regulations. Under federal law, "subsistence uses means the customary and traditional uses by rural Alaska residents of wild renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade" (ANILCA Title VIII Section 803). Because the project area is on state lands, the federal subsistence program does not apply to harvests within the project area; however, project activities could affect subsistence uses outside the project area on nearby federal lands (e.g., the Arctic National Wildlife Refuge). In addition, resources that migrate through the Point Thomson area, including caribou, waterfowl, and migratory fish such as arctic cisco, may be harvested elsewhere on state, federal, or private lands.

The Alaska Federation of Natives (AFN 2005) describes subsistence as

> "the hunting, fishing, and gathering activities which traditionally constituted the economic base of life for Alaska's Native peoples and which continue to flourish in many areas of the state today. .... Subsistence is a way of life in rural Alaska that is vital to the preservation of communities, tribal cultures and economies. Subsistence resources have great nutritional, economical, cultural, and spiritual importance in the lives of rural Alaskans. … Subsistence, being integral to our worldview and among the strongest remaining ties to our ancient cultures, is as much spiritual and cultural, as it is physical."

Subsistence activities could include hunting, fishing, trapping, wood gathering, and berry picking.

3.22.4 Affected Environment

As noted above, Appendix Q provides a more detailed description of subsistence uses in the project area. Included in the appendix are descriptions of regional settlement patterns and historic overviews of the study communities. This affected environment section provides a general overview of subsistence uses in the study communities.

3.22.4.1 Patterns of Subsistence Resource Use

Residents from Kaktovik and Nuiqsut either hunt in or utilize subsistence resources that seasonally migrate in the Point Thomson area. The following sections address the contemporary seasonal round, subsistence harvest data, and subsistence-use areas for Kaktovik and Nuiqsut.

Kaktovik

Kaktovik is located on Barter Island on the northern edge of the arctic refuge, a location that offers access to marine mammals, land mammals, and fish. Kaktovik is uniquely situated for regular access to terrestrial, marine, and riverine resources, although inland summer hunting by boat is difficult due to the shallow and braided nature of rivers in the area. Caribou and bowhead whale are staple subsistence resources for the area. While not harvested in the same quantities as caribou, sheep are relatively important to Kaktovik identity, as only the North Slope communities of Kaktovik and Anaktuvuk Pass harvest them regularly (IAI 1990a). Seals (bearded, ringed, and spotted) are also important supplemental resources, as are ducks, geese, and several fish species (Jacobson and Wentworth 1982). Riverine resources are important as well, and subsistence rivers include the Hulahula, Canning, and other regional rivers. Like many other North Slope communities, the bowhead whale is central to Kaktovik residents' cultural identity and an important source of food. Kaktovik is one of 11 Alaska Eskimo bowhead whaling communities. Kaktovik bowhead whaling occurs only in the fall, when the whales migrate close to shore, as the spring migration passes too far offshore for hunts to occur. Other resources harvested by Kaktovik residents include polar bear, beluga whales, muskox, brown bear, berries, and plants. Subsistence resource harvests are key components of the economy and cultural integrity of the village.

Contemporary Seasonal Round

The annual round in Kaktovik is based on the seasonal availability of resources. Because few rivers in the Kaktovik area are navigable, the majority of inland travel occurs by snowmachine during the winter and spring months. During the open-water season, residents' subsistence activities are focused along the coast or in the open ocean. Appendix Q (Table 1 and Figure 3) provides more detailed descriptions of the seasonal round in Kaktovik. Early springtime (April and May) activities include harvests of arctic squirrel, ptarmigan, Dall sheep, brown bear, wolf, and wolverine (Appendix Q, Table 3). In late May or early June, migratory waterfowl hunting begins. Subsistence activities in June are scant because there is not enough snow for snowmachine transportation and the ice conditions make boat travel difficult. Caribou hunting occurs from July to late August (peaking in July when animals seek relief from insects at the coast) and often continuing into the fall months (Pedersen 1990, SRB&A 2010a). Fishing begins in July, usually with set gill nets, in the rivers, lagoon systems, and along the barrier islands. Dolly Varden and arctic cisco are primarily harvested from August through September. Kaktovik hunters also harvest bearded, ringed, and spotted seals during this time (SRB&A 2010a).

Activities related to whaling continue throughout the year, but preparations for the whaling season increase in intensity in late August, when the fall bowhead whale migration usually reaches the Kaktovik area. Once the whaling season is over, usually in late September, hunters focus on caribou and Dall sheep. Hunting and trapping usually begins early in November and continues throughout the winter months. Early November is the peak time for travel to mountain camps, and Kaktovik residents often stay in these camps from a few days to a few months. Subsistence activity slows in mid-December due to limited daylight. Polar bears are harvested on an opportunistic basis. Wolf and wolverine hunting occurs from early December through mid-May. Winter fishing occurs from late February through early April. Dall sheep, wolf, wolverine, caribou, and an occasional moose are also harvested from late February through early April (Jacobson and Wentworth 1982).

Subsistence Harvest Estimates

The ADF&G (2011b) collected comprehensive (i.e., all resources) subsistence harvest data for Kaktovik in 1985, 1986, and 1992 (Appendix Q, Tables 2 and 3); ADF&G selected 1992 as the representative year of the three available harvest years for subsistence harvest data in Kaktovik. In addition, NSB harvest data are available for 1992 and 2002 to 2003. Kaktovik's total annual subsistence harvests increased from 61,663 pounds in 1985 to 84,060 pounds in 1986, and 170,939 pounds in 1992 (Appendix Q, Table 2). Table 3.22-2 shows resource contribution toward the total subsistence harvest, by study year for four study years (1985, 1986, 1992, and 2002 to 2003). Table 3.22-3 shows average annual species-level harvest data (for available study years), including the average percentage of households attempting harvests of subsistence species, the percentage of households receiving species, and the percent each species has contributed, on average, toward the total annual harvest. Marine mammals, particularly bowhead whales and seals, generally contribute a high percentage of each year's total harvest, followed by terrestrial mammals (caribou and Dall sheep) and fish (Dolly Varden, whitefish, and grayling; Table 3.22-3). Annual harvest data for individual species are available in Appendix Q. Bowhead whales, caribou, and Dolly Varden accounted for 84 percent of Kaktovik's annual subsistence harvest in terms of edible pounds in 1992, with bowhead whales alone accounting for 63 percent of the total harvest (Appendix Q, Table 3). Bowhead whaling and caribou hunting provide the greater portion of subsistence foods by weight. The yearly contribution of these two species to the total subsistence harvest fluctuates depending on resource availability and harvest success (Appendix Q, Table 3). The importance of subsistence to Kaktovik residents is further reflected by the percent of households that use (96 percent), harvest (89 percent), try to harvest (89 percent), and share (92 percent) subsistence resources, as represented in the 1992 data (Appendix Q, Table 2). On average, over 50 percent of households have attempted harvests of bowhead whale, caribou, Dolly Varden, seal, geese, whitefish, upland game birds, ducks, and wood; in addition, over 50 percent have reported receiving bowhead whale, caribou, seal, geese, whitefish, Dall sheep, and muskox during available study years (Table 3.22-3).

Table 3.22-2: Composition of Annual Subsistence Harvests–Kaktovik

Resource	Percentage of Total Harvest by Study Year (%)				
	1985	1986	1992	1992*	2002—2003
Fish	18	8	13	18	4
Land Mammals	58	30	17	14	15
Marine Mammals	17	59	68	66	79
Birds and Eggs	6	3	2	1	2
Vegetation	<1	<1	<1	<1	—

Sources: Fuller and George 1999 for 1992; Bacon et al. 2009 for 2002—2003; ADF&G 2011b for 1985, 1986, 1992

Note: — indicates data not available.

a These data should be viewed with caution due to a low response rate.

Table 3.22-3: Average Annual Kaktovik Harvest Data Over All Available Study Years, by Species

Resource	Average[a] % of Households Attempting Harvest	Average % of Households Receiving Harvest	Average % of Total Harvest
Bowhead Whale	54	87	38
Caribou	71	85	27
Dolly Varden	81	49	10
Seal	53	66	9
Geese	59	58	3
Whitefish[b]	62	67	3
Dall Sheep	27	69	2
Grayling	11	17	2
Moose	7	28	2
Muskox	10	53	2
Polar Bear	5	16	1
Upland Game Birds	65	49	1
Beluga Whale	6	26	<1
Berries	18	29	<1
Bird Eggs	9	9	<1
Brown Bear	3	4	<1
Burbot	1	5	<1
Cod	14	9	<1
Ducks	50	45	<1
Flounder	3	<1	<1

Table 3.22-3: Average Annual Kaktovik Harvest Data Over All Available Study Years, by Species			
Resource	Average[a] % of Households Attempting Harvest	Average % of Households Receiving Harvest	Average % of Total Harvest
Fox	21	2	<1
Greenling	<1	2	<1
Land Otter	2	<1	<1
Lingcod	<1	2	<1
Marmot	4	4	<1
Mink	2	<1	<1
Pike	<1	2	<1
Plants/Greens/Mushrooms	11	6	<1
Salmon	4	11	<1
Sculpin	<1	2	<1
Squirrel	33	19	<1
Swan	2	0	<1
Walrus	4	36	<1
Weasel	1	1	<1
Wolf	12	1	<1
Wolverine	14	2	<1
Wood	64	21	<1

Sources: ADF&G 2011b (ADF&G study years 1985, 1986, and 1992)

[a] Averages include unsuccessful bowhead whale harvest years.

[b] Includes arctic cisco.

Table 3.22-4 and Table 3.22-5 provide all available years of Kaktovik bowhead whale and caribou harvest data, showing number and edible pounds harvested. Annual harvests of caribou vary widely from year to year and depend on a range of factors, including environmental conditions (e.g., snow and ice conditions, water levels), the timing and route of the caribou migration, and the distribution of caribou within residents' usual hunting areas. For all available study years between 1981 and 2003, Kaktovik respondents harvested an average of 150 caribou annually, accounting for an annual average 17,543 edible pounds (Table 3.22-4). Per capita pounds are only available for some study years (Appendix Q, Table 3); available data (Table 3.22-4) show Kaktovik harvesting an average of 123 edible per capita pounds of caribou annually.

Table 3.22-4: Kaktovik Caribou Harvests, All Available Study Years			
	Estimated Harvest		
Study Year	Number	Total Pounds	Per Capita Pounds
1981—82	43	5,031	—
1982—83	160	18,720	—
1983—84	107	12,519	—

Table 3.22-4: Kaktovik Caribou Harvests, All Available Study Years

Study Year	Estimated Harvest		
	Number	Total Pounds	Per Capita Pounds
1985—86	235	27,941	149
1986—87	201	21,188	109
1987—88	189	22,229	104
1990	113	13,453	67
1991	181	22,113	94
1992	158	19,136	99
1994—1995[a]	78	9,126	—
2002—2003	112	13,104	—
Total	1,499	184,560	—
Average[b]	150	17,543	123

Sources: Pedersen 1990, Bacon et al. 2009, ADF&G 2011b
Note: — indicate data not available.
[a] For 1994-1995, data represent reported harvests and do not represent estimates for the community as a whole.
[b] Averages do not include 1994 to 1995 data, which did not attempt to extrapolate to the community as a whole.

Kaktovik bowhead whale harvest numbers are available from 1964 through 2010 (Table 3.22-5). Edible pounds were calculated using bowhead whale lengths and the method provided in SRB&A and ISER (1993). Kaktovik has harvested an average of 2.6 bowhead whales annually not including unsuccessful years (an average of 3 since the 1990s), providing an average of 65,135 edible pounds of meat and blubber per year (for years that Kaktovik harvested a bowhead whale). Using 2010 census data showing a population of 239 residents in 72 households, and an estimated 53,167 edible pounds of bowhead whale in 2010, Kaktovik harvested 222 pounds of edible foods per capita in 2010, or 738 edible pounds per household. This is on the lower end of estimated mean household pounds and per capita pounds for years where community harvest data are available (Appendix Q, Table 4).

Table 3.22-5: Kaktovik Bowhead Whale Harvests, All Available Study Years

Year	Number	Total Edible Pounds
1964	2	—
1966	0	—
1967	1	—
1968	0	—
1972	1	—
1973	3	55,597
1974	2	—
1975	0	—
1976	2	47,448

Table 3.22-5: Kaktovik Bowhead Whale Harvests, All Available Study Years

Year	Number	Total Edible Pounds
1977	2	66,450
1978	2	56,535
1979	5	124,436
1980	1	16,076
1981	3	133,885
1982	1	48,924
1983	1	45,866
1984	1	16,076
1985	0	—
1986	3	80,919
1987	0	—
1988	1	45,866
1989	3	120,000
1990	2	40,381
1991	2	38,773
1992	4	116,010
1993	3	58,812
1994	3	—
1995	4	—
1996	1	45,866
1997	4	103,819
1998	3	45,013
1999	3	56,345
2000	3	57,205
2001	4	78,852
2002	3	75,715
2003	3	71,752
2004	3	73,038
2005	3	45,013
2006	3	79,692
2007	3	40,833
2008	3	57,482
2009	3	88,488
2010	3	53,167

Table 3.22-5: Kaktovik Bowhead Whale Harvests, All Available Study Years

Year	Number	Total Edible Pounds
Total	97	2,084,334
Average[a]	2.6	65,135

Sources: Suydam and George n.d., Suydam et al. n.d.a, NSB 2010
Note: — = data not available (i.e., bowhead whale lengths not available to determine edible pounds).
* Averages do not include unsuccessful harvest years.

Subsistence-Use Areas and Harvest Locations

Lifetime and 1996-to-2006 subsistence-use areas for all resources are shown on Figure 3.22-1. The 1996-to-2006 subsistence-use areas depicted on Figure 3.22-1 are only for selected species and do not include use areas for Dall sheep, bear, ptarmigan, vegetation, and certain species of fish. From 1996 to 2006, Kaktovik subsistence users utilized an area of up to 20,341 square miles, extending along the coast from Prudhoe Bay to beyond the Mackenzie River delta, including the offshore barrier islands, and to the foothills and low passes of the Brooks Range via several river drainages (Figure 3.22-1).

Summer resource harvests tend to take place along the coast and barrier islands, while winter harvests tend to take place inland along river courses such as the Hulahula, Shaviovok, and Sadlerochit Rivers (Pedersen 1990). A high number of overlapping contemporary (1996-to-2006) use areas occur along the coast between Bullen Point and Demarcation Point; inland around Hulahula, Sadlerochit, Jago, and Okpilak Rivers; and offshore up to 25 miles. Maps showing subsistence-use areas for individual resources are provided in Appendix Q. According to these maps, resources harvested in the project area include caribou, seal, walrus, polar bear, fish, waterfowl, and furbearers. Although not harvested in the project area, bowhead whales migrate through the project area on their way to and from Kaktovik residents' whale hunting area to the east of Point Thomson. Residents hunt bowhead whales offshore from and in an area surrounding Barter Island as the whales migrate from east to west during their fall migration.

Caribou is the most intensively hunted resource by Kaktovik residents in the project area. Because of the relative importance of the project area to subsistence caribou hunting as opposed to other subsistence hunting and harvesting activities, this discussion provides a more in-depth analysis of Kaktovik caribou hunting patterns compared to other subsistence resources. Additional information related to caribou and other subsistence resources is available in Appendix Q.

Figure 3.22-2 depicts 1996-to-2006 caribou hunting areas in the Point Thomson vicinity, as reported by Kaktovik residents during an MMS-funded subsistence mapping study (SRB&A 2010a). The map represents caribou use areas (i.e., search areas) for the given time period as reported by a sample of 38 active harvesters and does not represent the total area used by all Kaktovik residents for caribou from 1996 to 2006. As discussed in Section 3.22.2, the overlapping use area method depicted on Figure 3.22-2 depicts the number of reported use areas overlapped on top of one another, with the red color representing a high number of overlaps and the yellow color representing a low number of overlaps. These maps illustrate search and harvest areas reported by Kaktovik respondents, as well as the importance of hunting areas in terms of how many people use them and (for multi-resource maps) in terms of how many different resources are harvested in each area. As shown in Figure 3.22-2, the coastal area to Bullen Point shows a high amount of overlapping use areas compared to inland areas and the coastal area beyond

Bullen Point. Figure 3.22-3 shows "last 12-month" caribou hunting areas as reported by Kaktovik respondents and depicts low to moderate overlapping hunting areas extending beyond Konganevik Point.

Table 3.22-6 depicts the number of respondents reporting subsistence use areas for the "last 10-year" time period by resource and coastal hunting area during SRB&A mapping interviews in 2005 and 2006 (SRB&A 2010a). As depicted in this table, the only resource for which more than 10 percent of Kaktovik respondents reported use areas in the project area (i.e., in the coastal or offshore area between Brownlow Point and Bullen Point) was caribou.

Table 3.22-6: Number (%) of Kaktovik Respondents Reporting 1996-2006 Use Areas[a] by Coastal Hunting Area

Resource Category	Number (%) of Respondents Reporting Subsistence Use Areas			
	Barter Island to Konganevik	Konganevik to Brownlow Point	Brownlow Pt. to Bullen Point	Bullen Point to Prudhoe Bay
Caribou	35 (92)	29 (76)	15 (39)	7 (18)
Seals	24 (63)	2 (5)	2 (5)	2 (5)
Bowhead Whales	27 (71)	0	0	0
Walrus	6 (16)	1 (3)	1 (3)	0
Furbearers	13 (34)	1 (3)	0	0
Waterfowl	28 (74)	3 (8)	2 (5)	2 (5)
Fish	23 (61)	6 (16)	3 (8)	1 (3)
All Resources	37 (97)	29 (76)	15 (39)	7 (18)

Source: SRB&A 2010a

Note: The total number of Kaktovik respondents interviewed for all resources = 38.

[a] Number of respondents represents the number who reported using an area at least once during the 1996-2006 time period.

Table 3.22-7 depicts the number of caribou harvester respondents reporting caribou use areas by coastal area, for the "last 10-year" time period and for the "last 12-month" time period. For the coastal area west of the community of Kaktovik to Konganevik Point, nearly all respondents (97 percent, or 35 of the 36 reporting caribou hunters) reported "last 10-year" caribou use areas. Areas farther west of the community show gradually fewer respondents reporting use areas, with 81 percent of caribou respondents traveling between Konganevik and Brownlow Point, 42 percent between Brownlow Point and Bullen Point, and 19 percent beyond Bullen Point. A smaller number of respondents (27) reported hunting caribou during the "last 12 months." Of those respondents, 81 percent reported hunting in the area between Barter Island and Konganevik, 56 percent reported hunting between Konganevik and Brownlow Point, and 7 percent reported hunting between Brownlow Point and Bullen Point. According to the available data, the area west of the community to Konganevik and Brownlow Point is a caribou hunting area that is used regularly by a substantial percentage of Kaktovik harvesters. The area west of Brownlow Point to Bullen Point is one that is within a relatively high percentage of harvesters' current caribou hunting areas but is visited by most hunters only during certain years, likely when they are unsuccessful closer to the community.

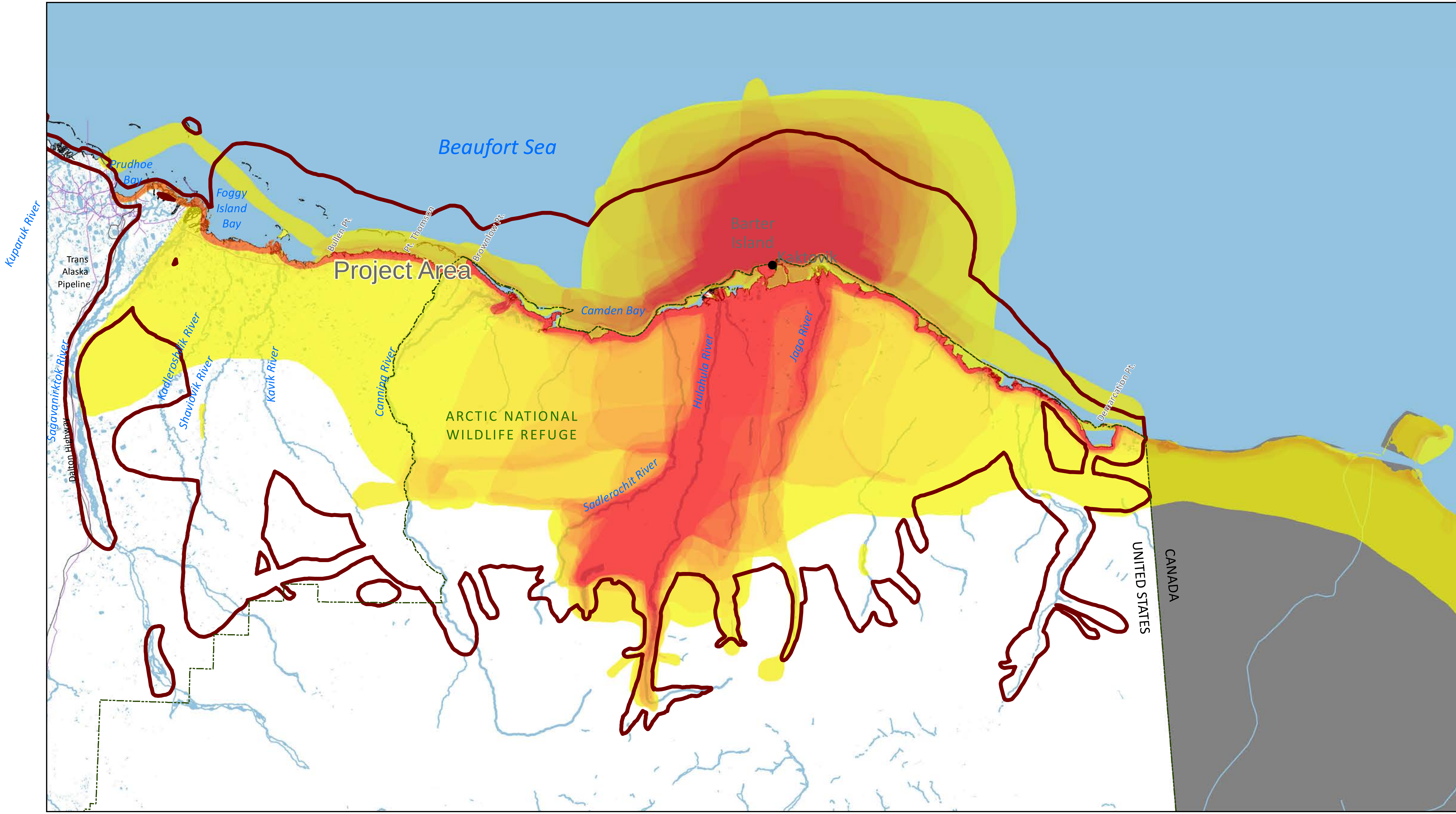
Table 3.22-7: Number (%) of Kaktovik Caribou Hunter Respondents Reporting Caribou Use Areas[a] by Coastal Hunting Area

	Caribou Hunter Respondents	Barter Island to Konganevik	Konganevik to Brownlow Point	Brownlow Point to Bullen Point	Bullen Point to Prudhoe Bay
10-year (1996-2006) Respondents	36	35 (97)	29 (81)	15 (42)	7 (19)
12-month (2004-2005 or 2005-2006) Respondents	27	22 (81)	15 (56)	2 (7)	0

Source: SRB&A 2010a

Note: The total number of Kaktovik respondents interviewed for all resources = 38.

[a] Number of respondents represents the number who reported using an area at least once during the 10-year or 12-month time periods.



POINT THOMSON PROJECT EIS

Legend

- Community
- Road
- Existing Pipelines
- Arctic National Wildlife Refuge

Subsistence Use Areas

Lifetime (Source: Pedersen 1979)

Overlapping 1996-2006 Use Areas (Source: SRB&A 2010)

High / Low — 1,135 use areas reported by 38 respondents

0 5 10 Miles

N

Respondents reported additional 1996-2006 use areas that are located in Canada and in the vicinity of Teshekpuk Lake and are not shown here.

Figure 3.22-1

Kaktovik Lifetime and 1996-2006 Use Areas, All Resources

Date: 11 August 2011

Map Author: Stephen R. Braund & Associates

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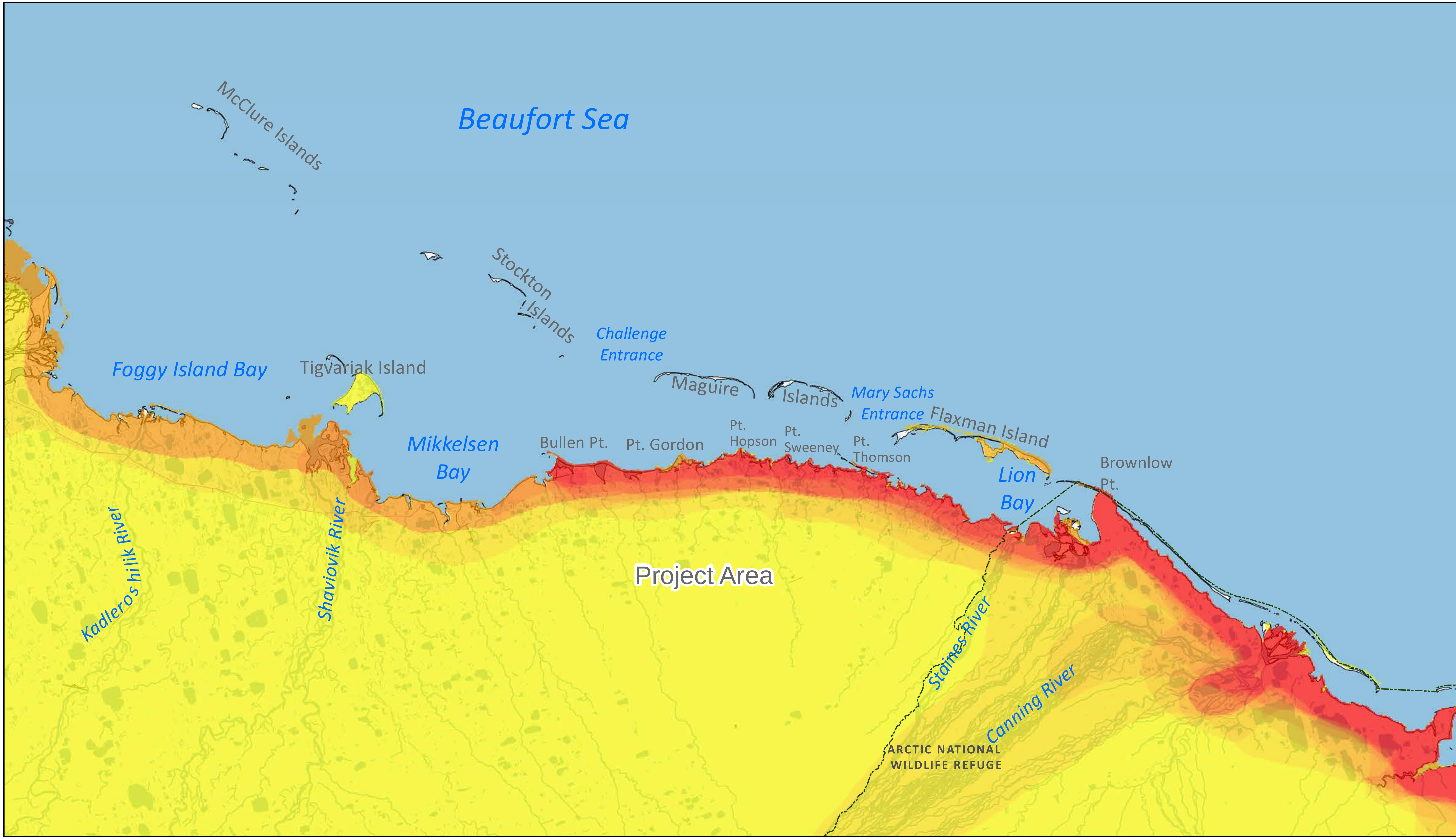

POINT THOMSON PROJECT EIS

Legend

- Road
- Existing Pipelines
- Existing Facilities and Roads
- Arctic National Wildlife Refuge

Subsistence Use Areas

Overlapping 1996-2006 Use Areas (Source: SRB&A 2010)

High 172 use areas reported by
Low 36 respondents

0 1 2 Miles

N

Figure 3.22-2

Kaktovik Partial 1996-2006 Subsistence Use Areas for Caribou, Point Thomson Vicinity

Date: 11 August 2011
Map Author: Stephen R. Braund & Associates

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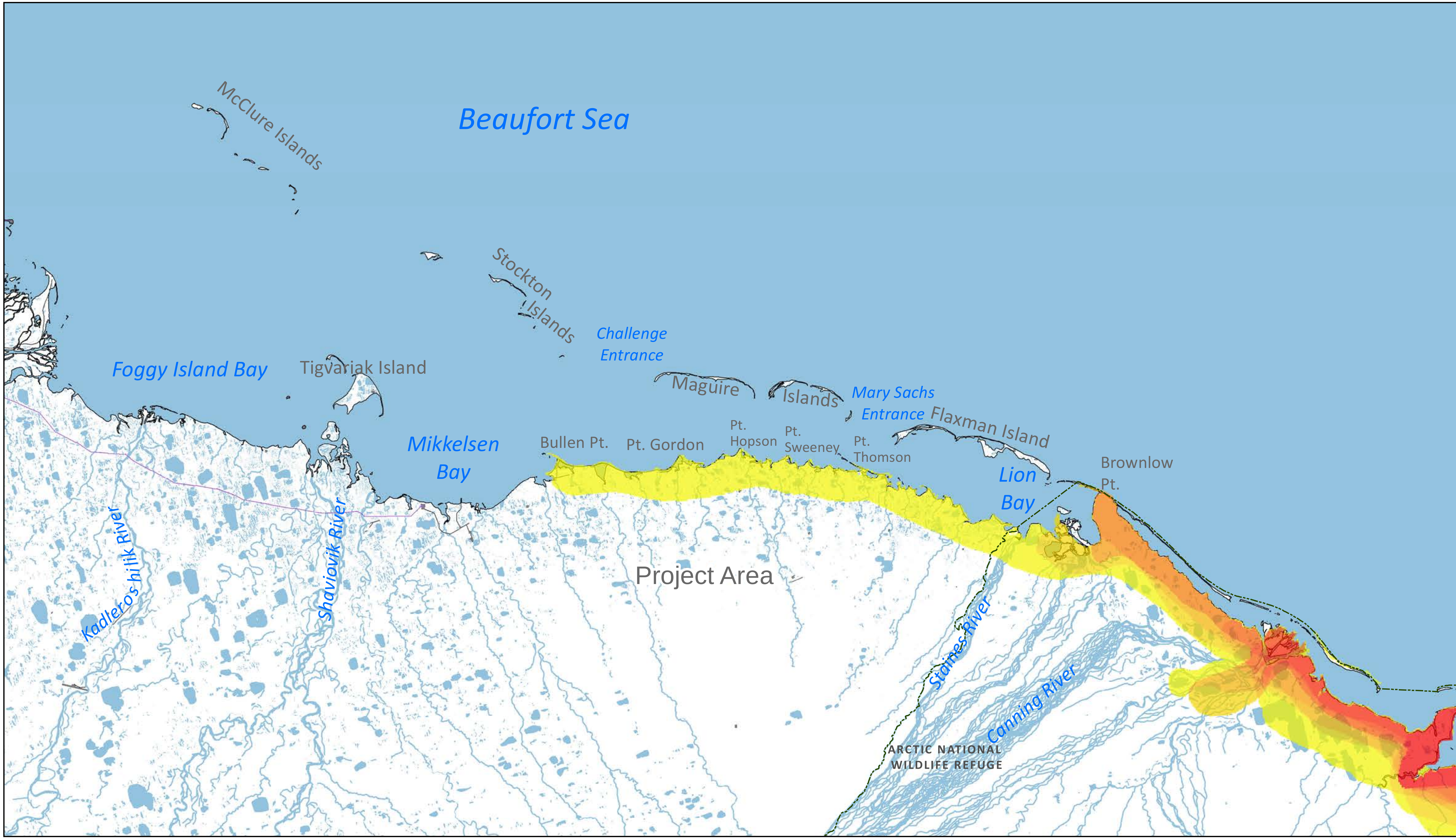

POINT THOMSON PROJECT EIS

Legend

- Road
- Existing Pipelines
- Existing Facilities and Roads
- Arctic National Wildlife Refuge

Subsistence Use Areas

Overlapping Last 12 Months Use Areas (Source: SRB&A 2010)

High 59 use areas reported by
Low 27 respondents

0 1 2 Miles

N

Figure 3.22-3

Kaktovik Partial Last 12 Months Subsistence Use Areas for Caribou, Point Thomson Vicinity

Date: 11 August 2011
Map Author: Stephen R. Braund & Associates

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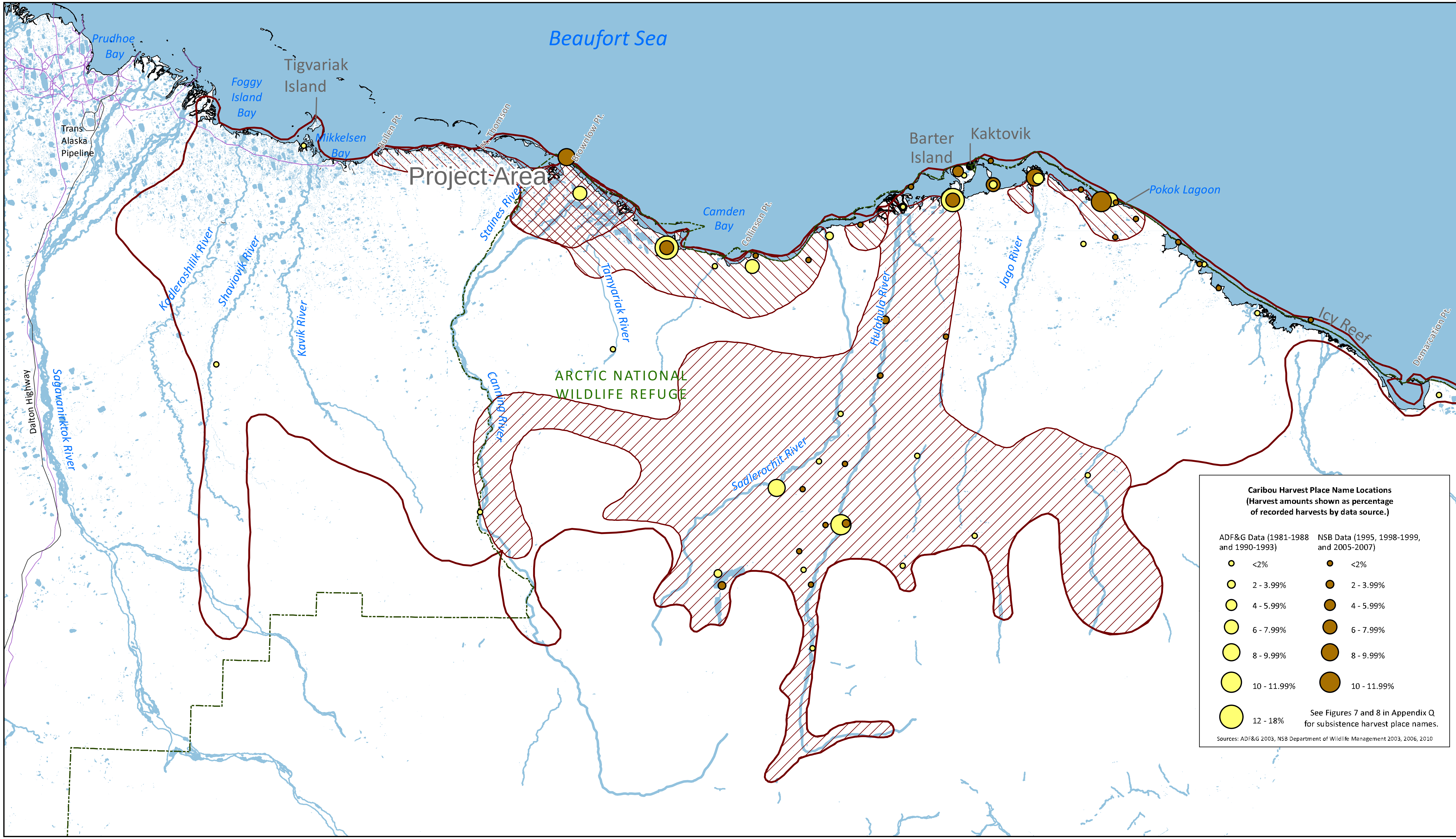
The NSB Department of Wildlife Management (2003, 2006, 2010b) and ADF&G Division of Subsistence (2003a) have both documented Kaktovik harvest amounts by placename location. Maps showing these locations are provided in Appendix Q (Figures 5 and 6). Figure 3.22-4 shows the percentage of ADF&G and NSB reported caribou harvests by harvest placename location and Kaktovik 1923-to-1983 caribou-use areas. The size of each placename location depicts the percentage of caribou harvests from that location during the study years for the data source (either NSB or ADF&G). A high percentage of caribou harvests have been reported at coastal locations, including Brownlow Point, Konganevik Point, the mainland south of Barter Island, Jago River mouth, and Griffin Point. Inland locations associated with high percentages of caribou harvests include Kekituk Creek and 2nd Fish Hole. Other smaller harvests occur at various coastal and inland locations. While successful caribou harvest locations vary from year to year depending on the location and availability of caribou, certain coastal locations have resulted in substantially larger harvests of caribou than other locations. These include locations west of Kaktovik in the direction of the project area (Brownlow Point, Canning River delta, and Konganevik Point). Even the most productive harvest sites vary widely from year to year in terms of importance. Konganevik, for example, has provided over 40 percent of the total reported caribou harvest during some years (1983, 1984, 1986, 1987), while in other years (1988, 1993, 1995, 1999, and 2007), no successful caribou harvests were reported at that location.

Figure 3.22-4 through Figure 3.22-8 show a substantial percentage of Kaktovik coastal caribou harvests occurring west of the community as far as Konganevik, Brownlow Point, and Canning River Delta, with Brownlow Point providing approximately 8 percent of total reported harvests during NSB study years (between 1995 and 2007) and Canning River Delta accounting for approximately six percent of cumulative harvests during ADF&G study years (between 1981 and 1993). Residents have reported a total harvest of 118 caribou at these two locations (Canning River Delta and Brownlow Point) over all study years; harvests at these locations were reported during 15 of the 18 available study years. The two harvest placename locations within the project area (Point Thomson and Bullen Point) represent a smaller percentage of total caribou harvests over all study years accounting for a total of 16 harvested caribou (Figure 3.22-4 through Figure 3.22-8). Harvests associated with the Point Thomson and Bullen Point locations occurred during four of the 18 available study years. The two locations with the highest percentages of caribou harvests during the study years were the mainland, south of Barter Island, and Konganevik Point.

The majority of caribou hunting activities in the project area occur during the summer months of July and August, although caribou hunting occurs year-round. Figure 3.22-5 and Figure 3.22-6 depict the cumulative percentage of caribou harvested by season and coastal location for 18 years of ADF&G and NSB data. Kaktovik residents primarily travel to inland sites during the winter. However, some winter harvests have been reported at coastal locations, notably Konganevik Point, POW-D (Collinson Point), and at locations near Kaktovik, and the Jago River area (Figure 3.22-5 and Figure 3.22-6). Over the data years, some coastal locations resulted in substantially larger harvests of caribou than other locations. Griffin Point, Brownlow Point, Manning Point, Konganevik Point, Jago River, Canning River Delta, and the Kaktovik area (including the mainland south of Barter Island) were especially productive harvest locations during the ice-free July to September period. Coastal sites such as the Canning River Delta, Konganevik Point, POW-D, and the Mainland South of Barter Island were used in both seasons based on the earlier ADF&G harvest data (1981 to 1988 and 1990 to 1993).

When the snow and ice melts in June, travel by snowmachine is curtailed. As the coastal waters become free of ice in early to mid-July, hunters use coastal areas for resource harvests by boat. After calving, caribou aggregate along the coastline and concentrate on points to escape flies and mosquitoes. This behavioral pattern allows hunters to harvest large numbers of caribou with relative efficiency. Based on 15 years of ADF&G and NSB data, an average of approximately 65 percent of the caribou harvested were taken from coastal sites primarily in July and August by hunters in boats. The proportion of caribou harvested on the coast during the 15 years of data has varied from 51 to 78 percent annually (based on data and analysis from Pedersen and Coffing 1984, Pedersen 1990, ADF&G 2003a, NSB 2003).

Figure 3.22-7 and Figure 3.22-8 depict only the coastal caribou subsistence harvest placename locations for Kaktovik arranged in sequence from west to east, with Kaktovik/Barter Island and its environs in the center (see mapped placename locations on Appendix Q Figures 7 and 8). Summer caribou harvests at coastal sites focus on points and spits such as Brownlow, Griffin, Konganevik, Bullen. POW-D (Collinson), Manning, and Demarcation points. These figures provide caribou harvests for each placename location broken out by study year. The annual harvests (shown by location on Appendix Q, Figures 10 and 11) indicate that when large numbers of caribou are encountered during migration or while seeking insect relief, they are harvested in corresponding numbers. The more recent NSB data emphasizes this harvest pattern, with large harvests taken at different locations yearly. The greatest coastal harvest was at Brownlow Point between 1994 and 1995, at Manning and Griffin Points in 1998, Griffin Point in 1999, and the mainland south of Barter Island in 2006. The data for 2005 show a more balanced distribution of harvests across the coast that year.



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- Road
- Existing Pipelines
- Arctic National Wildlife Refuge

Subsistence Use Areas (Source: Coffing and Pedersen 1985)

- Extent of Caribou Hunting (ca. 1923 to 1983)
- Intensively Used Caribou Hunting (Summer)
- Intensively Used Caribou Hunting Area (Winter)

The subsistence harvest place names shown here are associated with common harvest areas and do not necessarily represent actual harvest site locations.

0 5 10 Miles

N

Figure 3.22-4

Percentage of Harvested Caribou by Harvest Place Name Location, Kaktovik

Date: 11 August 2011
Map Author: Stephen R. Braund & Associates

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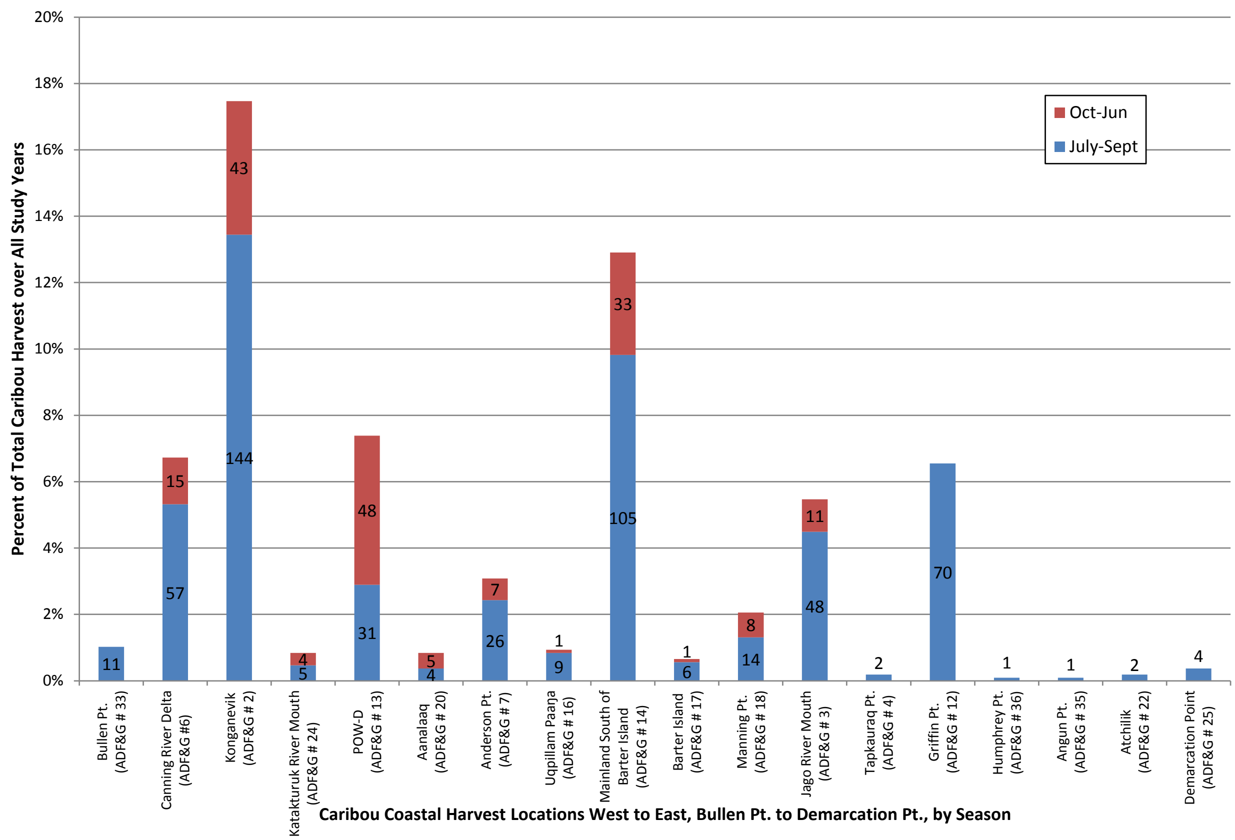


Notes: Numbers in bars represent number of reported caribou harvests at each location
Source: ADF&G Division of Subsistence Caribou Harvest Data for Kaktovik, 1981-1988, and 1990-1993

Figure 3.22-5: Seasonality of Kaktovik Caribou Harvest Locations, 1981—1988 and 1990—1993

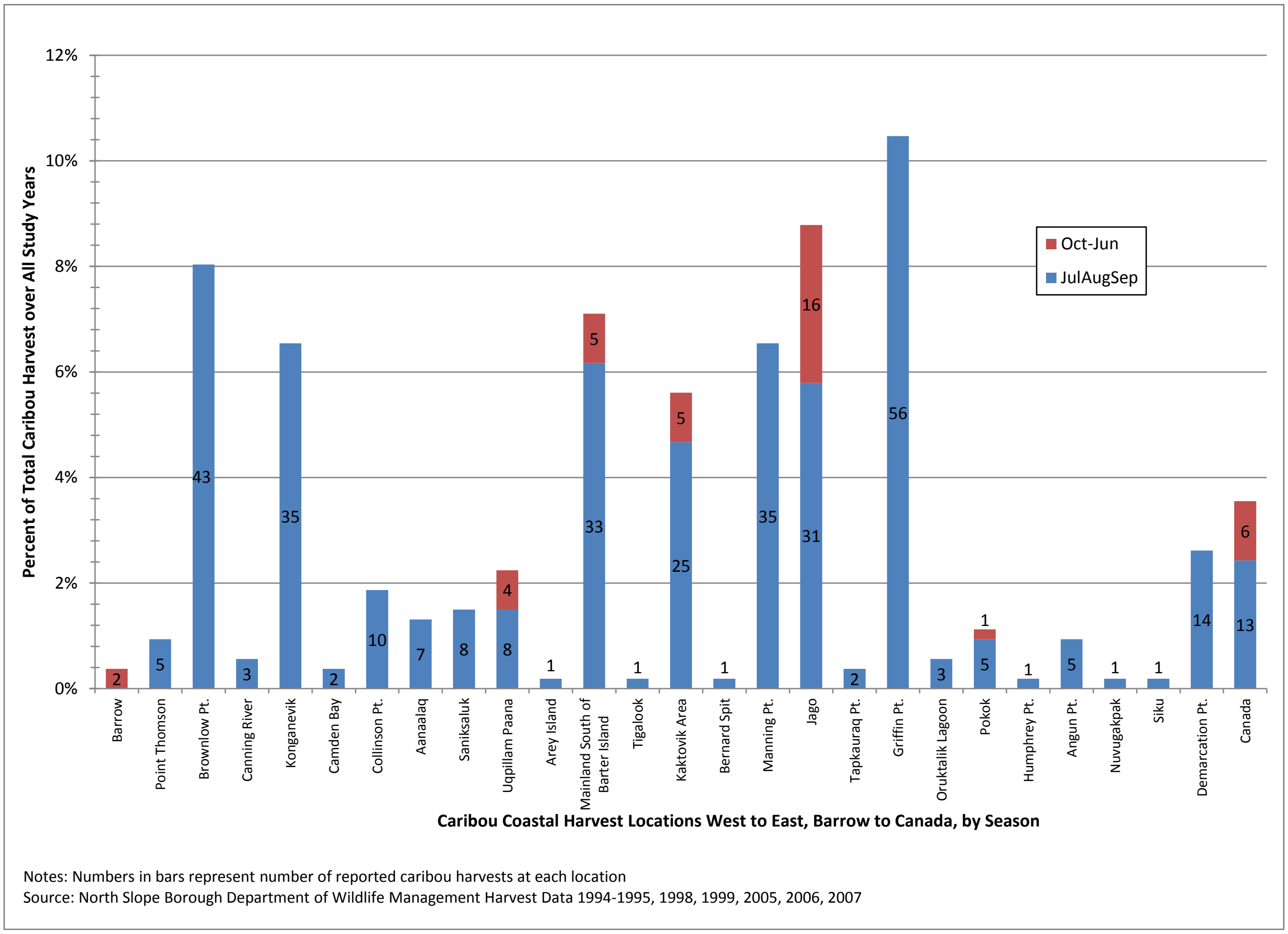


Figure 3.22-6: Seasonality of Kaktovik Caribou Harvest Locations, 1994—1995, 1998, 1999, 2005, 2006, and 2007

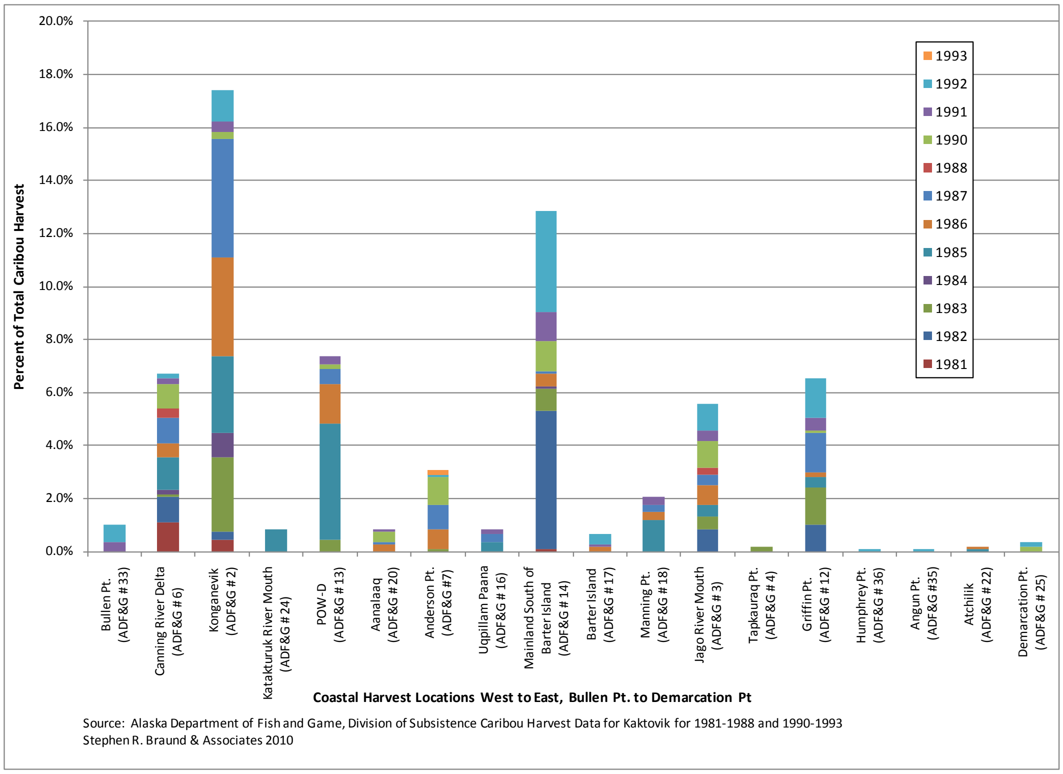


Figure 3.22-7: Kaktovik Coastal Caribou Harvests from West to East, 1981—1988 and 1990—1993

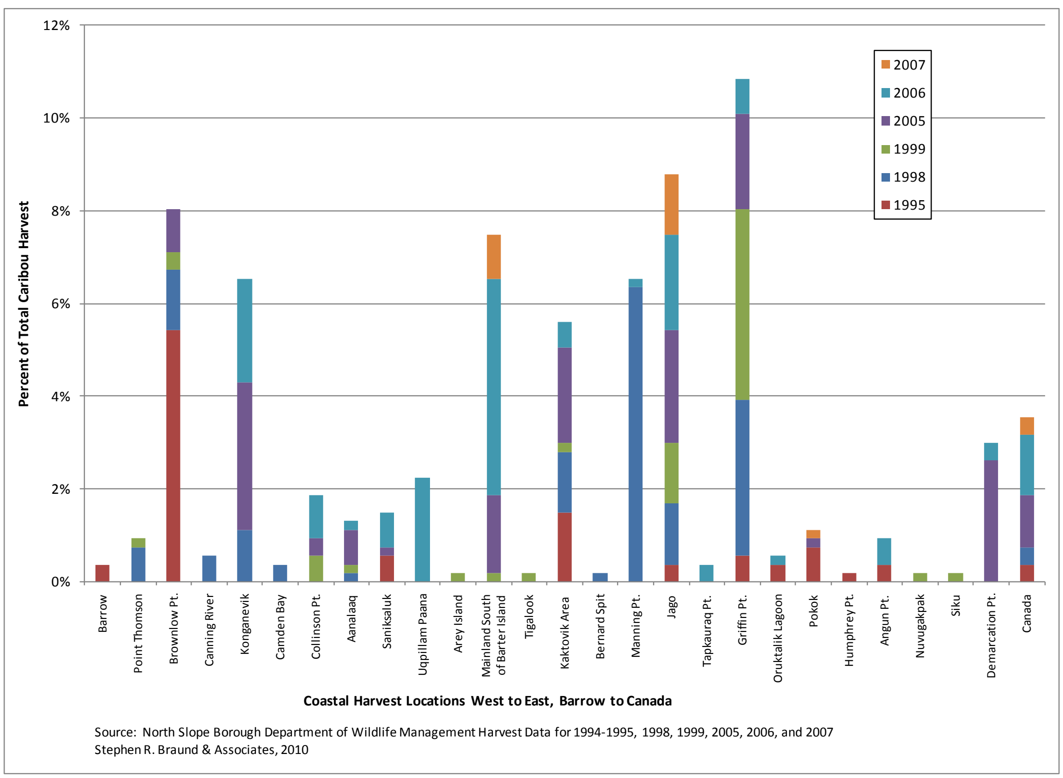


Figure 3.22-8: Kaktovik Coastal Caribou Harvests from West to East, 1994—1995, 1998, 1999, and 2005—2007

Traditional Knowledge

Appendix Q includes traditional knowledge from Kaktovik subsistence users relevant to subsistence resources and activities in the Point Thomson area. In addition, Appendix Q includes issues and concerns expressed by Kaktovik residents regarding the Point Thomson Project. The traditional knowledge, issues, and concerns were derived from individual interviews conducted by SRB&A with Kaktovik harvesters in March 2003 in association with previous Point Thomson efforts. In addition, traditional knowledge related to the Point Thomson Project was derived from a previous Point Thomson EIS meeting on caribou, which included participants from Kaktovik, held in Fairbanks, Alaska in December 2002. The issues and concerns discussed do not necessarily reflect the positions of the entire community, but the position of those individuals who participated in the interviews and workshops. Kaktovik respondents' primary concerns related to the project were in regard to the effects of the pipeline on caribou movement, and residents' subsistence activities along the coast in the Point Thomson vicinity.

Nuiqsut

Nuiqsut is located on the western side of the Colville River delta, and the area offers an abundant diversity of terrestrial mammals, fish, birds, and other resources. The Colville River is the largest river system on the North Slope and supports the largest overwintering areas for whitefish (Craig 1989, Fuller and George 1999). Documented subsistence activities in the Nuiqsut area have revolved principally around caribou, fish, and marine mammals. Moose, waterfowl, and furbearers are secondary but important supplementary resources. Residents of Nuiqsut are active subsistence harvesters, and their location on Nigliq Channel is well situated for yearly harvests of caribou, arctic cisco, and various other resources. Although not located directly on the coast, Nuiqsut is 1 of 11 Alaska Eskimo whaling communities; instead of using Nuiqsut as a base for their hunting efforts, whaling crews travel to Cross Island, located approximately 74 "direct" miles east of Nuiqsut (Galginaitis 2006) and approximately 45 "direct" miles from Point Thomson. Like other North Slope communities, bowhead whale hunting is central to Iñupiat cultural identity in Nuiqsut.

The primary large land mammals harvested are caribou and moose, with caribou harvests accounting for the vast majority of large land mammal harvests each year. Moose hunting is a highly important yearly activity for many residents. Large numbers of arctic cisco migrate from the Mackenzie River delta to the Colville River each year, and Nuiqsut residents take full advantage of this readily available resource. Along with caribou and bowhead whale, harvests of arctic cisco generally constitute a large percentage of residents' subsistence harvests each year.

Contemporary Seasonal Round

The seasonal round of subsistence activities in Nuiqsut is based on resource availability and harvesters' ability to access areas where resources are present. During interviews for an MMS Mapping project in 2005 and 2006, Nuiqsut respondents reported a relatively steady amount of subsistence harvest effort throughout the year, with a peak in May, July, and August (Appendix Q, Figure 28). Early spring activities, beginning in March and April, include hunting for ptarmigan, wolf, and wolverine. Waterfowl hunting begins in the spring (for geese), and continues into the summer months in offshore areas for eider ducks. Caribou are hunted year-round but are harvested primarily during the summer and fall months of June through September. Moose hunting takes place in August and September in boat-accessible hunting areas south of Nuiqsut (Fuller and George 1999). Fishing is also an important subsistence activity in which many of the residents participate. If weather and ice conditions permit, summer net fishing at fish camps begins in June or July (IAI 1990b); fishing activities, however, continue throughout the year. Residents also travel to the ocean in the summer to hunt ringed and bearded seals and coastal caribou.

The bowhead whaling season usually occurs in September from Cross Island. Nuiqsut residents sometimes harvest polar bear on an opportunistic basis during the fall whaling season. Gill netting at campsites and near the community, especially for arctic cisco, is the most productive between October and mid-November (SRB&A 2010a). Jigging for grayling also occurs in the fall (IAI 1990b). During the winter months, residents focus on accessing wolf and wolverine hunting areas by snowmachine and harvesting caribou as needed. Wolf and wolverine are hunted and sometimes trapped, primarily during the months of February and March (SRB&A 2010a). Other late winter and early spring activities include ptarmigan hunting and seal hunting.

Subsistence Harvest Estimates

ADF&G collected subsistence harvest data for all resources for Nuiqsut in 1985 and 1993, and caribou harvest data from 2002 to 2006. ADF&G chose 1993 as the most representative year for subsistence harvest data in Nuiqsut. Additional NSB data are available for the 1992, 1994 to 1995, 1995 to 1996, and 2000 to 2001 study years. ADF&G's most representative year (1993) shows the highest recorded total harvest for Nuiqsut, with households reporting a total harvest of 267,818 pounds, or 742 pounds per capita. Other years show Nuiqsut households harvesting a total of between 83,211 pounds and 183,576 pounds. According to available harvest data (see Appendix Q, Tables 5 and 6), Nuiqsut's total annual subsistence harvests ranged from 83,211 pounds between 1994 and 1995 to 267,818 pounds in 1993 (Appendix Q, Table 5). The low harvest in 1994/1995 is primarily due to an unsuccessful bowhead whale hunt that year (Brower and Hepa 1998). Table 3.22-8 shows the percentage each resource category has contributed toward the total subsistence harvest for each study year. Table 3.22-9 shows average species-level harvest data (for available study years), including the average percentage of households attempting harvests of subsistence species, the percentage of households receiving species, and the percent each species has contributed, on average, toward the total annual harvest. Marine mammals (particularly bowhead whales and seals), land mammals (caribou and moose), and fish (whitefish, including arctic cisco, burbot, and Dolly Varden) all contribute substantially to Nuiqsut's yearly subsistence harvest, although the contribution of each resource varies from year to year based on its availability (Table 3.22-8 and Table 3.22-9). Detailed harvest data for individual species are available in Appendix Q (Table 6). Caribou, whitefish, and bowhead whales contributed 89 percent of Nuiqsut's annual subsistence harvest in terms of edible pounds in 1993 (Appendix Q, Table 6).

Other harvested marine mammals included polar bear and bearded and ringed seals. Fish, including broad whitefish and least and arctic cisco, comprised 34.6 percent of the total harvest for Nuiqsut in 1992 (Appendix Q, Table 6). Approximately 28 percent of the total harvest in 1992 was land mammals, including caribou and moose. The harvest of birds, including geese and eiders, was approximately three percent of the total harvest in 1992. Commonly harvested species during all study years, in terms of their contribution toward the total subsistence harvest, included bowhead whale, caribou, broad whitefish, arctic cisco, moose, seals, and geese (Appendix Q, Table 6).

Table 3.22-8: Composition of Annual Subsistence Harvests–Nuiqsut

Resource	Percentage of Total Harvest by Study Year					
	1985	1992	1993	1994-1995	1995-1996	2000-2001
Fish	44	35	34	56	9	15
Land mammals	42	27	33	39	24	34
Marine mammals	8	35	32	2	66	48
Birds and eggs	5	3	2	3	1	3
Vegetation	0		0	<1	<1	<1

Sources: Brower and Hepa 1998 for 1994-1995; Fuller and George 1999 for 1992; Bacon et al. 2009 for 1995-1996 and 2000-2001 ADF&G 2011b for 1985, 1993, 2003-2006

Note: Blank cells indicate data not available.

[a] Nuiqsut did not successfully harvest any bowhead whales in 1994.

Table 3.22-9: Average Nuiqsut Harvest Data over All Available Study Years, by Species

Resource	% of Households Attempting Harvest	% of Households Receiving	% of Total Harvest
Caribou	82	70	35
Whitefish	74	82	33
Bowhead Whale	30	98	17
Geese	82	48	3
Moose	43	44	3
Seal	42	56	3
Burbot	61	44	2
Dolly Varden	48	26	2
Upland Game Birds	66	19	1
Beluga Whale	5	32	<1
Berries	50	29	<1
Bird Eggs	23	23	<1
Brown Bear	19	27	<1
Cod	7	7	<1
Dall Sheep	0	13	<1
Ducks	37	37	<1
Fox	35	4	<1
Grayling	67	31	<1
Marmot	2	2	<1
Mink	0	<1	<1
Muskox	0	8	<1
Plants/Greens/Mushrooms	12	6	<1
Polar bear	9	41	<1

Table 3.22-9: Average Nuiqsut Harvest Data over All Available Study Years, by Species			
Resource	% of Households Attempting Harvest	% of Households Receiving	% of Total Harvest
Salmon	44	35	<1
Sheefish	<1	3	<1
Smelt	14	24	<1
Squirrel	31	5	<1
Swan	8	3	<1
Walrus	7	49	<1
Weasel	5	<1	<1
Wolf	20	6	<1
Wolverine	26	5	<1
Wood	50	3	<1

Source: ADF&G 2011 (ADF&G study years 1985 and 1993)
[a] Averages include unsuccessful bowhead whale harvest years.
[b] Includes arctic cisco.,

Table 3.22-10 and Table 3.22-11 provide all available years of Nuiqsut bowhead whale and caribou harvest data, showing number and edible pounds harvested. Annual harvests of caribou vary widely from year to year and depend on a range of factors, including environmental conditions (e.g., snow and ice conditions, water levels), the timing and route of the caribou migration, and the distribution of caribou within residents' usual hunting areas. For all available study years between 1985 and 2006-2007, Nuiqsut respondents harvested an average of 416 caribou annually, accounting for an average 44,887 edible pounds (Table 3.22-10). Per capita pounds are only available for some study years; the limited available data show Nuiqsut harvesting an average of 152 edible per capita pounds of caribou annually.

Table 3.22-10: Nuiqsut Caribou Harvests, All Available Study Years			
	Estimated Harvest		
Study Year	Number	Total Pounds	Per Capita Pounds
1985	513	60,021	150
1992	278	32,551	78
1993	672	82,169	228
1994-1995	258	30,186	—
1995-1996	362	42,354	—
2000-2001	496	57,985	—
2002-2003	292	19,890	—
2003-2004	429	36,153	—
2004-2005	436	42,354	—
2005-2006	362	34,515	—

Table 3.22-10: Nuiqsut Caribou Harvests, All Available Study Years			
	Estimated Harvest		
Study Year	Number	Total Pounds	Per Capita Pounds
2006-2007	475	55,575	—
Total	4,573	493,753	—
Average	416	44,887	152

Sources: ADF&G 2011, Pedersen 2008, Fuller and George 1999, Brower and Hepa 1998, Bacon et al. 2009

Note: Blank cells indicate data not available.

Bowhead whale harvest numbers for Nuiqsut are available from 1973 through 2010 (Table 3.22-11). Edible bowhead whale pounds were calculated using bowhead whale lengths and the method provided in SRB&A and ISER (1993). Nuiqsut has harvested an average of 2.7 bowhead whales annually, providing an average of 68,506 edible pounds of meat and blubber per year (Table 3.22-11). Using 2010 census data showing a population of 402 residents in 114 households, and an estimated 125,346 edible pounds of bowhead whale in 2010, Nuiqsut harvested 311 pounds of edible foods per capita in 2010, or 1,099 edible pounds per household. This is on the higher end of estimated mean household pounds and per capita pounds for years where community harvest data are available (Appendix Q, Table 11).

Table 3.22-11: Nuiqsut Bowhead Whale Harvests, All Available Study Years

Year	Number	Total Edible Pounds
1973	1	12,861
1974	0	—
1975	0	—
1976	0	—
1977	0	—
1978	0	—
1979	0	—
1980	0	—
1981	0	—
1982	1	14,469
1983	0	—
1984	0	—
1985	0	—
1986	1	32,979
1987	1	45,866
1988	0	—
1989	2	78,845
1990	0	—
1991	1	32,979
1992	2	46,699

Table 3.22-11: Nuiqsut Bowhead Whale Harvests, All Available Study Years

Year	Number	Total Edible Pounds
1993	3	91,660
1994	0	—
1995	4	110,715
1996	2	58,727
1997	3	74,967
1998	4	89,436
1999	3	120,000
2000	4	86,220
2001	3	87,159
2002	4	90,184
2003	4	55,597
2004	3	65,131
2005	1	32,979
2006	4	76,762
2007	3	89,295
2008	4	69,736
2009	2	55,528
2010	4	125,346
Total	64	1,644,140
Average[a]	2.7	68,506

Sources: Suydam and George n.d, Suydam n.d.a,.b, c, NSB 2010
Note: — indicate data not available.
[a] Averages do not include unsuccessful harvest years.

Contemporary Subsistence-Use Areas

Nuiqsut lifetime and post-1970s use areas for all resources are shown on Figure 3.22-9. Nuiqsut residents reported traveling as far as Barrow in the west, and almost as far as Kaktovik in the east for subsistence purposes. A high number of overlapping use areas occur in the Colville River delta and along the Colville, Anaktuvuk, and Chandler Rivers, as well as in an overland area south and west of the community. Offshore hunting areas extend between Harrison Bay and Camden Bay. Maps showing subsistence-use areas for individual resources are provided in Appendix Q. According to these maps, Nuiqsut harvesters have reported subsistence-use areas in the vicinity of Point Thomson for bowhead whales, seals, and waterfowl. Although they do not harvest caribou in the project area, Nuiqsut residents rely heavily on their yearly harvest of caribou, some of which may migrate through the project area. Pedersen (2008) estimated that approximately 30 percent of Nuiqsut's caribou harvest comes from the Central Arctic Herd; other harvests come from the Western Arctic or Teshekpuk Lake Herd, which do not range as far as the Point Thomson project area. In addition, arctic cisco pass the project area while migrating from the Mackenzie River delta in Canada to the Colville River, where Nuiqsut residents harvest them (Appendix Q, Figure 33).

Table 3.22-12 depicts the number of respondents reporting subsistence use areas for a 10-year time period (1995 to 2006) by coastal hunting area and resource during SRB&A mapping interviews in 2004, 2005, and 2006 (SRB&A 2010a). As shown in this table, the only resource for which more than 10 percent of Nuiqsut respondents reported use areas in the project area (i.e., in the coastal or offshore area between Brownlow Point and Bullen Point) was bowhead whale. Twenty-one percent of Nuiqsut harvesters reported seal hunting use areas in the area west of Bullen Point to Prudhoe Bay.

Table 3.22-13 depicts the number of respondents reporting bowhead whale subsistence use areas for both a 10-year (1996 to 2006) and 12-month time period (2003/2004, 2004/2005, or 2005/2006). These data show that the majority of active bowhead whale hunter respondents reported subsistence use areas offshore from the Point Thomson project area within the 10-year time frame. In addition, 75 percent of last 12-month active bowhead whale hunters reported traveling offshore from the Brownlow Point to Bullen Point within a 12-month time frame.

Table 3.22-12: Number (%) of Nuiqsut Respondents Reporting 1995-2006 Use Areas[a] by Coastal Hunting Area

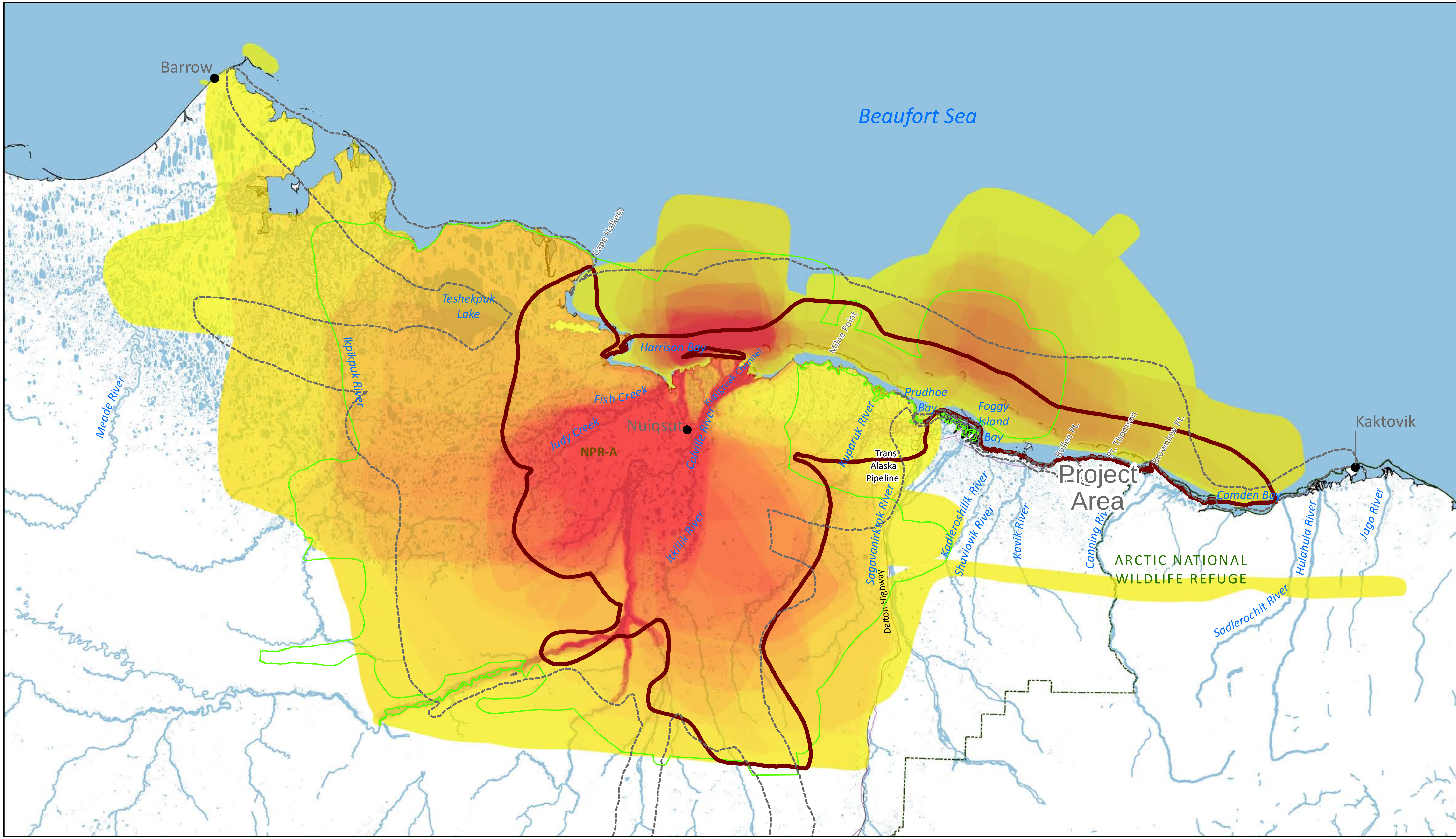
	Number (%) of Respondents Reported Subsistence Use Areas	
Resource Category	Bullen Point to Prudhoe Bay	Brownlow Point to Bullen Point
Caribou	2 (6)	0
Seals	7 (21)	3 (9)
Bowhead Whales	19 (58)	15 (45)
Walrus	1 (3)	0
Furbearers	2 (6)	0
Waterfowl	3 (9)	2 (6)
All Resources	19 (58)	15 (45)

Note: Total Number of Nuiqsut Active Harvester Respondents = 33.
[a] Number of respondents represents the number who reported using an area at least once during the 1995-2006 period.

Table 3.22-13: Number (%) of Nuiqsut Bowhead Whale Hunter Respondents Reporting Bowhead Whale Use Areas[a] by Coastal Hunting Area

		Number (%) of Bowhead Whale Respondents Who Reported Subsistence Use Areas	
	Bowhead Whale Hunter Respondents	Bullen Point to Prudhoe Bay	Brownlow Point to Bullen Point
10-year (1995-2006) Respondents	19	19 (100)	15 (79)
12-month (2003-2004, 2004-2005, or 2005-2006) Respondents	12	12 (100)	9 (75)

Source: SRB&A 2010a
Note: The total number of Nuiqsut respondents interviewed for all resources = 33.
[a] Number of respondents represents the number who reported using an area at least once during the 10-year or 12-month time periods.



POINT THOMSON PROJECT EIS

Legend

- Community
- Road
- Existing Pipelines
- Arctic National Wildlife Refuge

Subsistence Use Areas

- Lifetime (Source: Pedersen 1979)
- 1973-1985 (Source: Pedersen 1986)
- 1994-2003 (Source: SRB&A 2003a)

Overlapping 1995-2006 Use Areas (Source: SRB&A 2010)

High / Low — 756 use areas reported by 33 respondents

The 1973-1985 use areas extend south along the Anaktuvuk River to Anaktuvuk Pass and along the Kuparuk River to the Dalton Highway.

0 5 10 Miles

N

Figure 3.22-9

Nuiqsut Lifetime and Post-1970s Use Areas, All Resources

Date: 11 August 2011
Map Author: Stephen R. Braund & Associates

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Bowhead whales are the resource most intensively harvested by Nuiqsut residents in the project area. Whaling crews travel to Cross Island, which is northeast of Prudhoe Bay and approximately 11 to 12 miles from shore, and hunt from there. A high number of overlapping bowhead whale-use areas occur offshore, up to 30 miles from Cross Island, and east of Cross Island as far as Flaxman Island (Appendix Q, Figure 30). Nuiqsut bowhead whale hunting GPS tracks from 2001 to 2009 (Appendix Q, Figure 31) extend as far east as Flaxman Island and over 30 miles offshore from Cross Island.

Traditional Knowledge

Nuiqsut traditional knowledge related to the project is available from a December 2002 Point Thomson EIS meeting on caribou for a previous Point Thomson development effort. A summary of Nuiqsut observations and concerns from this meeting is provided in Appendix Q.

Anaktuvuk Pass

Appendix Q provides a brief description of Anaktuvuk Pass subsistence-use patterns as Nuiqsut and Kaktovik residents share subsistence resources harvested in the project area with Anaktuvuk Pass residents. Because Anaktuvuk Pass residents do not directly harvest subsistence resources in the project area and because they typically harvest caribou from the Western Arctic Herd, which does not migrate through or near the Point Thomson project area, the description does not include that community’s subsistence-use areas, seasonal round, and subsistence harvest information.

The Draft EIS team has proposed to conduct telephone interviews with Anaktuvuk Pass residents to characterize the nature and extent of sharing with the communities of Kaktovik and Nuiqsut. The study team sent letters to the Village of Anaktuvuk Pass, Naqsragmiut Tribal Council, and the City of Anaktuvuk Pass on June 16, 2010 asking for the community’s participation in the telephone interviews. A response from the community has not been received at this time, likely because residents are busy participating in summer subsistence activities. Telephone interviews with residents in the community may not be possible until after the peak of the subsistence season.

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3.23 HUMAN HEALTH

The study area for human health analysis encompasses the health service area of the Arctic Slope Native Association (ASNA) which covers a majority of the NSB. Within the NSB, the analysis focuses on the communities of Kaktovik, Nuiqsut, Barrow, Prudhoe Bay/Deadhorse, and Anaktuvuk Pass where project-related health impacts may reasonably be expected to occur.

This section provides a summary of the affected environment for human health based on the State of Alaska's technical report, *Health Impact Assessment: Point Thomson Project* (HIA), which was lead by State of Alaska public health professionals (Alaska State HIA Team). For more detailed discussion on the affected environment for human health, please refer to the full HIA in Appendix R.

3.23.1 Key Information About Human Health

Alaska Natives in the NSB region exhibit poorer health status and outcomes compared to other groups (i.e., Alaska Natives statewide, Alaska nonnatives statewide, and/or U.S. whites) with respect to the following health outcome indicators:

- Death from chronic obstructive pulmonary disease (COPD) is significantly greater in the NSB than in the state.
- Obesity among NSB Alaska Natives is greater than among Alaska Native statewide.
- Levels of physical activity are lower among NSB Alaska Natives than other Alaska Natives and nonnatives in the state.
- Infant mortality rate is significantly higher among NSB Alaska Natives than U.S. whites; however, there is improvement as the NSB infant mortality rate decreased from the early 1980s to 2003.
- Vaccination of older adults against influenza is lower among NSB Alaska Natives than for U.S. whites.
- Colon/rectum cancer is the second leading cause of cancer mortality among NSB Alaska Natives, but only a smaller proportion of NSB Alaska Natives received colorectal cancer screening compared to Alaska Natives statewide.
- Teen birth rate in the NSB region is much higher than for Alaska Native statewide and Alaska whites.

Where NSB Alaska Natives seem to show better health status or outcomes are in relation to the following health indicators:

- NSB communities have significantly higher adequate water and sanitation services than the majority of areas serviced by other regional health corporations.
- Prevalence of diabetes among NSB Alaska Natives is lower than for Alaska Natives statewide, although diabetes has increased in every region of the state.
- Vaccination of older adults against pneumococcal is higher among NSB Alaska Natives than for U.S. whites.
- NSB Alaska Natives have lower rates of gonorrhea infections than for Alaska Natives statewide.

Overall, Alaska Natives statewide exhibited poorer health status in comparison to the U.S. white population in the following health outcomes: cerebrovascular disease death rate, unintentional injury death rates, suicide mortality rate, colorectal cancer incidence rate, and Chlamydia infection rate (among men).

3.23.2 Health Effects Categories

Human health effects may have beneficial or negative consequences to communities within the study area. The Point Thomson HIA assessed potential impacts from the project against eight Alaska-specific Health Effects Categories (HECs; see Table 3.23-1). These HECs represent health effects relevant for Alaskan resource development projects, including the Point Thomson Project. The human health analysis does not consider occupational health and safety issues, which are generally managed separately, except where issues of worker health and community health intersect (such as roadway traffic). For more information on the HECs, see the HIA (Appendix R).

Table 3.23-1: Health Effects Categories (HECs) for the Point Thomson Project

Health Effects Category	Reason For Concern
Social Determinants of Health (SDH)	SDH and psychosocial issues are very important in Alaska, particularly for small, remote villages. Subsistence-based rural populations can suffer significant anxiety/stress associated with perceived changes in their autonomy, traditional lifestyles, and cultural stability. Furthermore, anxiety/stress related to fear of oil spills that threaten marine resources can lead to increased rates of depression among those that rely on subsistence. Important SDH outcomes include drug/alcohol usage, teen/unwed pregnancy rates, gender violence, suicides, and depression. Psychosocial issues, specifically elevated suicide rates, are already present and a concern in NSB.
Accidents and Injuries	Unintentional injury rates are significant contributors to death and morbidity for the NSB, specifically off-road and snowmachine accidents. Concerns related to the project focus on potential influx of nonresident project workforce and project-related increase in traffic on roadways and air corridors. In addition, changes to required travel distance for successful subsistence harvest activities can be a factor for accidents and injuries.
Exposure to Potentially Hazardous Materials	Communities have expressed concerns over human exposure to potentially hazardous materials, including air pollutant emissions (e.g., volatile organics, persistence organic pollutants). However, distances from project facilities to physical communities are substantial and anticipated concentrations are expected to be *de minimis*, even during subsistence activities.
Food, Nutrition, and Subsistence Activity	Communities in rural Alaska continue to rely on subsistence resources to varying degrees. The villages within the study area (Barrow, Anaktuvuk Pass, Nuiqsut, and Kaktovik) are not equivalent in terms of potential impacts to subsistence. Impacts on subsistence activity can have effects on diet and food security of a community, in the context of other factors (e.g., income, personal choice work schedule/time off) that influence subsistence harvesting, food consumption patterns, and access to adequate amounts of food.
Infectious Disease	The burden of infectious respiratory diseases (COPD, pneumonia, and influenza) is extremely high in the NSB. Sexually=transmitted infections (STIs), particularly chlamydia, are also a serious concern, though however, the rate is less than for Alaska Natives statewide. Influx of nonresident workforce from outside the region can facilitate the transmission of infectious diseases.
Water and Sanitation	In some areas of rural Alaska, lack of adequate water service is linked to the high rates of lower respiratory infections and invasive skin infections; however, most of the NSB area is connected to public water and sewer services (94%)– greater than the Alaska Native statewide averages.
Noncommunicable and Chronic Disease	Rates of noncommunicable diseases in the NSB are evolving in complex ways and appear to be multifactorial. Cancer is the leading cause of death in the NSB, specifically lung/bronchus cancer as they correlate with the extremely high tobacco usage in the NSB. High rates of heart disease and obesity are also observed in the NSB population.
Health Services Infrastructure and Capacity	Local/regional health services infrastructure and capacity can be affected by a project through (1) revenues, and (2) increased demands by a large workforce. In addition, increases in accidents and injuries could have effects on the local emergency management systems. The NSB has a fully functioning health services system, including in-patient, out-patient and public health services.

3.23.3 Review and Adequacy of Sources for Human Health

The Alaska State HIA team reviewed available baseline health data for the NSB population from sources maintained by federal, state, and tribal health authorities. The databases for the Arctic Slope Health Corporation are quite comprehensive and detailed and use standardized reporting formats that allowed comparisons over time and with other similar communities. Typically, Alaskan health data are reported by regional area, which generally equate to regional health corporations, and provided general health information for the HIA.

Because the villages in the Point Thomson study area are very small, health information privacy concerns and problems with statistical validity limit the ability to analyze information at the village level. With the exception of Barrow, the potentially affected communities are extremely small, i.e., total population levels less than 500 (see Section 3.15, Socioeconomics). Both state and tribal health authorities will not publically report an "observation" if they document fewer than six cases. Therefore, the health baseline data for communities in the study area are presented in this section at the aggregated regional level and not at an individual village level. Professional experience indicates that village level data are generally consistent with the aggregated regional level data. Much of the health data for NSB Alaska Natives are based on the ASNA geographical health service area. The only NSB community not included in the ASNA health service area is Point Hope (population of 674 in USCB 2010b). The exclusion of Point Hope will not materially change the key baseline health observations that apply to the NSB geographical unit. Therefore, for many reported health outcome indicators discussed in this section, "Arctic Slope Service Area" is defined as the NSB.

Based on available data, the health outcome indicators of NSB Alaska Natives are compared to other Alaska state populations, i.e., Alaska Natives, Alaska whites, and/or Alaska Nonnatives, as well as U.S. whites.

Table H-23 in Appendix H discusses the publications, reports, and data available for human health that are cited in the EIS and their relevance to the proposed project. Full references for the studies cited in the following text are in Chapter 9, References.

3.23.4 Legal, Administrative, and Legislative Framework

Under NEPA regulations, projects that require an environmental assessment or EIS must include an analysis of health impacts associated with federal actions. The HIA is one process that can provide a systematic evaluation of health impacts. HIA is a preventive health tool that anticipates the human health impacts of new or existing development projects, programs, or policies. Currently, NEPA regulations and the State of Alaska do not require a formal HIA for projects that require an environmental assessment or EIS under NEPA. However, in consultation with the LFA and other Cooperating Agencies, and with the Applicant's concurrence, the State of Alaska's Department of Health and Social Services (ADHSS) conducted the HIA to analyze potential impacts to human health associated with the proposed project. The State drew largely on the resource-specific impact findings (e.g., socioeconomics, subsistence) of this Draft EIS for their analyses in the HIA. The HIA is included as Appendix R of this Draft EIS.

The Point Thomson HIA uses the approach described in the *Draft State of Alaska HIA Toolkit* (ADHSS, 2011) but makes modifications unique to the setting of the project. In addition to the *Draft Alaska HIA Toolkit*, the Point Thomson HIA follows international guidelines on HIA, including the performance standards from the International Finance Corporation (IFC 2007).

3.23.5 Area of Influence and Potentially Affected Communities

The Point Thomson Project is located 60 miles east of Prudhoe Bay/Deadhorse, 60 miles west of Kaktovik, 120 miles east of Nuiqsut, 250 miles east of Barrow, and 200 miles north of Anaktuvuk Pass (see Figure 3.23-1). These five communities were selected as Potentially Affected Communities (PACs) where project-related health impacts may reasonably be expected to occur.

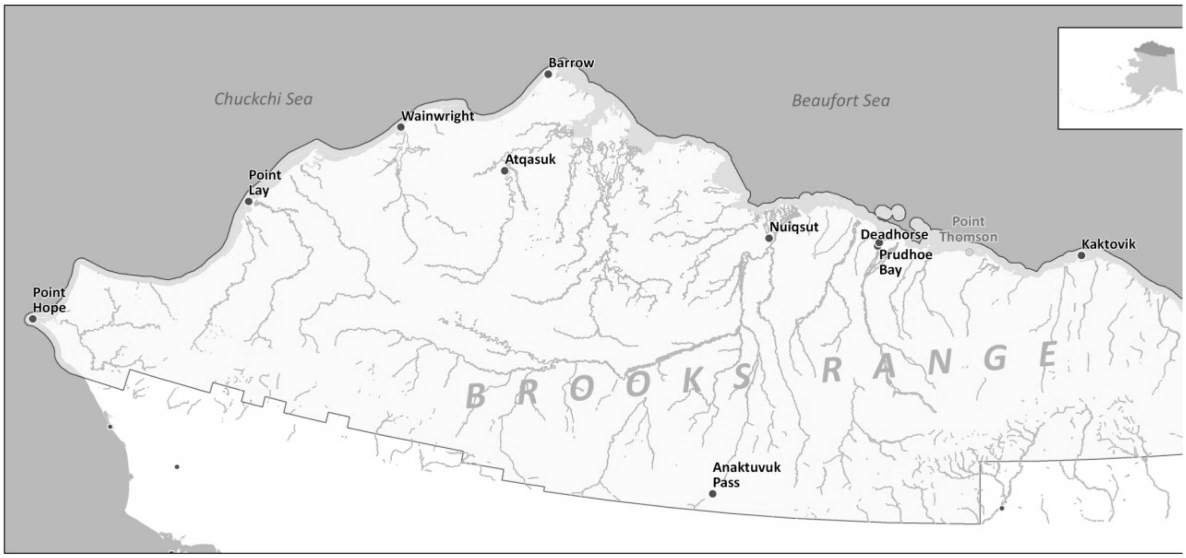

Figure 3.23-1: Point Thomson Project and Communities in the NSB

From an HIA perspective, these PACs have been divided into three zones based on the likelihood of significant health impacts from the Point Thomson Project:

- Zone 1: Kaktovik and Nuiqsut
- Zone 2: Anaktuvuk Pass, Prudhoe Bay/Deadhorse, and Barrow
- Zone 3: Atqasuk, Wainwright, Point Lay, and Point Hope

Zone 1 PACs are deemed more likely to be directly impacted by the Point Thomson Project based on their closer proximity to the project (Kaktovik and Nuiqsut), greater likelihood of critical impacts related to subsistence (Kaktovik and Nuiqsut), and the importance of considering the regional effects of the project.

The Zone 2 PAC includes Anaktuvuk Pass, a small village located south and west of the Point Thomson Project. As will be discussed in Chapter 4.23, Human Health, the potential subsistence impacts to Anaktuvuk Pass are important and considered; however, they are geographically different from those under consideration for Kaktovik and Nuiqsut. The potential impacts on Prudhoe Bay and Deadhorse are related to barges docking at West Dock and transportation of personnel, supplies, and equipment from that transport hub. Similarly, the effects on Barrow are due to its position as the regional center for the NSB and the impact on health services from increased usage and taxes generated during Point Thomson operations.

The Zone 3 PAC includes NSB communities that are remote from the Point Thomson Project and that have minimal to no interaction with workers, materials, or products related to the project. These villages include Atqasuk, Wainwright, Point Lay, and Point Hope, and are not further discussed in this section.

3.23.6 Zone 1 Potentially Affected Communities

3.23.6.1 Kaktovik

Kaktovik is located on the northern shore of Barter Island, facing Kaktovik Lagoon and the Beaufort Sea. The village is on the northern edge of the region that has become the Arctic Refuge, and is 90 miles from the Canadian border. It is the easternmost village in the NSB. The community has a young population, with a high ratio of dependents to wage earners. Historically, there have been high rates of unemployment and under-employment. The community has high levels of subsistence activities and use of subsistence resources. Kaktovik's infrastructure has had several upgrades in recent years. Water and sewer projects funded by the NSB have been completed. An electric utility is functional in the community, as well as telecommunications.

3.23.6.2 Nuiqsut

Nuiqsut is located approximately 30 miles from the Beaufort Sea on the Nechelik channel of the Colville River delta. This area has been used for centuries for subsistence activities, including hunting, fishing, gathering, and traditional celebrations. The growth and development of the community has been influenced by oil and gas development. Nuiqsut is located in the northeast section of the region that has become the NPR–A. The community infrastructure has had several upgrades in recent years. Water and sewer projects funded by the NSB have been completed. An electric utility is functional in the community, as well as telecommunications. Surface transportation to Nuiqsut is often possible in the winter months, where the ice road from Nuiqsut connects to a network of gravel roads servicing the oil fields east of Nuiqsut, and ultimately leads to the Dalton Highway.

3.23.7 Zone 2 Potentially Affected Communities

3.23.7.1 Anaktuvuk Pass

This community is the only remaining settlement of the inland northern Iñupiat. Anaktuvuk Pass is situated at approximately 2,200 feet in elevation in the Endicott Mountains of the Brooks Range, within the region that has become Gates of the Arctic National Park and Preserve. The community is located about 250 miles southeast of Barrow. Anaktuvuk Pass has historically had high rates of unemployment and underemployment. Economic and employment opportunities are very limited in Anaktuvuk Pass. The NSB and school district provide most local jobs. City government and the village corporation are also important employers in the community. The community has high levels of subsistence activities and use of subsistence resources. Anaktuvuk Pass has a young population; average ages in Anaktuvuk Pass are less than in the state or nation. There is a high ratio of dependents to wage earners.

3.23.7.2 Prudhoe Bay /Deadhorse

Prudhoe Bay is a census-designated place (CDP) located in the NSB. As of the 2000 U.S. Census, the population of Prudhoe Bay was five people; however, at any given time several thousand transient workers support the Prudhoe Bay oil field and associated activities (USCB 2000). The airport, lodging, and general store are located at Deadhorse; the rigs and processing facilities are located on scattered gravel pads laid atop the tundra. It is only during winter that the surface is hard enough to support heavy equipment and new construction happens at that time.

3.23.7.3 Barrow

Barrow is the largest community in the NSB with a population of about 4,212 (about 60 percent of the NSB's population). It is the hub for regional government, transportation, communications, education, and economic development. The community is located on the northern edge of the ACP on the Chukchi Sea Coast. While all NSB communities have access to water and sanitation, only 94 percent of houses are connected to the public water and sewer system. Barrow's public infrastructure is the most extensive of any North Slope community, and includes water, sewer, electric, and telecommunication utilities. Demographically, Barrow has a 65 percent Alaska Native and 35 percent nonnative population mix. There is a high ratio of dependents to wage earners. The NSB is the city's primary employer, providing approximately 50 percent of employment in the city (ADCCED 2011).

3.23.8 Demographics

Health status is influenced by many demographic factors such as education, employment, and household income. Section 3.15, Socioeconomics, provides overall population and demographic data for the NSB and the specific two zones for PACs (see Table 3.15-1 and Table 3.15-2). NSB has a population density of 0.08 persons per square mile with fewer than 7,000 people currently residing in the 88,800 square miles of the NSB. The NSB population had an average annual decline of 0.7 percent from 2000 (7,385 residents) to 2010 (6,903 residents), primarily due to out-migration (Section 3.15, Socioeconomics). Based on 2010 census data, 71 percent of the population in the NSB is Alaska Native. The communities in the Area of Influence with the greatest Alaska Native population (over 85 percent) are Kaktovik and Nuiqsut (USCB 2010).

The population of the NSB in 2009 was generally young; the median age was 26 years and 34 percent of the population was under the age of 18 (ACS 2005-2009), a much larger proportion as compared to the U.S. population; while only one in 15 Alaska Natives is over age 65 (see Figure 3.23-2).

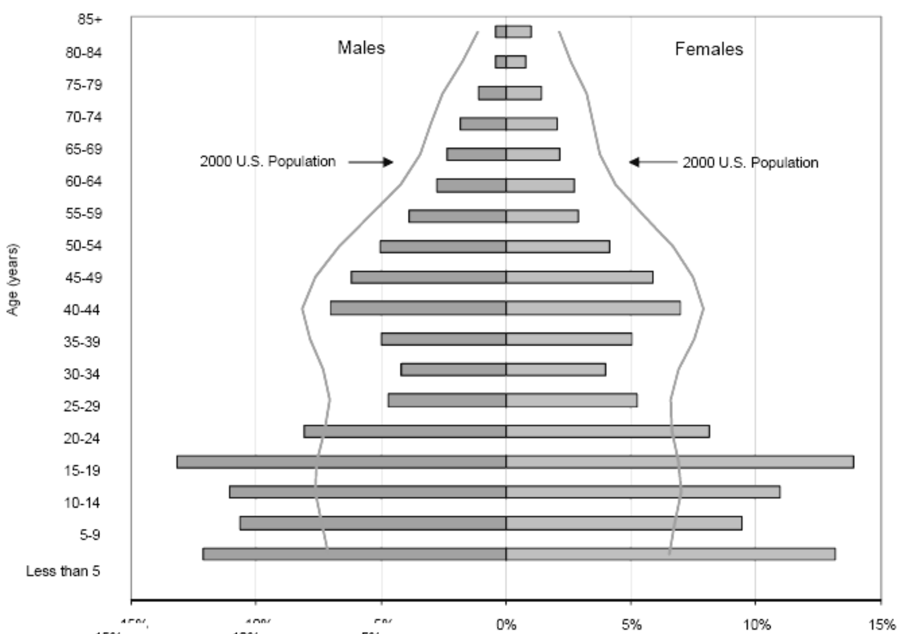

Figure 3.23-2: Alaska Native Population Pyramid, North Slope Borough (2006)

Source: AN EpiCenter 2009a

Globally, improved overall family health status positively correlates with highest level of household educational attainment. In addition, educational attainment levels also predict challenges or opportunities in local hiring programs. This is especially true in the oil and gas extraction industry where permanent positions require educational attainment. According to the ACS (2005-2009) the adult population of the NSB has a comparatively low rate of educational attainment compared to the state average. Eighty percent of the adults over the age of 25 have graduated from high school as compared to 91 percent in Alaska. Alaska Natives living in the NSB received an associate degree or higher at a rate five times lower (5 percent vs. 25 percent) than U.S. whites (see Appendix R, Figure 8: Highest Education Attainment).

Employment and income are other key demographic factors that influence health. Despite the economic recession, the NSB maintains a low unemployment rate relative to other regions in the state. The 2005-to-2009 ACS reported that 14.8 percent of individuals and 12.7 percent of families in the NSB were below the poverty level. See Section 3.15, Socioeconomics, for greater detail and analysis of the employment and income situation in the NSB overall and for each PAC.

3.23.9 Mortality

Cancer and heart disease were the leading causes of death among NSB Alaska Natives from 2004 to 2007, in which they had higher risks of dying from these diseases than Alaska Native people statewide (Table 3.23-2). In addition, NSB Alaska Native people had a significantly higher risk of dying from COPD than Alaska Native people statewide (Table 3.23-2).

Table 3.23-2: Leading Causes of Death in the NSB, 2004—2007

	Causes of Death	Number of Deaths	% Deaths	Rate per 100,000	Rate Ratio: NSB vs. Alaska Natives
1	Cancer	25	23	274.5	1.2
2	Heart Disease	17	15	273.4	1.5
3	Suicide	12	11	73.5	1.8
5	Unintentional Injury	8	7	48.4	0.5
6	COPD	8	7	140.9	2.6[a]
	Total – All Causes	111	100	1,350.5	1.3*

[a] Significant difference, $p<0.05$
Source: AN EpiCenter 2009a

Based on mortality data from 2000 to 2004, suicide was a fourth leading cause of death among NSB Alaska Natives as well as for the Alaska Native people statewide (Table 3.23-3). In contrast, suicide ranked tenth for U.S. whites among the leading causes of death during this same time period.

Table 3.23-3: Leading Causes of Death in the NSB, 2000-2004					
	Alaska Natives in NSB	Number	% Deaths	US Whites Rank	Alaska Native Statewide Rank
1	Cancer	36	22.1	2	1
2	Unintentional Injury	27	16.6	5	3
3	Heart Disease	19	11.7	1	2
4	Suicide	15	9.2	10	4
5	COPD	11	6.7	4	6
6	Cerebrovascular	7	4.3	3	5
7	Pneumonia and Influenza	5	3.1	7	7
9	All other causes	43	26.4	—	—
	Total	163	100	—	—

Source: AN EpiCenter 2009a

3.23.9.1 Cancer

For the NSB Alaska Natives, the cancer death rate increased by 33 percent between the period from 1979 to 1983, and the period from 1999 to 2003. The explanation for this finding is complex and multifaceted. Cause-specific cancer rates are strongly influenced by a variety of lifestyle behaviors, including diet and smoking habits. In 2007, over 90 percent of NSB patients screened for tobacco use were smokers. The most frequently diagnosed invasive cancers for NSB Alaska Natives from 1989 to 2003 were lung (41 cases), colon/rectum (32 cases), and breast (15 cases). These three cancers accounted for more than half (56 percent) of all cancers diagnosed (AN EpiCenter 2009a, b). The cancers most frequently diagnosed for NSB Alaska Natives were similar to the cancers most frequently diagnosed for all Alaska Native people statewide.

Compared to Alaska whites, Alaska Native people statewide have a higher risk of dying from cancer than Alaska whites over the period from 2004 to 2007 (173 deaths/100,000 and 236.8 deaths/100,000, respectively; AN EpiCenter 2009b). Lung/bronchus cancer was the leading cause of cancer death among Alaska Native people statewide over the 2001 to 2005 timeframe, which is strongly related to the extremely high tobacco usage that occurs in Alaska Native populations.

3.23.9.2 Chronic Obstructive Pulmonary Disease

COPD is a lung disease in which the airways in the lungs become partially blocked, making it hard to breathe. Cigarette smoking is the most common cause of COPD. At over 90 deaths per 100,000 between 2004 and 2007, the NSB region had a significantly higher death rate from COPD than other regions in the state (AN EpiCenter 2009b). Among Alaska Native people statewide, the COPD death rate has increased by 92 percent since 1980. The rate peaked between 1994 and 1998 and appears to be decreasing. Compared to Alaska whites, the Alaska Native COPD death rate was 40 percent higher during the period from 2004 to 2007.

3.23.9.3 Cardiovascular Diseases

The data for cardiovascular diseases are complex. Heart disease mortality rate in the NSB (273 deaths per 100,000) is among the higher rate in the state (see Figure 3.23-3); however, only Kenai Peninsula's rate is significantly higher than the rate for all other regions. Interestingly, the Alaska Native heart disease death rate decreased by 43 percent between 1980 and 2007, with similar declines among Alaska whites and U.S. whites.

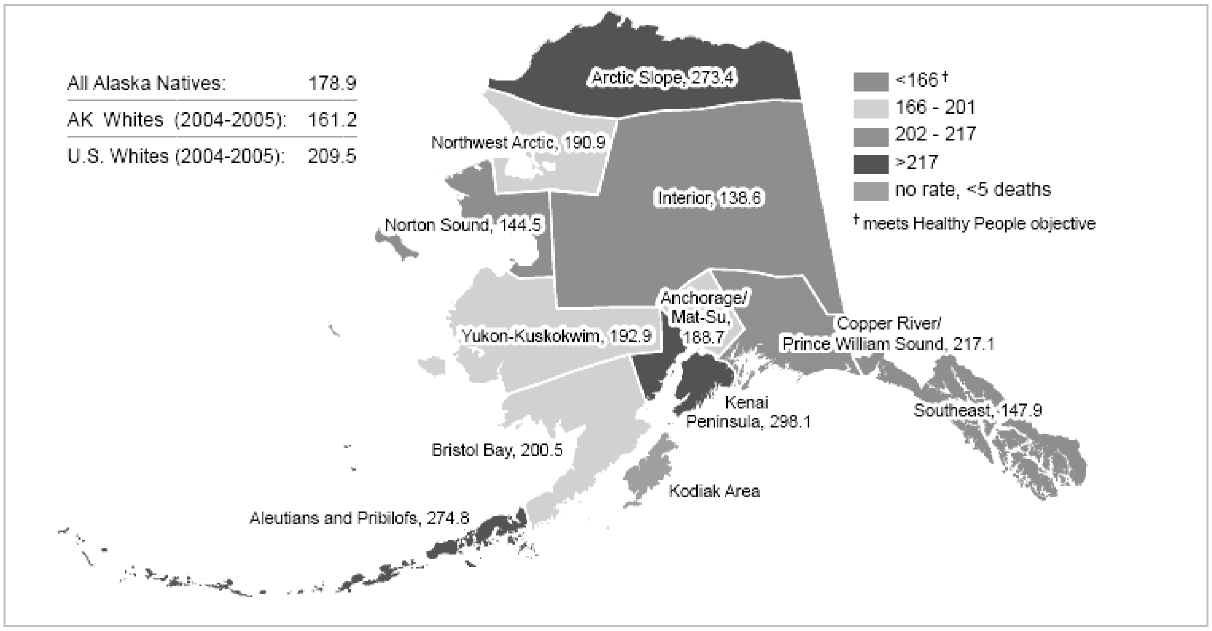

Figure 3.23-3: Alaska Native Heart Disease Mortality Rate (Per 100,000 Population)
Source: AN EpiCenter 2009b

3.23.9.4 Cerebrovascular Diseases

Cerebrovascular diseases, commonly known as strokes, relate to the condition when there is a loss of brain function due to a disruption in the blood supply to the brain. The cerebrovascular disease mortality rate in the NSB (104 deaths per 100,000) is the second highest rate in the state; however, the rate is not significantly different than all other regions combined (AN EpiCenter 2009b). During the period between 2004 and 2007, the Alaska Native cerebrovascular disease death rate was higher but not significantly different than for Alaska whites (60.1 deaths per 100,000 and 48.9 deaths per 100,000, respectively). Furthermore, the Alaska Native cerebrovascular death rate was 30 percent higher than for U.S. whites.

3.23.9.5 Unintentional Injury and Suicide

Between the periods between 1984 and 1988, and 1989 and 1993, the unintentional injury death rate for NSB Alaska Native population declined. In more recent years, approximately 57 percent of injury deaths among NSB Alaska Natives are attributed to unintentional injuries. Specifically, off-road vehicles accounted for 18 percent of injury deaths among NSB Alaska Natives. Among Alaska Native people statewide, the overall unintentional injury death rate is higher for men than women for all age groups, decreased by 47 percent between 1980 and 2007, and was two times greater than for U.S. whites and two times greater than for Alaska whites during the period between 2004 and 2007.

In NSB, suicide was the leading cause of injury death (39 percent) between 1999 and 2000, with regional data showing that the suicide mortality rate in the NSB is among the highest rate in the state (at 73.5 deaths per 100,000; see Figure 3.23-4; AN EpiCenter 2009b). From 1984 to 2003, suicide rates in NSB increased by 49 percent.

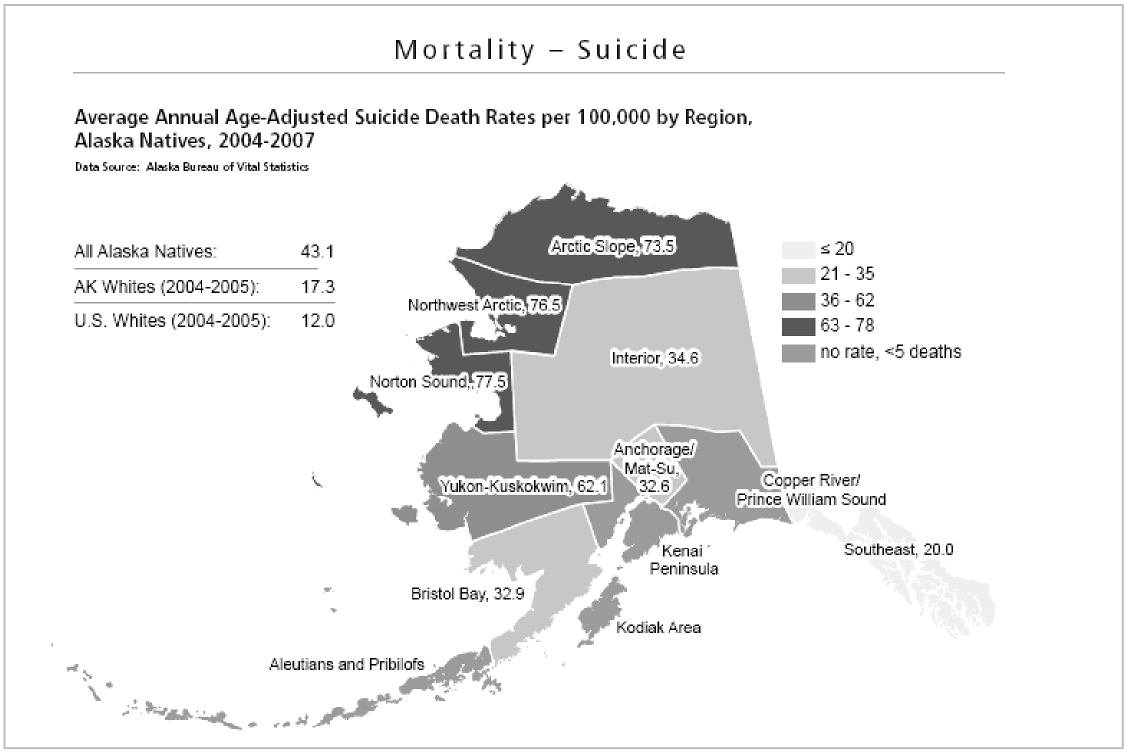

Figure 3.23-4: Suicide Death Rates by Region
Source: AN EpiCenter 2009b

Among Alaska Native people statewide, suicide is the leading cause of injury death (see Table 3.23-4). The suicide rate for Alaska Native people has not changed significantly since 1980. During 2004 to 2007, the Alaska Native suicide death rate was almost three times greater than for Alaska whites.

Table 3.23-4: Leading Causes of Injury Death, Alaska Natives, 2005-2007		
	Causes	% of Total
1	Suicide	28.7
2	Unintentional Poisoning	12.4
3	Motor Vehicle Traffic	9.3
4	Drowning	8.3
5	Homicide	7.9
6	Natural/Environmental	7.9
7	ATV/Snowmachine	5.5
8	Other Transport (boat, etc.)	5.5
9	Suffocation	3.9
10	Fire/Flame	3.0
11	Fall	1.4
12	Pedestrian (other)	1.2
13	Firearm	0.6
14	Other	1.9
15	Not Specified	2.4
	Total	100.0

Source: AN EpiCenter 2009b

3.23.10 Morbidity

Morbidity (illness) is tracked by following hospitalization and outpatient department data. The top leading causes of hospitalizations across the NSB for 2006 were complications of pregnancy, diseases of the respiratory system, and childbirth/deliveries (see Table 3.23-5). These causes accounted for over 50 percent of all hospitalizations. The leading cause of outpatient visits across the NSB for 2006 was upper respiratory problems (12 percent), followed by accidents and injuries (11 percent) and thirdly, pregnancy/childbirth/puerperium (9 percent).

An injury hospitalization is defined as either an inpatient admission or transfer to an acute care facility due to injury. Between 2000 and 2005, there were 728 injury hospitalizations among NSB Alaska Natives. Suicide and falls were the most common causes of injury hospitalization in the NSB. Suicide attempts accounted for 24 percent of all injury hospitalizations. Assault injury accounted for more than one out of every eight injury hospitalizations in the NSB. The NSB injury hospitalization rate is 119 per 10,000, higher than for Alaska Natives statewide (100 per 100,000).

Table 3.23-5: Hospitalization Data, NSB				
	Hospital Discharges by Admission Diagnosis, All Ages, 2006	% of Total	Inpatient by Admission Diagnosis, All Ages, 2006	% of Total
1	Complications of Pregnancy/Childbirth	25.3	Diseases of the Respiratory System	32.35
2	Diseases of the Respiratory System	21.8	Complications of Pregnancy/Childbirth	19.3
3	Deliveries/Childbirth	21.8	Deliveries/Childbirth	13.7
4	Disease of the Digestive System	5.7	Diseases of the Skin and Subcutaneous Tissue	8.7
5	Diseases of the Skin and Subcutaneous Tissue	5.7	Disease of the Digestive System	5.9
6	Symptoms, Signs, and Ill-defined Conditions	4.6	Symptoms, Signs, and Ill-defined Conditions	4.6
7	Endocrine, Nutrition, Metabolic, Immunity Disorders	2.3	Endocrine, Nutrition, Metabolic, Immunity Disorders	3.3
8	Diseases of the Nervous System and Sense Organs	2.3	Diseases of the Musculoskeletal System and Connective Tissue	3.1
9	Diseases of the Circulatory System	2.3	Diseases of the Circulatory System	2.5
10	Diseases of the Musculoskeletal System and Connective Tissue	2.3	Diseases of the Nervous System and Sense Organs	2.0

Source: AN EpiCenter 2009a

3.23.11 Health Risk Factors

3.23.11.1 Tobacco Use

The smoking prevalence in the NSB, Norton Sound, and Aleutians and Pribilofs regions is significantly higher than for Alaska Native people statewide. In the NSB, approximately 42 percent of patients were screened for tobacco use during 2007. More than 9 out of 10 (91 percent) NSB patients who were screened for tobacco use were smokers and 1 percent of screened patients were smokeless tobacco users (see Appendix R, Figure 17, NSB Tobacco Usage Rates).

Younger adults are significantly more likely to smoke (49 percent) than older adults (17 percent of those age 65 and over). Men are more likely to smoke than women. Smoking prevalence among Alaska Native people has remained constant since the early 1990s, while among Alaska nonnatives it has declined slightly. Between 2005 and 2007, more than twice as many Alaska Native people were estimated to be current smokers than Alaska nonnatives (41 percent versus 20 percent).

3.23.11.2 Substance Abuse

Substance abuse includes illegal drugs (e.g., marijuana, cocaine) and binge drinking. In 2007, almost one-third (32 percent) of Alaska Native high school students reported using marijuana during one or more of the past 30 days compared to 20 percent of U.S. whites. The percent of Alaska Native high school students who used any form of cocaine was similar to that for U.S. whites.

The prevalence of binge drinking has declined since the early 1990s, when it was estimated to be over 30 percent among Alaska Native people. Binge drinking is equally prevalent among Alaska Natives and Alaska nonnatives at about 18 percent. Men are more likely to binge drink than women (25 percent vs.

14 percent). For NSB residents, the same male versus female trend is true, i.e., self-reported rates of binge drinking of NSB males are more than double that for NSB females.

3.23.11.3 Obesity (Adult) and Overweight (Children)

In the NSB, more than 1 out of every 3 Alaska Native children between the ages of 2 and 5 years, meet the definition of overweight based on body mass index (38 percent). Current body mass index assessments have been recorded for approximately half of the patients in the NSB service area. Forty-two percent of these NSB patients are considered obese (adult) or overweight (children) as compared to 36 percent of Alaska Native people statewide.

3.23.11.4 Physical Activity

Consistent physical activity is an important indicator of future cardiovascular risk. Based on a combination of data from 2001, 2003, and 2005, the number of Alaska Natives in the NSB service area who meet physical activity recommendations is about 4 percent less than for Alaska Natives statewide. Thirty-two percent of Alaska Native high school students engaged in recommended levels of physical activity. This was 15 percent less than Alaska nonnative students and 5 percent less than U.S. whites.

3.23.11.5 Water and Sanitation

Adequate provision of water and sanitation services is a critical public health infrastructure. As of 2008, 94 percent of the communities in the NSB region serviced by the ASNA had water and sewer service, a level higher than the majority of areas serviced by other regional health corporations (see Appendix R, Table 11, Water and Sewer Rates).

3.23.12 Preventive Services and Access to Health Care

3.23.12.1 Maternal and Childcare

Adequate prenatal care is a critical key health outcome indicator. About 37 percent of mothers in the NSB region received adequate prenatal care from 2006 to 2007. In addition, 48 percent of mothers in the NSB smoked during pregnancy, higher than Alaska Native people statewide (29 percent) and Alaska whites (10 percent). Suboptimal prenatal care performance is reflected in the NSB region having an infant mortality rate almost two times greater than for U.S. whites (see Figure 3.23-5). However, there is improvement as the infant mortality rate in the NSB decreased from 30 infant deaths per 1,000 infants born between 1980 and 1983 to 9 deaths per 1,000 births between 1999 and 2003, approaching the Health People Goal of 5 infant deaths per 1,000 births. Alaska has established state targets within the framework of the national Healthy People initiative to address Alaska's specific health status, prevention priorities and objectives (ADHSS 2001).

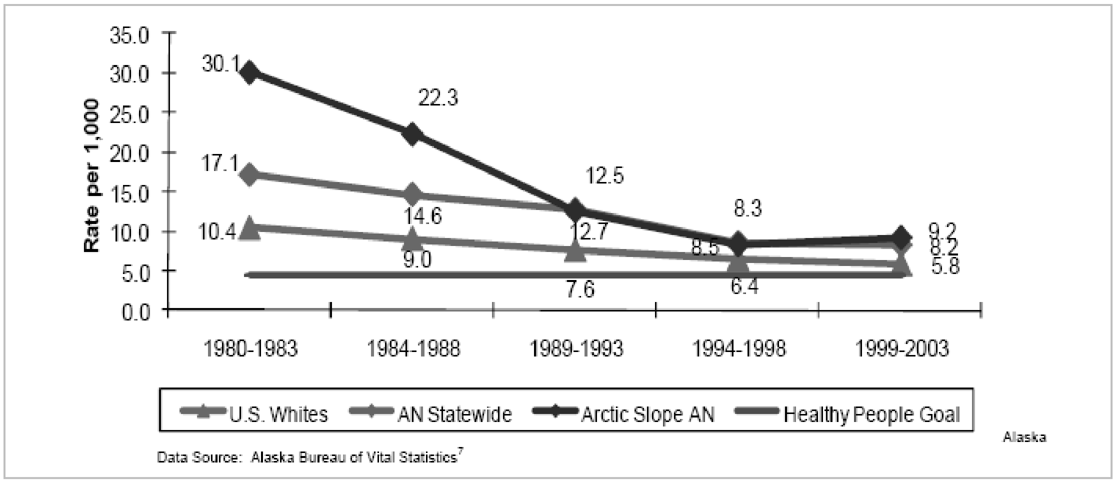

Figure 3.23-5: Infant Mortality Rate in 5-year Intervals, 1980–2003
Source: AN EpiCenter 2009b

3.23.12.2 Cancer Screening

In the NSB, more than 6 out of 10 Alaska Native women had received a pap smear within 3 years of the end of 2007. This is about 3 percent higher than that for all Indian Health Service American Indians/Alaska Natives nationwide.

There are no significant differences in breast cancer incidence and cervical cancer incidence between Alaska Native women and U.S. white women. The Alaska Native colorectal cancer incidence rate is more than twice that for U.S. whites (98 vs. 45). NSB Alaska Native people aged 51 to 80 years had lower colorectal cancer screenings (12 percent) when compared to Alaska Native people statewide (47 percent).

3.23.12.3 Diabetes

Diabetes mellitus, commonly referred to as diabetes, is a metabolic disease characterized by high blood sugar levels, which results from defects in insulin secretion, insulin action, or both. The prevalence of diabetes has increased in every region of the state between 1990 and 2007. In the NSB, the rate of diabetes has increased by 132 percent among Alaska Natives from 1990 to 2006, compared to 114 percent for all Alaska Natives. However, in 2006, the age-adjusted prevalence of diabetes among Alaska Natives in the NSB service area was 28 per 1,000 population (81 cases), 30 percent lower than for Alaska Natives statewide.

3.23.12.4 Immunizations

Immunization rates for both children and adults are a critical health outcome indicator. As of December 2007, the NSB attained 82 percent immunization coverage, meeting the Healthy Alaskans 2010 goal of 80 percent (ADHSS 2001). For adults aged 65 years and older, respiratory diseases are an extremely important source of observed mortality and morbidity. By June, 2007, 46 percent of NSB users 65 years and older were vaccinated against influenza in the past year as compared to 71 percent of U.S. whites. As of June, 2007, 82 percent of NSB users 65 years and older had ever received a pneumococcal vaccine as compared to 69 percent of U.S. whites.

3.23.12.5 Family Planning

Teen birth rate, defined as live births per 1,000 females between the ages of 15 and19 years, is another important key health outcome indicator. The teen birth rate for the NSB service area is higher than for Alaska Native people statewide and nearly five times the Alaska whites (see Figure 3.23-6).

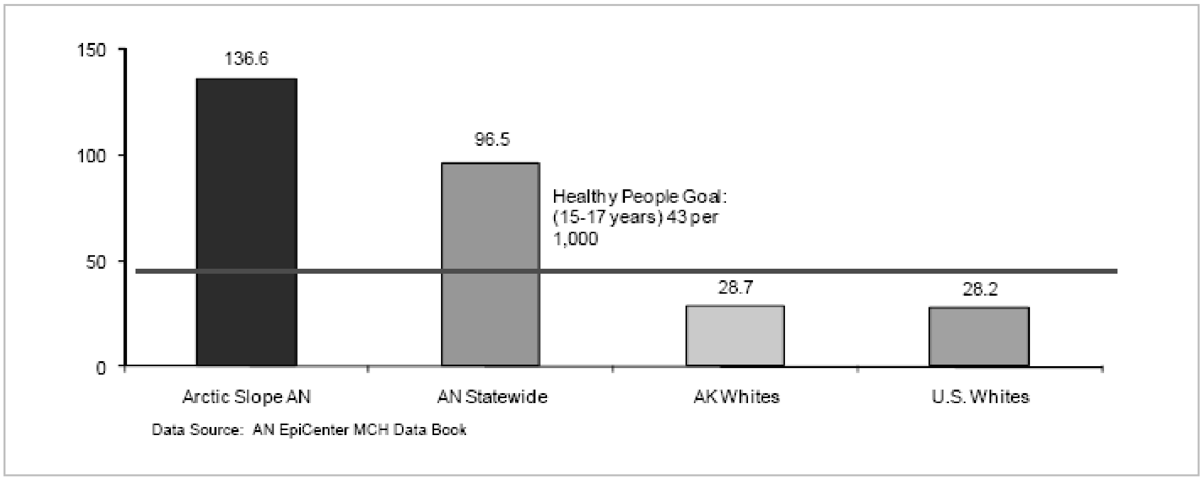

Figure 3.23-6: Teen Birth Rate (Per 1,000 Females 15-19 Years), 2001-2005

Source: AN EpiCenter 2009a

3.23.12.6 Infectious Diseases

The NSB Alaska Native has a lower rate of chlamydia infections (1,317 per 100,000) than Alaska Natives statewide, but twice as much as for Alaska statewide (all races). The gonorrhea rate of 20 per 100,000 in the NSB is one-fifth that of the rate among all Alaskans.

Reportable infectious disease cases for Alaska Native people statewide from January 2007 to October 2008 are shown in Table 3.23-6. Sexually-transmitted infections comprised 89 percent of all Alaska Native reportable infectious disease cases. The chlamydia rate reported for Alaska Native men is about four times greater than is reported for Alaska white men. The chlamydia rate reported for Alaska Native women is about seven times greater than is reported for Alaska white women. Chlamydia was by far the most commonly reported infectious disease, accounting for 80 percent of all reported infectious diseases.

Table 3.23-6: Reportable Infectious Disease Cases, Alaska Natives, January 1, 2007 – October 3, 2008		
Infectious Disease	Cases	%
Chlamydia	4103	79.3
Gonorrhea	476	9.2
Hepatitis C	198	3.8
Pneumococcal Invasive	135	2.6
Tuberculosis,Ppulmonary	52	1.0
Chlamydia, PID	37	0.7
Pertussis	32	0.6
Salmonella	25	0.6
GAS Invasive Disease	24	0.5
GBS Invasive Disease	18	0.3
Chicken Pox	15	0.3
Botulism, Food-borne	13	0.3
Campylobacter	12	0.2
Gonorrhea, PID	9	0.2
Invasive H Flu, Not Meningitis	7	0.1
Giardia	5	0.1
Hepatitis B	3	0.1
Meningitis, Haemophilus	3	0.1
Other Infectious Diseases	10	0.2
Total	5,177	100.0

Source: AN EpiCenter 2009b

3.24 CONTAMINATED SITES AND SPILL HISTORY

The study area for identification of contaminated sites and hazardous materials is defined as a rectangular shape centered on the proposed pipeline between Point Thomson and the existing Badami pipeline at Mikkelsen Bay. The search area included offshore areas up to 2 miles from the coast, and inland approximately 10 miles. Historical spill data was reviewed for the entire North Slope.

3.24.1 Key Information About Contaminated Sites and Spill History

Information regarding spills and contaminants on the North Slope provides a context to understand the risks due to existing contamination or potential spills associated with the proposed actions and measures to minimize those risks. Energy exploration and DOD facility operations have been occurring on the North Slope since the 1950s. The production and use of petroleum and hazardous materials and the generation of wastes has created the potential for spills, leaks, and persistent contamination issues for the region. Based on state and federal databases containing information regarding known contamination, spills, and hazardous materials, 41 sites with potential for contamination are within or near the project area.

Thirteen ADEC contaminated sites were identified; one of these, North Staines River No. 1 Gravel Pad, is listed as active. The North Staines River No. 1 Gravel Pad is located within the footprint of the proposed project. This site contained diesel impacted soil and surface water. Conditional closure was granted in 1996, with final closure pending further investigation.

The Bullen Point DEW line station, located 5 miles from the proposed export pipeline route, is a registered Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) site. Remediation of this site has been completed. Twenty-five spills were listed in association with Point Thomson and most of these were listed for PTU-3. No spill summaries indicated that further action was required.

The ADEC spill database for the North Slope shows 9,120 spill records from 1995 through 2009, including crude and refined oil (such as diesel, hydraulic oil, lubricating oil, transmission oil, gas condensate), saltwater (brine from produced waters and treated seawater), drilling muds, other hazardous materials, and “freshwater” spills. The largest spills identified were crude oil or water.

3.24.2 Review and Adequacy of Information Sources for Contaminated Sites and Spill History

Table H-24 in Appendix H discusses the publications, reports, and data available for contaminated sites and spill history that are cited in this Draft EIS and their relevance to the proposed project. The references in this section contain information specific to the North Slope. The databases of known contamination, spills, and hazardous materials covered the area containing all of the alternatives. Table 3.24-1 also includes information sources for the hazardous waste management and spill risk assessment discussion in Section 5.24, Spills Impact and Risk Assessment. Full references for the studies cited in this Draft EIS are in Chapter 9, References.

3.24.3 Overview of North Slope Spill History

Energy exploration and DOD facility operations in the project area have been ongoing since the 1950s, and these activities have used hazardous materials in their operations. The project area included for identification of contaminated sites and hazardous materials is defined as a rectangular shape centered on the proposed pipeline between Point Thomson and the existing Badami pipeline at Mikkelsen Bay. Use of hazardous materials, including petroleum products, lubricants, chemicals, and generation of solid wastes, create potential spills, leaks, and persistent contamination issues. The potential for encountering hazardous materials through construction or operation of the Point Thomson Project requires planning to minimize risk to human health and the environment.

The rate, risk, likelihood, and impacts of oil and hazardous material spills on the North Slope nearshore and onshore environments have received extensive analysis and review in several recent EISs, environmental assessments, and other reports. The basic data and conclusions from analysis in early reports (NRC 2003b) indicate that oil, produced fluids, hazardous material, and saltwater spills on the North Slope continue to occur and that the total annual number of spills and volume spilled varied from year to year. According to NRC (2003b), there was a generally level or slightly decreasing trend in the number of oil spills and total volume of oil spilled over more than 30 years of oil-field operating history through 2000.

The rate of reported spills remained generally level from 2001 through 2005, rose between 2006 and 2007, and fell slightly in 2008 to 2009 (ADEC 2010c; see Table 3.24-4). A general increase in reported spills since about 2006 may be the result of both better reporting of all sizes of spills (especially the small spills), and aging oilfield infrastructure even though the total output of oil into the TAPS has been declining. The incidence of spills is being better controlled by improved technology, including advances in the ability to use long-reach directional drilling to access offshore reservoirs from land-based facilities, better engineering design, greater stress on clean operations, and greater awareness of spill prevention, reporting and cleanup on the part of all the oil field personnel. Increasingly stringent federal, state, and borough regulatory requirements for reporting spills, as well as for preparation of response plans and training, also contribute to controlling the number of spill incidents and volume spilled.

3.24.4 Hazardous Materials and Contaminated Sites

State and federal databases containing information regarding known contamination, spills, and the presence of hazardous materials in the project area were searched to identify sites within, and in proximity to the project area. The search area included offshore areas up to 2 miles from the coast, and inland approximately 5 miles. Table 3.24-1 lists the name and type of databases included in the search with the number of sites identified in the project area by each database. Further information about identified sites is included below.

Table 3.24-1: Hazardous Materials and Contaminated Sites Within the Project Area Identified by Database Source

Database Name	Database Description	No. of Sites
Federal		
National Priorities List (NPL)	The NPL is the EPA's database of uncontrolled or abandoned hazardous waste facilities that have been listed for priority remedial actions under the Superfund program.	0
Delisted NPL	The National Oil and Hazardous Substances Pollution Contingency Plan established the criteria that the EPA uses to delete sites from the NPL.	0

Table 3.24-1: Hazardous Materials and Contaminated Sites Within the Project Area Identified by Database Source

Database Name	Database Description	No. of Sites
Comprehensive Environmental Response, Compensation, and Liability Information System / No Further Remedial Action Plan (CERCLIS/ NFRAP)	The CERCLIS database is a compilation of facilities that the EPA has investigated or is currently investigating for a release or threatened release of hazardous substances pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980. NFRAP refers to facilities that have been removed and archived from its inventory of CERCLA sites.	1
Resource Conservation and Recovery Act / Corrective Action Tracking System (RCRA CORRACTS/ Treatment, Storage, or Disposal (TSD) Facilities	The EPA maintains a database of RCRA facilities associated with TSD of hazardous materials that are undergoing “corrective action.” A “corrective action” order is issued when there has been a release of hazardous waste or constituents into the environment from a RCRA facility.	0
RCRA Non-CORRACTS/ TSD	The RCRA Non-CORRACTS/TSD Database is a compilation by the EPA of facilities that report storage, transportation, treatment, or disposal of hazardous waste. Unlike the RCRA CORRACTS/TSD database, the RCRA Non-CORRACTS/TSD database does not include RCRA facilities where corrective action is required.	0
RCRA Info	The RCRA Info database, maintained by the EPA, lists facilities that generate hazardous waste as part of their normal business practices. Generators are listed as large, small, or conditionally exempt. Large quantity generators (LQG) produce at least 1,000 kg/month of nonacutely hazardous waste or 1 kg/month of acutely hazardous waste. Small quantity generators (SQG) produce 100 to 1,000 kg/month of nonacutely hazardous waste. Conditionally exempt small quantity generators (CESQG) are those that generate less than 100 kg/month of nonacutely hazardous waste.	1
Emergency Response Notification System (ERNS)	ERNS records and stores information on reported releases of oil and hazardous substances.	0
PCB Activity Database System (PADS)	PADS identifies generators, transporters, commercial storers, and/or brokers and disposers of polychlorinated biphenyls (PCBs) who are required to notify the EPA of such activities.	0
Toxic Chemical Release Inventory System (TRIS)	TRIS identifies facilities that release toxic chemicals to the air, water, and land in reportable quantities under the Superfund Amendments and Reauthorization Act of 1986 (SARA) Title III, Section 313.	0
State		
State Solid Waste Facilities and Landfill Sites (SWF/LF)	The ADEC maintains a list of SWF/LF sites.	0
ADEC Contaminated Sites	ADEC’s Contaminates Sites database is the state version of the federal CERCLIS list and includes registered Leaking Underground Storage Tank sites.	13
ADEC Spills List	ADEC lists potentially hazardous material spills and incidents referred to the Emergency Response Unit.	25
ADEC Air Permits	A listing of air permits and emissions information	1
Brownfields	A brownfield site is an industrial or commercial project corridor that is abandoned, inactive, or underutilized, on which expansion or redevelopment is complicated because of the actual or perceived environmental contamination.	0

3.24.4.1 ADEC Contaminated Sites

The ADEC Contaminated Sites database includes those sites with known contamination or leaking underground storage tanks. These records include a summary of investigations conducted at the site, and the status assigned to each site according to ADEC's standards for remedial action. Searches for ADEC-registered contaminated sites and spills were conducted on March 29 and April 5, 2010. Thirteen contaminated sites were identified; the North Staines River No. 1 Gravel Pad is the only site listed as active. The North Staines River No. 1 Gravel Pad is located within the footprint of the proposed project infrastructure development. A summary of the contaminated sites database search is included below in Table 3.24-2.

Table 3.24-2: Summary of Contaminated Sites – Database Search

ADEC File Number	ADEC Hazard ID	Site Name	Miles from Proposed Development	Date Added to Database	Substance	Site Information and Cleanup Status
300.38.040	875	Exxon Pt. Thomson Exploration Unit 1	0	8/2/1978	Diesel	Diesel fuel detected 1978; approx. 1,000 gallons recovered. Site closure approved 1995.
375.38.002	779	Bullen Pt. DEW Statewide	5	10/1/1981	PCB, Petroleum	Summary of contamination at facility; database entry split into individual sites in 2008. Site listed as nonqualifying; see Hazard ID entries 743, 794, 795, 870, 871, 872, 4322, 4323, 4682.
300.38.111	2688	North Staines River No. 1 Gravel Pad	0	11/15/1995	Diesel	Soil and surface water impacts. Conditional closure granted 1996; final closure pending further investigation. Active status.
375.38.002	743	Bullen Pt. DEW POL Tanks ST005	5	1/23/1997	Petroleum, oil, lubricants (POL)	Seven 20000-65,000 gallon tanks and associated piping identified. . Remedial action taken in 2008; site closure approved 2008.
375.38.002	794	Bullen Pt. DEW Old Landfill LF006	5	1/23/1997	Petroleum	Former landfill subject to wave erosion; remedial action conducted 2008. Site closure approved 2008.
375.38.002	795	Bullen Pt. DEW Inside Transfmr OT04	5	1/23/1997	PCB	Remediation of PCB-impacted soils associated with former transformer conducted 2008; site closure approved 2008.
300.38.190	4660	ExxonMobil Bullen Point Support Pad	2	10/1/1998	Petroleum	Pad used 1974 to 1978. No further remedial action required as long as in compliance with institutional controls 2011.
375.38.002	870	Bullen Pt. DEW Pump House SS002	2	8/17/2004	Petroleum	Pump house operated 1956 to 1971; remediation 2008. Site closure approved 2008.

Table 3.24-2: Summary of Contaminated Sites – Database Search						
ADEC File Number	ADEC Hazard ID	Site Name	Miles from Proposed Development	Date Added to Database	Substance	Site Information and Cleanup Status
375.38.002	871; 872	Bullen Pt. DEW Drum Storage ST07; Fuel Storage ST08	2	8/17/2004	POL	Site used for drummed liquid storage until 1971. Remediation plan approved 2007; site closure approved 2007.
375.38.002	4322	Bullen Pt. DEW SS001 Shed No. 1	5	11/28/2006	POL	Shed used for flammable liquid storage. Remediation conducted 2008; site closure approved 2008.
375.38.002	4323	Bullen Pt. DEW Outside Transformer OT003	5	11/28/2006	PCBs	2004 remedial investigation. Remediation conducted 2008; site closure approved 2008.
375.38.006	4682	Bullen Point SRRS	5	8/1/2008	Not identified	Contamination not accessible during 2008 remediation efforts; site closure approved 2010.

3.24.4.2 State-Registered Spills

Locations identified on the ADEC Spills List within the project area are dependent on the individual reporting the spill; therefore, the potential exists for inaccurate location data. Twenty-five spills were listed in association with "Point Thomson." No spill summaries were identified that required further action. Table 3.24-3 summarizes the listings.

Table 3.24-3: Summary of State-Registered Spills						
Date and Time	Facility Name	Substance	Release Volume (gallons)	Contained Volume (gallons)	Recovered Volume (gallons)	Cause; Source
3/7/01; 3:45 pm	East North Slope Flaxman Island	Propylene glycol	1	0	1	Overfill; drums
3/11/01; 5:45 pm	East North Slope, A-1 Flaxman Island	Seawater	168	0	168	Equipment failure; tank
3/6/02; 2:00 am	East North Slope Flaxman Island	Other	15	0	15	Other; tank
1/8/09; 7:28 pm	PTU-3 Drill Pad	Diesel	284	275	284	Seal failure; well
2/25/09; 2:10 pm	PTU-3 Drill Pad; ice road	Hydraulic oil	<1	0	<1	Equipment failure; heavy equipment
3/10/09; 9:30 pm	PTU-3 Drill Pad	Diesel	1	1	1	Overfill; heavy equipment
3/29/09; 9:30 am	PTU-3 Drill Pad	Engine lube oil	<1	0	<1	Equipment failure; heavy equipment
4/16/09; 4:30 pm	PTU-3 Drill Pad; ice road	Engine lube oil	<1	0	<1	Seal failure; heavy equipment
4/20/09; 10:00 am	PTU-3 Drill Pad	Hydraulic oil	1	0	1	Line failure; heavy equipment

Table 3.24-3: Summary of State-Registered Spills

Date and Time	Facility Name	Substance	Release Volume (gallons)	Contained Volume (gallons)	Recovered Volume (gallons)	Cause; Source
5/1/09; 6:45 am	PTU-3 Drill Pad	Other (paint)	<1	0	<1	Cargo not secured; container
7/4/09; 3:00 am	PTU-3 Drill Pad	Hydraulic oil	<1	0	<1	Human error; container
7/6/09; 6:00 am	PTU-3 Drill Pad	Diesel	2	2	2	Overfill; tank
7/12/09; 5:00 pm	PTU-3 Drill Pad	Other	<1	0	<1	Line failure; refrigeration system
7/24/09; 2:00 pm	PTU-3 Drill Pad	Hydraulic oil	<1	0	<1	Seal failure; heavy equipment
7/27/09; 8:10 am	PTU-3 Drill Pad	Other	0	0	0	Unknown; unknown
8/21/09; 9:00 pm	PTU-3 Drill Pad	Hydraulic oil	5	4	5	Equipment failure; heavy equipment
10/11/09; 9:45 am	PTU-3 Drill Pad	Diesel	<1	<1	<1	Line failure; pipe or line
10/11/09; 3:30 pm	PTU-3 Drill Pad	Hydraulic oil	<1	0	<1	Equipment failure; heavy equipment
10/13/09; 7:30 am	PTU-3 Drill Pad	Diesel	<1	0	<1	Valve failure; tank
11/29/09; 3:35 pm	PTU-3 Drill Pad	Drilling mud	137	127	137	Line failure; drill
1/3/10; 6:00 pm	PTU-3 Drill Pad	Hydraulic oil	2	0.5	2	Line failure; heavy equipment
1/15/10; 1:30 am	PTU-3 Drill Pad	Sulfuric acid	<1	0	<1	Cargo not secured; battery
2/25/10; 4:30 am	PTU-3 Drill Pad	Drilling mud	126	126	126	Valve failure; drill
2/25/10; 11:00 am	Point Thomson; Central Pad	Diesel	25	2	10	Equipment failure; other
4/3/10; 5:30 am	East North Slope; Pt. Thomson Central Pad	Hydraulic oil	13	0	13	Line failure; heavy equipment

3.24.4.3 Federal Databases

The Bullen Point DEW line station is included in the CERCLIS database by the EPA (AK2570028652). CERCLIS is a compilation of facilities that the EPA has investigated or is currently investigating for a release or threatened release of hazardous substances pursuant to the CERCLA of 1980. The DEW site is a registered CERCLA site, but is not included on the National Priorities List (NPL). The site operated as an auxiliary DEW line station from 1953 until its deactivation in 1971. The primary responsible party has been identified as the USAF 611th. Remedial investigations took place in 1993. Five sites located within the installation were identified as containing contaminants of concern that included PCBs and petroleum products. Additionally, the Bullen Point DEW line station landfill/dump site (located on the shore of an ocean lagoon) has been eroded by wave action, which exposed buried drums along approximately 500 feet of shoreline. According to the CERCLIS report, the most significant public health concern at the

Bullen Point DEW line station site is the possibility of injury from activities associated with exposed metal at the former landfill/dump site. The Bullen Point DEW line station is located approximately 12 miles west of the center of the Point Thomson infrastructure development, and 5 miles from the planned pipeline route.

Additional federal databases did not identify any other sites within the project area associated with a spill or release of hazard materials.

3.24.5 Spills

3.24.5.1 ADEC North Slope Spill Database – Frequency of Spills

A review of the ADEC spill database from January 1, 1995, to December 31, 2009, (ADEC 2010) for the North Slope shows 9,120 spill records, including crude and refined oil (diesel, hydraulic oil, lubricating oil, transmission oil, gas condensate, and others), saltwater (composed of brine from produced waters and treated seawater), drilling muds, and other hazardous materials (e.g., corrosion inhibitors, methanol, antifreeze, acids, salts, and others), "freshwater" spills, and a large number of "other," which may include some or all of the substances listed previously. Over the reporting period, the number of spills recorded generally increased each year, with some exceptions. At the same time there has been a substantial increase in the scope and amount of in-field production drilling and exploration activities, and more rigorous reporting requirements implemented by the oil field operators and contractors.

Table 3.24-4: Summary of ADEC Database Spill Records for the North Slope, 1995-2009

Year	Number of Spill Records	Approximate Cumulative Spill Volume (gallons)[a, b]
1995	224	64,000
1996	446	52,000
1997	488	105,000
1998	446	110,000
1999	391	60,000
2000	427	79,000
2001	663	185,000
2002	691	75,000
2003	633	72,000
2004	645	72,000
2005	673	116,000
2006	816	577,000[c]
2007	1,013	105,000
2008	844	273,000
2009	706	102,000
TOTAL	9,106	2,047,000
Annual Average	607	136,000

Table 3.24-4: Summary of ADEC Database Spill Records for the North Slope, 1995-2009

Year	Number of Spill Records	Approximate Cumulative Spill Volume (gallons)[a, b]

[a] About 120 spills are not included in this table because they were recorded as pounds instead of gallons. The majority were small amounts (<100 pounds) and composed mostly of halon, freon, drilling muds, methanol, and "other." Included was one incident reported as four separate entries as 300,000 pounds of "other" in a truck rollover.

[b] Each year, several incidents occur for which multiple (up to six) entries exist for what appears to be the same incident. These multiple entries appear to result from (a) different parties submitting a report, (b) incident involved more than one substance (e.g., produced water and crude oil), or (c) redundancy to ensure a report was made as required by regulation. The record count was left the same as it is in the ADEC database but the extra volumes were deleted where the spill was recorded as ≥ 500 gallons for the incident.

[c] This volume is skewed by the single very large crude spill, reported in the ADEC database (ADEC 2010c) as 267,000 gallons, at the BP GC-2 site. The final Situation Report (SITREP #23, ADEC, March28, 2008) ratified a final spill volume of 212,252 gallons that covered about 1.9 acres of snow covered tundra. (ADEC 2008b). To maintain consistency with the rest of the spill volumes reported in the ADEC database, we used the 267,000 gallon volume as initially reported. It is possible, even likely, that some of the other large volume spills would show discrepancies, up or down, between the initial reported volume and that verified in the final SITREP.

3.24.5.2 Size of Reported Spills by Material

Of the 9,106 spill records in the ADEC database that were used for this assessment, three spills were greater than 100,000 gallons (i.e., very large spills). The majority of the spills listed in the ADEC database (5,136 records or 56.3 percent) reported a release of 5 gallons or less.

In March 1997, 995,400 gallons of saltwater "spilled" at DS 4 in the Prudhoe Bay Unit when saltwater broached the surface and was completely contained on the pad (ADEC 2010c). In March 2006, as the result of corrosion, 267,000 gallons of crude oil leaked from the BP GC-2 gathering pipeline at Prudhoe Bay and covered about 1.9 acres of snow-covered tundra and frozen lake. The third very large spill was 234,738 gallons of produced water in December 2006 from a corroded tank in West Prudhoe Bay.

Table 3.24-5 provides a summary of the types of materials spilled, number of records in the ADEC database (including some replicates but excluding some spills reported in pounds rather than gallons in the first years of the reporting system), size in gallons of the three largest spills of a material, and the percentage of all spill records represented by the material. Diesel and hydraulic oil represent about 43 percent of the spills by number while crude oil spills are about 9.5 percent of the total. Water spills (e.g., saltwater, process water, source water, seawater, produced water) taken together compose about 8 percent of the spills but tend to be the largest spills. Other large volume spills include drilling muds, methanol, and "other." Most of the spills occur on roads and pads, and some may have reached the adjacent tundra. Some crude oil and water spills result from failures of pipelines and may have reached tundra or tundra ponds remote from the roads and pads.

Table 3.24-5: Type, Number, Size, and Percentage of Spills in ADEC Database for the North Slope, 1995-2009

Material[a]	Number of Records[b]	Size of Largest Spills (Gallons)	Total Volume (Gallons)	Percent of All Records
Diesel	2,027	11,000; 10,000; 7,600	186,022	22.5
Hydraulic Oil	1,727	660; 650; 500	23,353	19.2
Crude Oil	857	267,000[c]; 30,030; 25,500	749,142	9.5
Methanol	532	12,811; 2,520; 2,520	57,682	5.9
Corrosion Inhibitor	520	500; 500; 334	6,999	5.8
Engine Lube Oil	519	650; 400; 350	8,590	5.8
Drilling Mud	450	18,900; 12,118; 10,920	220,086	5.0
Antifreeze (Ethylene Glycol)	443	5,700; 1,500; 1,500	29,182	4.9
Produced Water	341	23,4738; 94,920; 92,400	885,993	3.8
Saltwater	291	995,400; 61,626; 12,600	1,176,172	3.2
Transmission Oil	145	73; 23; 15	474	1.6
Propylene Glycol	130	4,074; 3,000; 900	18,367	1.4
Glycol	115	1,500; 740; 500	10,215	1.3
Other Refined Petroleum Products[d]	141	5,700; 2,000; 600	14,429	1.6
Acids[e]	148	176; 211; 42	7,848	1.6
Used Oil	38	2,020; 1,500; 200	4,755	0.4
Process and Source Water	53	49,387; 38,600; 11,611	210,200	0.6
Other[f]	504	24,654; 5,670; 4,200	88,806	5.6
Unknown[g]	22	100; 40; 25	225	0.2

Notes:

[a] Based on total number of records for each material out of the total of 9003 spill records used from the ADEC 1995–2010 database.

[b] Number of records in the January 1995 to December 2009 ADEC database (ADEC 2010c). Some are duplicates (or even higher replicate) records of the same spill.

[c] This oil spill was initially reported as 267,000 gallons and that value is provided in the ADEC (2010c) database. The volume was subsequently ratified in the final SitRep (ADEC 2008b) as 212,252 gallons.

[d]. Includes asphalt, aviation fuel, gasoline, grease, kerosene, synthetic oil, transformer oil, propane, solvent, therminal, and turbine fuel.

[e]. Includes hydrochloric, sulfuric, and unspecified acids.

[f] Includes Halon, Freon, drag reducing agents, emulsion breakers, chemicals, alcohols, natural gas, and biocides.

[g] Record was incomplete or the material may not be listed by ADEC as being part of the database.

3.24.5.3 Cause and Size Range of Reported Spills

For about 75 percent of the approximately 9,100 spill records in the ADEC database, *human error* (including *overfill;* 1140 + 495 records) or failure of facilities (*line failure, equipment failure, leak, seal failure, valve failure;* 1508, 1410, 840, 784, 659) were the main cause (ADEC 2010c). In a few cases, the same spill had multiple causes as indicated by the duplication of largest volume in Table 3.24-6 (see *line failure* and *corrosion* for the BP GC-2 crude oil spill as an example). About 11 percent of the causes are unspecified and show up in the database as *unknown, other* or *external factors*; a review of the actual file reports might elucidate the specific cause in many of the spills. The smallest spills (0.001 gallons) in any cause category represent "less than a teaspoon of material" demonstrating the diligence of the oil field workers and contractors in reporting all detected spills. The largest spills tend to be crude oil or water.

Table 3.24-6: Causes, Size Range and Number of Spill Records for the Major Material Spills Recorded in the ADEC Database for the North Slope, 1995-2009

Cause	Number of Records	Smallest Volume (gallons)	Largest Volume (gallons)	Material
Line Failure	1,508	<0.1	267,000[a]	Crude Oil
Equipment Failure	1,410	<0.1	30,030	Crude Oil
Human Error	1,140	<0.1	25,500	Crude Oil
Leak	840	<0.1	995,400	Sea Water
Seal Failure	784	<0.1	38,600	Source Water
Valve Failure	659	<0.1	28,350	Produced Water
Overfill	495	<0.1	3,150	Sea Water
Unknown	457	0.0	63,000	Produced Water
Other	330	<0.1	24,654	Other
External Factors	208	<0.1	12,118	Drill Mud
Corrosion	193	<0.1	267,000	Crude Oil
Rollover/Capsize	188	<0.1	12,118	Drill Mud
Cargo Not Secured	139	<0.1	1,008	Drill Mud
Gauge/Site Glass Failure	126	<0.1	9,450	Produced Water
Vehicle Leak (All)	125	<0.1	130	Diesel
Crack	110	<0.1	3,576	Diesel
Containment Overflow	105	0.3	30,030	Crude Oil
Puncture	96	<0.1	1,100	Diesel
Collision/Allison	89	<0.1	5,217	Diesel
Erosion	27	1.0	1,146	Produced Water
Tank Failure	20	1.0	1,600	Other
Sabotage/Vandalism	15	1.0	500	Propylene Glycol
Intentional Release	9	2.0	1,100	Other
Explosion	8	0.1	250	Crude Oil
Hull Failure	5	1.0	500	Drill Mud
Grounding	3	0.0	2.0	Hydraulic Oil
Well Blow Out[b]	1	1.0	1.0	Hydrofluoric Acid

[a] This oil spill was initially reported as 267,000 gallons and that value is provided in the ADEC (2010c) database. The volume was subsequently ratified in the final SitRep (ADEC 2008b) as 212,252 gallons.

[b] The identification of this event as a “blowout” may not be accurate.

3.24.5.4 Blow Outs and Uncontrolled Releases

North Slope-wide, NRC (2003a) reported five events between 1977 and 2001 that resulted in uncontrolled surface release of gas condensate liquids or gas from the boring. Six incidents occurred in which the pressure on the formation fluids exceeded the pressure of downhole drilling fluids, but did not result in uncontrolled flow at the surface. Over this same period, approximately 5,000 wells were drilled or re-drilled, giving a rate of approximately one event per 1,000 wells drilled or a probability of approximately 0.001, about the same as for other areas (NRC 2003a).

The Alaska Oil and Gas Conservation Commission (AOGCC) records list 10 well blowouts on the North Slope between 1949 and 2008, including two blowouts near the project area: Kavik No. 1 (1969) and Endicott I-53/Q-20 (1994), which both resulted in gas at the surface (AOGCC 2008). Blowouts document loss of control at the well but do not always result in a surface spill. In summary, blowouts and uncontrolled releases from North Slope oil field activities, including at the project area, have been rare events and are likely to be even rarer in the future as better spill control technology, along with increasingly stringent regulations, are applied to current and future drilling and production activities.

The reservoir pressures at the Point Thomson field are higher than at other producing fields on the North Slope. As described more fully in Section 5.24, Spills Impact and Risk Assessment, from the reservoir to the CPF, a blowout or uncontrolled release may result in a larger volume per unit of time that the release continues than might be experienced in a similar situation elsewhere in North Slope wells where the reservoir pressures are lower.

3.24.5.5 Spills by the Applicant in the Project Area

The Applicant has reported about 25 spill incidents at or directly associated with the project area (Table 3.24-4), most of which occurred onshore at the gravel pads in 2009 (ADEC 2010c). Six spills were reported over 5 gallons. The largest spill reported was 284 gallons of diesel from a seal failure. The entire amount was later recovered. Other larger spills included drilling muds, seawater, and hydraulic oil. There have been no blowouts or uncontrolled releases of produced fluids at the project's exploration pads since drilling was initiated (ADEC 2010c).

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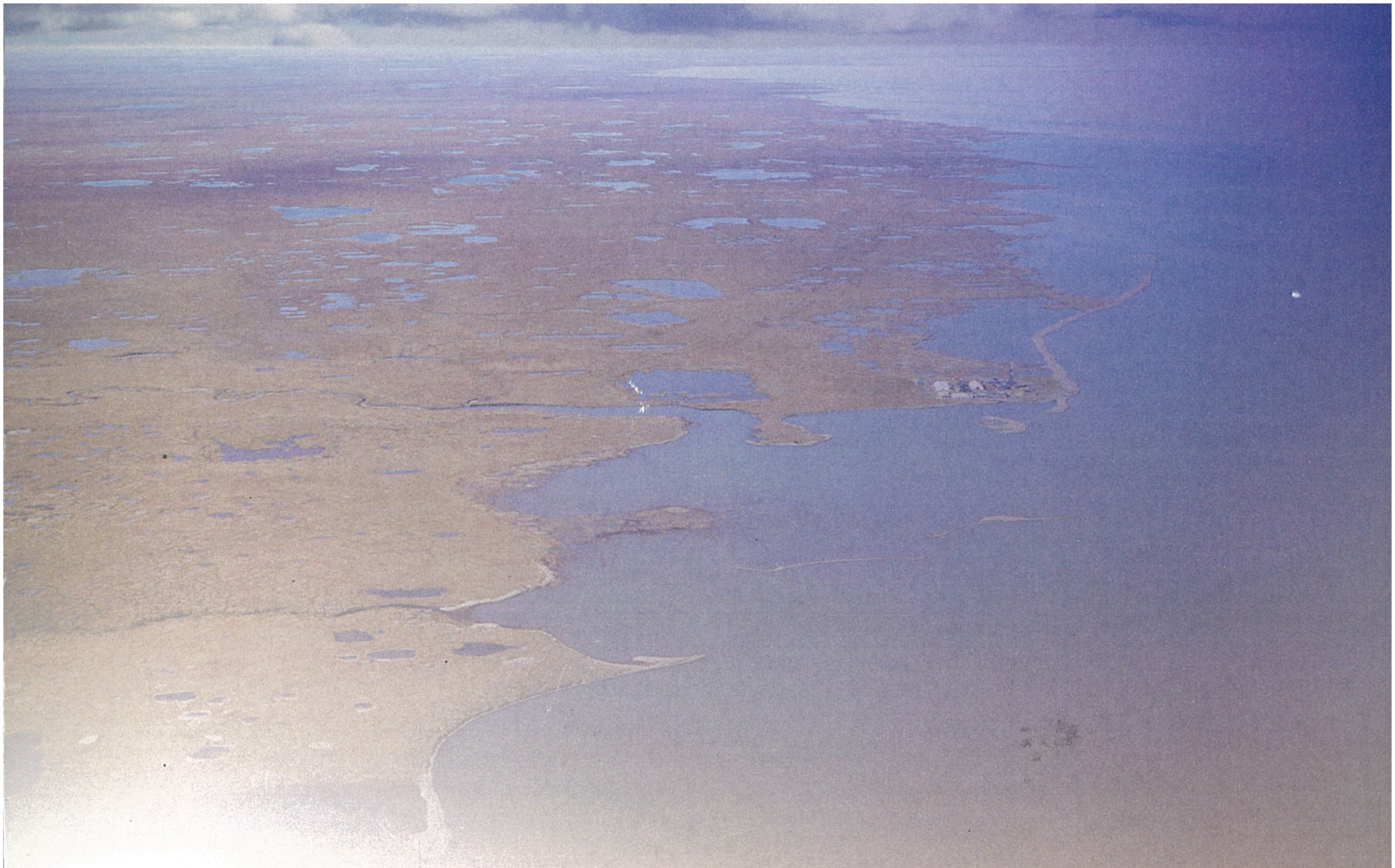

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