POINT THOMSON PROJECT EIS

Final Environmental Impact Statement

Volume 2

United States Army Corps of Engineers

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Chapter 4. Approach to the Environmental Analysis

This chapter describes the approach used for determining impacts described in Chapter 5. Distinction between direct, indirect, and cumulative impacts can be complex; this chapter identifies the goal of the impact analysis, clarifies the different types of impact analysis, and presents the common assumptions used for impact analysis. This chapter also addresses climate change as a condition not specific to a particular resource and sets the groundwork for how it is discussed under the resources within Chapter 5. The last section of this chapter defines the multiple types of mitigation and explains how design measures have been incorporated into the alternatives along with the process to develop mitigation measures for the Point Thomson Project.

4.1 DIRECT AND INDIRECT IMPACT DETERMINATION METHODOLOGY

This EIS serves to present a comparison of potential impacts to resources among alternatives. Potential direct and indirect impacts from the alternatives on each resource were considered in the context of four evaluation categories:

- Magnitude (major, moderate, or minor)
- Duration (long term, medium term, or temporary)
- Potential (probable, possible, or unlikely)
- Geographic Extent (extensive, local, or limited)

Direct and indirect impacts, as defined below, are considered together within each resource impact evaluation.

Direct Effects – Effects that are caused by the action and occur at the same time and place (40 CFR 1508.8). Examples of direct effects include filling of wetlands through the placement of gravel pads, and direct mortality of wildlife or vegetation.

Indirect Effects – Effects that are caused by an action but occur later in time or are farther removed in distance but are still reasonably likely. Indirect effects may include growth-inducing effects and other effects related to "induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems" (40 CFR 1508.8). Indirect effects are caused by the project, but do not occur at the same time or place as the direct effects.

To specifically evaluate potential impacts in the context of this project, subject matter experts developed definitions for impact levels for the four categories based on the resource under evaluation. These impact criteria were applied to determine the effects on the resource from the proposed action and alternatives. The impact evaluation categories were used to assess both detrimental and beneficial impacts. Key findings and differentiators are clearly identified at the beginning of each resource discussion to aid the reader with evaluating the project alternatives.

Each resource identifies the methodology used within its analysis. Definitions for intensity types are different for each resource and are typically presented in tables within the respective resource section.

Impacts that may result from project alternatives are discussed by resource and generally presented by phases of the project (construction, drilling, and operations). Design measures, where applicable, have been proposed by the Applicant and are identified in each resource section. Cumulative impacts are also presented, and the guidance and methodology used to determine cumulative impacts is further described in Section 4.2.

4.2 CUMULATIVE IMPACTS METHODOLOGY

The purpose of the cumulative impact analysis is to identify any project impacts that when combined with past, present, and reasonably foreseeable future actions (RFFAs) may result in beneficial or adverse impacts. The analysis of cumulative impacts in this Final EIS employs the definition of cumulative impacts found in the CEQ regulations (40 CFR 1508.7): “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such actions.” In many cases, quantitative estimates of cumulative impacts are not possible, and qualitative assessments are provided. Cumulative impacts and RFFAs are further described below.

Cumulative Impacts – Additive or interactive effects that would result from the incremental impact of the proposed action when added to other past, present, and RFFAs, regardless of what agency (federal or nonfederal) or person undertakes such other actions (40 CFR 1508.7). Interactive effects may be either countervailing, in which the net cumulative effect would be less than the sum of the individual effects, or synergistic, in which the net cumulative effect would be greater than the sum of the individual effects.

Reasonably Foreseeable Future Actions – RFFAs are potential federal or nonfederal actions identified within the spatial, or geographic, and temporal scopes of the cumulative effects analysis. The predicted impacts of the RFFAs are combined with the potential direct and indirect effects of the proposed project to determine potential future cumulative effects on a given resource. The term “reasonably foreseeable” is not defined in the regulations. For this analysis, RFFAs are those that are likely or reasonably certain to occur. Often, their applicability is based on publically available documents such as existing plans, permit applications, or announcements. Potential actions that are speculative or not likely to occur are not considered reasonably foreseeable.

4.2.1 Cumulative Impact Guidance

The CEQ has issued guidance on Considering Cumulative Impacts under NEPA (1997b). The purpose of a cumulative impact analysis “is to ensure that federal decisions consider the full range of consequences” (CEQ 1997b). Although no universally accepted framework for cumulative effects analyses exists, the following principles are provided by CEQ:

- Cumulative effects are caused by the aggregate of past, present, and reasonably foreseeable future actions.
- Cumulative effects are the total effect, including both direct and indirect effects on a given resource, ecosystem, and human community of all actions taken, no matter who (federal, nonfederal, or private) has taken the actions.
- Cumulative effects need to be analyzed in terms of the specific resource, ecosystem, and human community being affected.
- Analysis of cumulative effects on a global scale is not practical. Analysis is focused on those actions that are meaningful to the specific project.
- Cumulative effects on a given resource, ecosystem, and human community are rarely aligned with political or administrative boundaries.

- Cumulative effects may result from the accumulation of similar effects or the synergistic interaction of different effects.
- Cumulative effects may last for many years beyond the life of the action that caused the effects.

Each affected resource, ecosystem, and human community must be analyzed in terms of its capacity to accommodate additional effect, based on its own time and space parameters

4.2.2 Previous Study of Cumulative Impacts

The National Research Council (NRC) was requested by the U.S. Congress to review existing information about oil and gas activities on Alaska's North Slope and assess future cumulative effects on the physical, biological, and human environment (NRC 2003a). This request was based on the lack of a comprehensive understanding of the effects of oil and gas exploration, development, and production on the North Slope, as well as the acknowledgement that this information should be considered in future development projects. The NRC published its report in 2003, *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope*. While the existing activity on the North Slope has changed since 2003, the discussion and analyses conducted in the study are relevant and useful when considering the Point Thomson Project's potential contributions to cumulative effects on the North Slope environment. The NRC's findings include:

- The growth of industrial activity has created a complex of developed fields, roads, pipelines, and power lines, with incremental growth being added with each new development. Effects of these structures are present not only at the structures' footprint, but also at distances varying by the affected resource. These effects will accumulate with expanded activity. The committee assumes that regulatory oversight will continue, and notes that this oversight can be critical in reducing or limiting accumulation of these effects.
- Changes to the global and regional climates have been particularly pronounced on the North Slope. The committee states that continued warming trends will alter the presence and seasonality of sea ice, affect populations and distribution of marine and terrestrial plants and animals, and affect permafrost. These changes will, in turn, affect existing oil field infrastructure and may affect the applicability or usefulness of current technologies and their environmental impacts.
- Off-road travel over tundra areas for seismic exploration has adversely affected vegetation, caused erosion, and degraded visual experiences over a large area. Technologic improvements have been made to reduce these impacts, but increased exploration will likely lead to an increase in the area of damaged tundra areas.
- The infrastructure of roads on the North Slope causes effects resulting from dust, flooding, thermokarst, and snow accumulation. They also can alter animal habitat and behavior while increasing access to the region. Effects of roads accumulate and interact with pipelines and off-road vehicle trails. Future development will likely bring additional roads, which could increase contact between North Slope communities and those outside the area.
- Animals have been affected by industrial activities on the North Slope, but the magnitude and extent are not clearly defined. Expanded loss of preferred habitats resulting from increased exploration and development infrastructure are likely to adversely affect animals. Animal behavior and distribution will continue to be affected by additional development of North Slope facilities.
- Effects of a large oil spill in the marine environment, particularly when sea ice is present, would likely accumulate due to lack of cleanup methods or success in such an environment. Effects of contaminant

spills on vegetation have not accumulated because of the small size of the spills and successful cleanup and rehabilitation efforts.

- Lack of clear guidance regarding the extent and timing of restoration has limited the restoration of disturbed sites. This will continue if current technical and natural constraints imposed by the harsh environment of the North Slope are not changed, and it is likely that unrestored sites could accumulate as new structures are added in the region.
- Adaptation by residents to changes in the oil and gas exploration and development conditions will occur.
- Industrial activities on the North Slope have changed the landscape in aesthetic, cultural, and spiritual ways. Opportunities for solitude have been reduced and have changed wildland (wilderness) and scenic values. These consequences will persist as long as the landscape remains altered and will accumulate further with additional development.
- Offshore exploration and development have caused perceived risk concerns for the Inupiaq culture that are widespread, intense, and constitute a cumulative effect.

The EIS presents an analysis of cumulative impacts in each resource section of Chapter 5. Findings of the NRC (2003a) study were considered in the current analysis, though the age of the NRC analysis limits its applicability to the current impact consideration.

4.2.3 Methods

Cumulative impacts are assessed by combining the potential environmental impacts of the project with the impacts of projects that have occurred in the past, are presently occurring, or are proposed to occur in the future in the vicinity of the project. The actions considered in the cumulative impact analysis may vary from the proposed project in nature, magnitude, and duration. These actions are included based on their likelihood of occurrence, and only projects with either ongoing or reasonably foreseeable impacts are identified.

The general process includes the identification, through research and consultations, of federal and nonfederal actions with possible effects that would be coincident with those of the project on resources, ecosystems, and human communities. Coincident effects would only be possible if the geographic and time boundaries for the effects of the project and past, present, and RFFAs overlap. The anticipated cumulative impacts of the proposed project and the other actions identified in Section 4.2.1 are discussed in this Final EIS by resource in Chapter 5.

Although rare in occurrence, it is plausible that accidental or emergency events may arise due to an unforeseen chain of events during the project’s operational life. As a result of the rarity and magnitude of such events, they have not been assessed here, as they are extreme in nature when compared to the effects of normal operation and maintenance activities, and require separate, project-specific response plans.

4.2.3.1 Structure and Scope of the Cumulative Impacts Analysis

Spatial or Geographic Scope of the Analysis

The spatial scope for analysis of cumulative effects varies by resource. For certain resources such as migratory birds and wildlife, air quality, subsistence, and socioeconomics, the geopolitical barrier defined as the U.S.–Canadian Border may not be applicable. Executive Order 12114, *Environmental Effects Abroad of Major Federal Actions*, includes the following provisions:

- Federal agencies involved in actions with potential significant environmental impacts outside of the U.S. must provide information to federal decision makers so that the potential effects may be evaluated with other pertinent considerations of national policy;
- Activities involving foreign governments must be coordinated through the Department of State; and
- Pertinent information may be withheld from other agencies and nations when necessary to avoid adverse impacts to foreign relations and ensure appropriate reflection of diplomatic factors. Section 1 of the Executive Order provides that it is the U.S. government's "exclusive and complete determination of the procedural and other actions to be taken by federal agencies to further the purpose of the NEPA, with respect to the environment outside the United States, its territories and possessions."

The statutory provisions of NEPA (and the CEQ regulations implementing NEPA) do not require assessment of environmental impacts within the territory of a foreign country. As a voluntary measure to further the purposes of the Executive Order, and for the purpose of efficiency and convenience, this Final EIS includes an appropriate evaluation of potential cumulative impacts of project alternatives on resources such as wildlife, birds, and air quality that could extend past the geopolitical border to the northern reaches of the Yukon Territory, east to the MacKenzie River in the Northwest Territories of Canada. Relevant geographic subareas are defined based on resource.

Temporal Scope of Analysis

The time frame for this cumulative effects analysis begins in the 1940s with U.S. government-sponsored oil exploration and development activities. Prior to this time, human activities were primarily traditional uses by indigenous people, along with whaling and exploration by nonnatives. Although prehistoric indigenous people on Alaska's North Slope are known to have used oil and tars from shale and seepages, the first modern program and exploration, drilling, geophysical, and geological surveys was started by the U.S. Navy and U.S. Geological Survey (USGS) along the Colville River, later expanding to all major north-flowing rivers of the North Slope. These early exploration activities mark the beginning of oil and gas exploration and development with analogous components to modern-day exploration and drilling efforts.

To date, the most intense period of development activity on the North Slope occurred during the 1970s and early 1980s. During this period, the Prudhoe Bay and Kuparuk Oil Fields were developed, TAPS and the Dalton highway were constructed, and large areas of the North Slope were developed with roads, drilling pads, gravel sources, production facilities, and other infrastructure related to the oil industry. Economic and social effects both beneficial and detrimental were realized. There was also much activity in the NPR-A region with increased exploration activity, including thousands of miles of seismic lines surveyed and dozens of exploratory wells drilled. Since the mid-1980s, additional North Slope development has occurred, but incremental physical disturbance to the environment has been reduced. Development has focused on increasing yield and lengthening the life of existing oil fields.

The period for the cumulative impacts analysis extends through about 2100. This date is based on the assumption that oil and gas fields that are presently in the exploration phase, or new oil and gas deposits that could be discovered in the reasonably foreseeable future, would be developed and in production for approximately the next 50 years. After that, continued production and eventual abandonment of the fields could last an additional 40 years.

4.2.3.2 General Types of Actions/Activities Analyzed

Non-oil–and-gas Activities

These activities include past and continued human actions such as recreational and subsistence hunting and fishing, commercial fishing, tourism, recreational activities, future growth and development of villages and military sites (e.g., site management changes), road development (e.g., state-funded "roads to resources," Bullen Point Road), and future land resource management plans.

Oil and Gas Activities

These activities include construction and ongoing maintenance of present infrastructure support facilities and transportation systems, activities that are currently under construction or currently undergoing agency approval, and reasonably foreseeable future exploration, development, and production activities, including support and transportation components. These activities can also include extraction of discovered oil and gas that is not currently undergoing agency approval, or discovery and extraction of undiscovered oil and gas in areas with existing oil leases for which lease sales are planned.

4.2.3.3 Relevant Past, Present, and Reasonably Foreseeable Actions Considered in Cumulative Impacts Analysis

The cumulative effects analysis evaluates the proposed project together with past, present, and other RFFAs. These actions include projects or activities that may occur in a broader geographic area than the proposed project area and includes projects that may be in any one of a number of stages of development. To identify projects or actions for inclusion in the cumulative impact analysis, the following criteria were considered:

- Past and Current Actions: Activities that were associated with past actions and may involve present operations. This involves infrastructure development, non-oil-related actions, and oil industry facilities and present production from those facilities.
- Present Actions: This includes exploration, development, or production operations and related activities that may just have come on-line, are currently underway, or are planned for the near future. This may also include other non-oil-related development that is presently under development.
- Reasonably Foreseeable Future Actions: Oil and gas discoveries or other projects that are clearly identified and expected to initiate development-related activities (site surveys, permitting, appraisal drilling, or construction) within the next 20 years. In addition to oil and gas development, other RFFAs were identified. They include continued human activities such as sport and subsistence hunting and fishing, commercial fishing, sport harvest, tourism, and recreational activities.

Based on these criteria, Table 4.2-1 through Table 4.2-3 list the projects considered to be relevant to the cumulative effects analysis for the Point Thomson Project. Table 4.2-1 lists the types of actions considered, and Table 4.2-2 and Table 4.2-3 include detailed lists of oil and gas related actions on the North Slope and in Northwestern Canada, respectively.

Table 4.2-1: Relevant Past, Present, and Reasonably Foreseeable Actions Considered in the Cumulative Impacts Analysis		
Category	Area	Project/Activity
Oil and Gas Exploration, Development, Production, and Transportation	• North Slope and adjacent marine waters • Canadian Yukon and Northwest Territories east to the MacKenzie River	• See detailed Table 4.2-2 • See detailed Table 4.2-3
Scientific Research and Surveys	North Slope and adjacent marine waters	• Oceanographic sampling • Biological surveys
Community Development/ Capital Projects	NSB	• Sewer and water projects • Power generation upgrades and new facilities • Village expansions
Transportation	• Onshore • Marine • Air	• Dalton Highway • Bullen Point Road • Other new roads • Marine vessel traffic • Airstrips • Aircraft
Subsistence Activities	Vicinity of Kaktovik, Nuiqsut Barrow, and other North Shore villages and adjacent marine waters	• Gathering • Hunting • Trapping • Fishing • Whaling • Sealing • Traveling
Tourism, Recreation, Recreational Hunting, and Fishing	• Brooks Range • Kaktovik • Arctic Refuge • Canning River	• Flightseeing • Floating • Camping • Hunting • Fishing
Commercial Fishing	• Colville River	• Seasonal fishing activities for arctic cisco
Military	• North Slope	• DEW line stations
Tax Revenues Generated by the Petroleum Industry	• NSB • State of Alaska	• Alaska Permanent Fund • Other state and local programs
Disease	North Slope terrestrial and marine habitats.	• Viral infection in long-tailed ducks
Global Industrial Pollutants	North Slope terrestrial and adjacent marine waters.	• Bioaccumulation • Air quality

Table 4.2-2: Details Concerning North Slope of Alaska Oil and Gas-Related Actions Considered in the Cumulative Impacts Analysis

Category	Unit or Area	Participating Area	Past	Present	Reasonably Foreseeable Future
Oil/Gas Production	Badami	Badami Sands (plus future expansion)	X	X	X
	Colville River	Alpine (CD-1, CD-2)	X	X	X
		Fjord (CD-3)	X	X	X
		Nanuq (CD-4)	X	X	X
		Qannik	X	X	X
	Duck Island	Eider	X	X	X
		Endicott	X	X	X
		Sag Delta North	X	X	X
	Kuparuk River	Kuparuk	X	X	X
		Meltwater	X	X	X
		Palm (DS 3S)	X	X	X
		Tabasco	X	X	X
		Tarn	X	X	X
		West Sak/ N. E. West Sak	X	X	X
	Milne Point	Cascade	X	X	X
		Kuparuk	X	X	X
		Sag River	X	X	X
		Schrader Bluff	X	X	X
		Ugnu	X	X	X
	Nikaitchuq	Schrader Bluff	X	X	X
	Northstar	Northstar	X	X	X
	Oooguruk	Kuparuk/Nuiqsut/Torok	X	X	X
	Prudhoe Bay	Aurora	X	X	X
		Borealis	X	X	X
		Lisburne	X	X	X
		Midnight Sun	X	X	X
		N. Prudhoe Bay	X	X	X
		Niak IV-SR	X	X	X
		Niakuk/Combined Niakuk	X	X	X
		Orion	X	X	X
		Polaris	X	X	X
		Point McIntyre	X	X	X
		Prudhoe Bay IPA	X	X	X
		Raven	X	X	X
		Western Niakuk/Combined Niakuk	X	X	X
		West Beach	X	X	X

Table 4.2-2: Details Concerning North Slope of Alaska Oil and Gas-Related Actions Considered in the Cumulative Impacts Analysis

Category	Unit or Area	Participating Area	Past	Present	Reasonably Foreseeable Future
Oil/Gas Development	Colville River	Alpine West (CD-5)	X	—	X
	Liberty (OCS)	Liberty	X	—	X
	NPR-A – Greater Moose's Tooth (GMT)	GMT 1 (Alpine Satellite CD-6)	X	—	X
		GMT 2 (Alpine Satellite CD-7)	X	—	X
	Prudhoe Bay	Raven	X	X	X
		West Beach	X	X	X
	Point Thomson Area	Point Thomson (full-field development)	X	—	X
Oil/Gas Exploration	Arctic Fortitude Unit	Burglin 33-1	X	—	X
	Beechey Point	Gwydyr Bay	X	—	X
		North Shore	X	—	X
		Pete's Wicked	X	—	—
		Flaxman Island	X	—	—
		Kuvlum	X	—	—
		Mikkelson	X	—	—
		Stinson	X	—	X
	Bear's Tooth	—	—	—	X
	Beaufort Sea (OCS)	Camden Bay (Sivulliq/Torpedo)	X	X	X
	Brooks Range Foothills	Umiat	X	—	X
	Colville River Delta	—	—	—	X
	Dewline	—	X	—	X
	Greater Bullen (Proposed)	Telemark	—	X	X
	Greater Moose's Tooth	—	X	—	X
	Oooguruk	Nuna	—	—	X
	Point Thomson Area/ Eastern North Slope	Arctic Refuge private in-holdings	X	—	—
		Friezen	X	—	X
		Kavik	X	—	—
		Kemik	X	—	—
		Point Thomson	X	X	X
		Red Dog	X	—	X
		Slugger	X	—	X
		Sourdough	X	—	—
		Yukon Gold	X	—	—
	S. Miluveach (proposed)	Mustang	X	—	X

Table 4.2-2: Details Concerning North Slope of Alaska Oil and Gas-Related Actions Considered in the Cumulative Impacts Analysis

Category	Unit or Area	Participating Area	Past	Present	Reasonably Foreseeable Future
Oil/Gas Transportation	Carrier Pipelines		X	X	X
	Fuel Transfer (barges, etc.)		X	X	X
	Gas Treatment Plant (associated with an Alaska gas pipeline)		—	—	X
	In State Gas Line and Treatment Plant		—	—	X
	Offshore Tanker Transport		—	—	X
	Point Thomson Gas Sales Pipeline		—	—	X
	TAPS		X	X	X
	The Alaska Pipeline Project		—	—	X

Table 4.2-3: Details Concerning Northwestern Canada Oil and Gas-Related Actions Considered in the Cumulative Impacts Analysis

Category	Area	Past	Present	Reasonably Foreseeable Future
Oil/Gas Exploration	Mackenzie Delta/Tuktoyaktuk Peninsula	X	—	—
Oil/Gas Transportation	Carrier Pipelines	X	X	X
	Fuel Transfer (barges, etc.)	X	X	X

Reasonably Foreseeable Future Oil and Gas Actions in Close Proximity to Point Thomson

Development of the Point Thomson Project could facilitate the development of other oil and gas resources in the immediate area, including several Brookian formation reserves listed in Table 4.2-2 (e.g., Sourdough, Slugger, Flaxman). There are also hydrocarbon resources currently planned for exploration and development within OCS leases approximately 15 to 30 miles offshore of the Point Thomson area. Shell Offshore Inc., an affiliate of Shell Exploration and Production Company (Shell), plans to initiate an exploration drilling program on several of its OCS leases the summer of 2012. If commercial hydrocarbons are discovered, Shell would initiate steps to install a subsea pipeline, a sea-to-shore transition, and an onshore pipeline to connect to TAPS. The transition onto shore may be in the vicinity of Point Thomson if an agreement could be reached to share use of the Point Thomson proposed export pipeline (per Shell, Comment Document 246, Appendix W).

Construction of Point Thomson barge facilities, airstrip, and export pipeline could be used to support future development of these prospects and improve their development feasibility by reducing costs through shared facilities. For the purpose of this analysis, it is assumed that the infrastructure of the proposed Point Thomson Project could support development of other actions in proximity to Point Thomson, once any necessary contractual agreements and regulatory requirements were met.

The Federal Energy and Regulatory Commission (FERC) is evaluating a proposed new natural gas pipeline system that would transport natural gas produced on the North Slope to the Alaska-Canada border for onward delivery to markets in North America. The FERC filed an NOI on August 1, 2011 to prepare an EIS that will describe the environmental impacts of the planned Alaska Pipeline Project.

The Alaska Pipeline Project would involve construction and operation of a new pipeline system to transport up to 4.5 billion cubic feet of natural gas per day (Bcfd). Specifically, the planned project includes the following major components in Alaska:

- Approximately 60 miles of gas pipeline and associated facilities (the Point Thomson Pipeline) from Point Thomson to a planned gas treatment plant near Prudhoe Bay
- A new gas treatment plant near Prudhoe Bay capable of producing pipeline-quality gas
- Approximately 745 miles of pipeline and associated aboveground ancillary and auxiliary facilities (the Alaska Mainline) from the gas treatment plant to the Alaska-Yukon border
- Construction of at least five delivery points, eight compressor stations, two meter stations, various mainline block valves, and pig launching/receiving facilities.

Full–Field Development of Point Thomson

Point Thomson is the largest discovered, undeveloped gas field in North America. The vast majority of the hydrocarbon resource is in the form of natural gas, and full-field development necessary would encompass production of natural gas. Future expansion of the proposed gas cycling activities to produce liquid condensate and then production of gas for gas sales are both reasonably foreseeable. The expansion plan for any future gas cycling activities would be determined by the results of long-term flow testing. Based on currently available information, oil production is uncertain and not considered to be reasonably foreseeable.

Additional infrastructure anticipated for full-field development for gas production would include an expanded Central Pad to accommodate additional production facilities, additional wells on the proposed Central, East, and West Pads, and a gas export line. A conceptual general description of potentially necessary additional facilities, based upon information provided by the Applicant in its response to RFI 52 (Appendix D), follows.

The Central Pad would need to be expanded up to an estimated 25 acres to accommodate additional processing and compression equipment for gas sales or for expanded gas cycling. Many of the support facilities for full-field production, such as camps, would not need to be duplicated or expanded. Depending on the alternative ultimately permitted and built, equipment modules likely would be delivered in the same fashion as for full-field development. If a barge offloading facility is built as part of the Point Thomson Project, then gas modules would be delivered via barge. If not, full-field development would rely on ice roads. (Even if an all season gravel access road is built, it would most likely not be able to accommodate large module transport.) Additional infrastructure could include the following:

- A new gravel mine or reuse of the proposed gravel mine would be needed to supply gravel for a Central Pad expansion.
- Additional wells would be drilled from the three existing pads. The optimum number or location of these wells would depend upon the specific development plan being pursued. The three pads proposed under the present development plan would accommodate up to 8 wells each, for a total of 24 wells, which should be sufficient to support identified options for full-field development. Therefore, expansion of the East or West Pad would likely not be required.
- Additional infield pipelines would be needed for gas sales and potentially for expanded cycling, and additional VSMs would need to be constructed to support natural gas pipelines. These additional infield

supports would be required unless the permitted action included the infield VSM/HSM configuration of Alternative E, which was developed to accommodate an additional future infield pipeline.

- An above-ground or buried natural gas export pipeline from the Point Thomson Project to Deadhorse would be needed.
- A gas treatment plant and export pipeline system or other export method from the North Slope would be needed. Such projects are listed in Table 4.2-2.

Full-field development has not been included as part of the proposed Point Thomson Project because of the number of uncertainties surrounding gas production at Point Thomson. The proposed project development, delineation, and evaluation activities would provide the necessary information about reservoir character, connectivity, and the nature, location, and viability for production of the hydrocarbon resources. The Applicant's proposed gas condensate project would prove the viability of long reach drilling technology given the geology and high pressures of the Point Thomson Reservoir, and the technical challenges associated with compressing, cycling, and producing the resources, all of which are important to future development decisions.

Commercial uncertainties remain to be resolved before full-field development could commence. Production of natural gas is dependent on a market for the gas and a way to get the gas to that market. The most promising possibility today is a gas pipeline from the North Slope; it remains uncertain whether or when such a pipeline would be constructed.

4.2.3.4 Speculative Actions Not Brought Forward for Analysis

Developments for which no solid proposal has been submitted or which seem unlikely to occur within the foreseeable future are considered speculative. These may include projects that are discussed in the public arena, but which are prohibited by law or for which there is no current proposal before an authorizing agency. Speculative developments are not considered reasonably foreseeable and are not analyzed as part of the cumulative effects assessment.

4.2.3.5 Cumulative Impact Issues to be Considered

Cumulative impact issues were identified during the NEPA scoping process. Comments on cumulative effects included requests to evaluate potential consequences outside of the immediate project area boundaries, including impacts to air, land, water, and wildlife resources, as well as the potential for increased development pressure on the Arctic National Wildlife Refuge (see Scoping Comments Report provided as Appendix E). Comments also concerned long-term effects due to increased greenhouse gas (**GHG**) emissions, and cumulative effects from other development projects in the area. Requests were made to develop mitigation measures that protect wildlife and habitat, address spill prevention and response, and wastewater management. Additional topics included light and air pollution, drilling, construction, and operations wastes, and subsistence and cultural values.

In their scoping comments, EPA Region 10 specifically recommended consulting the NRC report (2003a). In addition, EPA recommended that the EIS should:

- Identify the current condition of the resource as a measure of past impacts, e.g., the percentage of species habitat lost to date.
- Identify the trend in the condition of the resource as a measure of present impacts, e.g., is the health of the resource improving, declining, or in stasis?

- Identify the future condition of the resource based on an analysis of the cumulative impacts of reasonably foreseeable projects or actions added to existing conditions and current trends, e.g., what could the future condition of the watershed be?
- Assess the cumulative impacts contribution of the proposed alternatives to the long-term health of the resources, and provide a specific measure for the projected impact from the proposed alternatives.
- Disclose the parties that would be responsible for avoiding, minimizing, and mitigating those adverse impacts.
- Identify opportunities to avoid and minimize impacts, including working with other entities.

4.2.3.6 Sequence of Cumulative Impacts Analysis

In general, the analysis of cumulative impacts completed for this EIS follows the process recommended in Table 1-5 of the CEQ handbook (1997b). The steps taken in this analysis are listed below and address the EPA recommendations for approaching the cumulative impacts analysis which are presented above in Section 4.2. The first four steps are described within this section of Chapter 4. Steps 5 through 10 were implemented for each individual resource and can be found within the cumulative impact sections for each resource in Chapter 5.

1. Identify the significant cumulative effects issues associated with the proposed action and define assessment goals *(see Section 4.2.3.7, Cumulative Impact Issues to be Considered)*.
2. Establish the geographic scope for the analysis *(see see Section 4.2.3.2, Spatial or Geographic Scope of the Analysis, with modifications for individual resources as necessary)*.
3. Establish the time frame for the analysis *(see Section 4.2.3.2, Temporal Scope of Analysis)*.
4. Identify other actions affecting the resources, ecosystems, and human communities of concern *(see Section 4.2.3.4, Relevant Past, Present, and Reasonably Foreseeable Actions Considered in Cumulative Impacts Analysis)*.

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5. Characterize the resources, ecosystems, and human communities identified in scoping in terms of their response to change and capacity to withstand stress.
6. Characterize the stresses (impacts) affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds (as available).
7. Define a baseline condition for the resources, ecosystems, and human communities.

DESCRIBING THE AFFECTED ENVIRONMENT

8. Identify the direct and indirect impacts of the proposed action and alternatives on human activities and resources, ecosystems, and human communities. Identify potential effects of the past, present, and reasonably foreseeable actions (external actions) on the resources, ecosystems, and human communities within the geographical and temporal scopes defined for cumulative effects.

9. Screen the effects of the combination of direct and indirect project actions and external actions. If the project effects and external effects do not overlap within the defined temporal and geographic scope, then there would be no cumulative effect. Step 9 will be completed by summarizing the cumulative effects for each resource and determining whether or not the cumulative impacts are considered to be adverse.

DETERMINING THE ENVIRONMENTAL CONSEQUENCES

10. Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects.

11. Monitor cumulative effects of the selected alternative and adapt management.

MITIGATING CUMULATIVE IMPACTS

Key Assumptions

Assumptions are important when considering cumulative effects, as they set the framework for what is considered reasonable for analysis. Analysis of cumulative effects for the Point Thomson Project relied on the best available information regarding past, present, and RFFAs as described. In addition, the following key assumptions have been used for consideration of cumulative effects for each resource:

- Trans-boundary effects are possible for certain resources such as air quality and migrating wildlife and birds, but direct impacts in Canada will not be analyzed.
- While spatial and possibly temporal scopes are generally described above in Section 4.2.3.1, they will be adjusted as necessary for relevance to a given resource. For example, cumulative effects for certain resources such as vegetation and wetlands could be discussed within the footprint of the North Slope oil and gas fields, but effects to migratory birds and mammals could be considered over a wider area of use.

4.3 CLIMATE CHANGE

Global climate change refers to long-term fluctuations in temperature, precipitation, wind, and other elements of Earth's climate system. Natural processes such as variations in solar irradiance, cyclical changes in Earth's orbital parameters, ocean circulation changes, and volcanic activity can produce variations in climate. Changes in climate that have resulted from these processes have occurred throughout Earth's history and have individually or collectively influenced Earth's climate over periods as short as a decade or as long as millennia.

Recently there has been much discussion of the ways in which the earth's climate system may also be influenced by changes in the concentration of various gases in the atmosphere. Of particular interest are those gases that affect the Earth's absorption of solar radiation. These gases serve a natural function of trapping heat in the atmosphere, thereby regulating Earth's climate. The most common of these gases include water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O); the latter three are referred to collectively as GHGs.

Natural processes, such as respiration by plants or animals and seasonal cycles of plant growth and decay, continuously cycle GHGs between the atmospheric, oceanic, and terrestrial systems. Such processes generally do not alter average atmospheric GHG concentrations. Human activities, however, can increase the amount of these gases to be emitted or sequestered, thereby changing their atmospheric concentrations. Human activities that contribute to GHG emissions include burning of fossil fuels (e.g., coal, natural gas, oil), production of ***Portland cement***, land use changes (e.g., conversion of forests to agricultural land), generation of waste, and farming practices.

4.3.1 Legal and Regulatory Framework for Climate Change in NEPA Documents

Recent legal findings have led to regulatory actions by the EPA and the CEQ regarding GHG emissions, climate change, and the manner in which NEPA documents should address both issues. The resulting actions have pointed to the body of science (e.g., IPCC 2007, USGCRP 2009, NRC 2005) that suggests ***anthropogenic*** sources of GHGs have resulted in increased global average atmospheric concentrations and to observed global and regional temperature and climatic changes.

In a 2007 ruling (549 U.S. 497 2007) regarding tailpipe emissions from cars and trucks, which account for about one-fourth of the country's total GHG emissions, the Supreme Court found that CO_2 and other GHG emissions meet the CAA definition of air pollutants. The Supreme Court required the EPA to determine whether GHG emissions from new motor vehicles (the specific sector cited in the lawsuit) cause or contribute to air pollution, which may reasonably be anticipated to endanger public health or welfare.

Based on an extensive review of the existing body of scientific evidence (EPA 2009b) and considering public comments received, the EPA determined that GHG emissions are an endangerment to public health and welfare. On December 7, 2009, the EPA made the determination that the current and projected concentrations of the six key GHG emissions (CO_2, CH_4, N_2O, hydrofluorocarbons [HFCs], perfluorocarbons [PFCs], and sulfur hexafluoride [SF_6]) are an endangerment (74 FR 66496). This determination is a required step in the process leading to the regulation of GHG emissions under the CAA. The EPA also found that mobile sources of emissions, such as new motor vehicles and new motor engines cause or contribute to the GHG pollution that threatens public welfare and health. Moreover, in response to these scientific findings (e.g., IPCC 2007, USGCRP 2009) and as required by the CAA, the EPA has also acted to regulate GHGs as air pollutants for stationary sources, including oil and gas facilities.

In October 2009 the EPA issued a final rule for mandatory GHG reporting from large stationary GHG emission sources in the U.S. (74 FR 56260). The goal of the rule is to collect accurate and comprehensive emissions data to inform policy-maker decisions regarding GHGs, and potentially to assist in developing a ***cap and trade system*** to manage industrial emissions. The rule became effective on December 29, 2009 and applies to suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions. Facilities with emissions greater than this 25,000 metric ton threshold in calendar year 2010 or beyond, must monitor, record, and report the GHG emissions annually as of January 1, 2011. The rule covers 85 to 90 percent of U.S. emissions and applies to approximately 13,000 facilities.

The EPA subsequently finalized additional proposed GHG reporting rules in November 2010 (75 FR 74458). These rules cover three sectors that were excluded from the 2009 rule: petroleum and natural gas systems, CO_2 injection and geologic sequestration, and fluorinated GHGs. Among the industries covered by this rule are onshore and offshore petroleum and natural gas production, onshore natural gas processing, and natural gas transmission. This rule requires these industries to begin monitoring and reporting their GHG emissions on March 31, 2012.

In June 2010, the EPA promulgated the Prevention of Significant Deterioration (PSD) and Title V Greenhouse Gas Tailoring Rule (Tailoring Rule). The intent of this rule was to outline a two-part phasing-in of the applicability criteria for stationary sources, and modifications to existing sources, that would be subject to GHG permitting requirements under the CAA. Under the PSD program, all major stationary sources emitting more than 100 or 250 tons per year (tpy) of ***CO_2 equivalents*** (CO_2-e), depending on industry category, would be required to obtain permit limits for the GHG that they emit based on criteria pollutant thresholds for lead, sulfur dioxide, and nitrogen dioxide. However, the EPA determined these threshold levels are not appropriate for the six GHGs that are emitted at higher volumes, and that the large number of permits such thresholds would trigger would also pose an onerous burden to industry, states, and the EPA, and so the EPA implemented the Tailoring Rule.

Generally, Step One of the Tailoring Rule's implementation time line required sources that are newly constructed or modified (in the first half of 2011) in a way that significantly increases emissions of a pollutant other than GHGs to be subject to GHG permitting requirements for their emissions. For these projects, only GHG increases of 75,000 tpy or more of total GHG, on a CO_2-e basis, would need to determine the Best Available Control Technology (BACT) for their GHG emissions. Step Two, covering the period July 1, 2011, to June 30, 2013, requires all new large sources (those that will emit or be capable of emitting 100,000 tpy of CO_2-e) to be subject to PSD and Title V permit requirements for GHGs. Additionally, modifications at existing facilities that increase their GHG emissions by at least 75,000 tpy will be subject to permitting requirements, even if they do not significantly increase emissions of any other pollutant.

Increasingly, the consideration of a proposed project's potential GHG emissions and the potential effects of climate change on those projects have been incorporated into NEPA reviews of proposed federal actions. However, federal agencies have had limited guidance or policies regarding the applicability or methodology for such analyses. On February 8, 2010, the CEQ released a draft guidance memorandum to provide guidance to federal agencies on their treatment of GHG emissions and climate change impact issues within the NEPA process (CEQ 2010). The guidance memorandum addresses two related issues: the treatment of GHG emissions that may directly or indirectly result from a proposed federal action, such as the permitting of a project; and the analysis of potential climate change impacts on a proposed federal action.

Within the guidance memorandum, the threshold of 25,000 metric tpy of CO_2-e GHG emissions is suggested as a "useful, presumptive, threshold for discussion and disclosure…because it has been used and proposed in rule-makings under the Clean Air Act." This guidance, once finalized, would apply to all federal agency actions requiring NEPA review, except federal land and resource management activities

4.3.2 Appropriateness of Climate Change Analysis for the Point Thomson Project

The CEQ draft NEPA guidance memorandum will serve as the primary guidance for this EIS's consideration of climate change. Specifically, the guidance recommends consideration of:

- The GHG emissions effects of a proposed action and alternative actions
- The relationship of climate change effects to a proposed action or alternatives in terms of:
  - Proposal design
  - Environmental impacts

- Mitigation
- Adaptation measures

As noted by the CEQ, because climate change can affect the environment in a variety of ways, the nature of the proposed action and its relationship to climate change must be considered to determine if a detailed analysis is warranted in the EIS. Because the proposed action for the Point Thomson Project would result in emissions from power generation that would exceed 25,000 metric tpy (see Section 4.3.2.1), and because the project area is in the Arctic, an area in which climate change effects are currently being observed (see Section 4.3.2.2), an analysis of climate change effects is warranted in the Point Thomson Project EIS under the CEQ guidance.

4.3.2.1 Greenhouse Gas Emissions Effects

The GHG emissions effects of the proposed action and action alternatives are those climate change effects occurring from the direct production of GHG emissions. Direct emissions can be calculated from the activities occurring at the site, and those occurring offsite but related to the action. For the proposed action these include production of GHG emissions through combustion of petroleum-based fuels to provide energy for the following activities at the Point Thomson site:

- Drilling operations to extract gas and possibly hydrocarbon liquids.
- Industrial processes at the CPF to separate natural gas, water, and condensate, to recover 10,000 bpd of condensate, and compress and reinject approximately 200 million cubic feet per day of natural gas.
- Construction and operations of a remote oil and gas facility, including temporary construction and permanent camps; offices, warehouses, shops, and electric power generating distribution facilities; treatment systems for drinking water and wastewater; a grind and inject module; waste management facilities; and communications facilities.
- Transportation of people and supplies via a gravel airstrip, gravel road, and/or barge.
- Development and operation of a gravel mine to support construction.

The proposed action would require approximately 29,000 kilowatts of energy (ExxonMobil 2010a). Energy would be created onsite through the combustion of petroleum-based fuels, which have been estimated to create approximately 238,000 metric tpy of CO_2-e from stationary sources during operations. This level of CO_2-e emissions is subject to GHG accounting requirements under CAA mandatory GHG emission reporting rules (74 FR 56260) based on the final rulemaking for petroleum and natural gas systems (75 FR 74458), and is subject to GHG permitting under the CAA Tailoring Rule.

4.3.2.2 Relationship of Climate Change Effects

The proposed action must be evaluated in the context of global climate change because in addition to producing GHGs, it would also be an activity affected by climate change. The proposed action would be located in the Arctic, a biome where effects from climate change are currently being observed. A 2004 findings overview report (ACIA 2004) and subsequent scientific report (ACIA 2005) were published by the Arctic Council and the International Arctic Science Committee. These reports focus on the particular vulnerabilities of the Arctic, where the average atmospheric temperature has risen at almost twice the rate as the rest of the world in the past few decades. Climate warming is occurring faster in the Arctic than in lower latitudes due to the unique physical and atmospheric characteristics not present in lower regions of the world (such as in the tropics).

The report findings for the Arctic Sub Region III, an area that includes Alaska, Chukotka, Western Canadian Arctic, and adjacent seas, notes some of the consequences of climate change effects being experienced in this region (ACIA 2004). Potential effects on Alaska's arctic environment could include increases in sea level, snow cover and storm activity, accelerated coastal erosion, permafrost thaw, hydrological changes and flooding, and vegetation and wildlife changes (ACIA 2005). The consequences of these changes could include alterations in the biological diversity and resiliency of arctic ecosystems; damage to infrastructure due to permafrost thawing, coastal erosion, and hydrologic events; and disruption to the social and economic lifestyle of communities (ACIA 2005). The environmental consequences of climate change are briefly summarized below and discussed in greater detail, as applicable by resource, in sections of Chapter 5.

4.3.3 Determining Greenhouse Gas Emissions of the Proposed Project

The EPA GHG Reporting Rule currently states that all entities that emit more than 25,000 tons of CO_2-e per year of direct emissions submit annual reports of GHG emissions to the EPA, beginning in 2011 for calendar year 2010. For petroleum and natural gas systems, the EPA has provided initial guidance on emissions calculations methodologies: direct measurement of emissions is only required for the most significant emissions sources, and engineering estimates, emission modeling software, and emission factors can be used as appropriate for other sources (75 FR 74458).

4.3.3.1 Determining the Greenhouse Gas Inventory Boundary

To obtain a comprehensive and meaningful inventory of emissions from appropriate GHG emission sources and activities, it is important to determine the inventory boundary, which is a two-step process. The initial boundary is determined by the organization, or owner, that controls the source. After the organizational boundary has been determined, the next step is defining the operational boundaries: creating a list of activities for a particular project, identifying which activities generate emissions, categorizing those emissions as direct and indirect, and defining the scope of accounting and reporting for indirect emissions (GHG Protocol).

The EPA organizes GHG emission sources into scopes according to the type of impact, direct or indirect, of the emissions within the organizational boundary:

- Scope 1: Direct GHG emissions from sources that are owned or controlled by the reporting entity. This can include emissions from fossil fuels burned on site, emissions from agency-owned or agency-leased vehicles, and other direct sources.
- Scope 2: Indirect GHG emissions resulting from the generation of electricity, heat, or steam generated offsite but purchased by the reporting agency.
- Scope 3: Indirect GHG emissions from sources not owned or directly controlled by the reporting agency but related to the agency's activities such as vendor supply chains, delivery services, outsourced activities, production of construction materials, and employee travel and commuting.

Once the inventory boundary and the GHG emissions sources that will be included in the inventory have been determined, the next step is to collect data and emissions factors. Emission factors for most sources can be found in units of CO_2 or converted to CO_2-e. Total emissions are then determined by multiplying activity data by the emissions factor for each source. The following section describes the sources of direct emissions to be included in the inventory boundary for the proposed Point Thomson Project.

4.3.3.2 GHG Emissions Associated with the Proposed Action and Alternatives

The EPA does not currently require reporting of Scope 2 or Scope 3 emissions; consequently, only Scope 1 emissions were calculated for the analysis in this EIS. Preliminary GHG emissions were estimated from the project's direct sources and included emissions of CO_2, CH_4, and N_2O resulting from combustion of fuel gas, diesel, and municipal solid waste by stationary and mobile (on-road and nonroad) equipment associated with the construction and operations phases of the proposed project. Methane emissions from natural gas extraction and natural gas liquids processing were negligible because the process occurs in a closed system. GHGs associated with produced condensate and oil are not accounted for as part of project GHG calculations because they would be included as part of end-product Scope 1 emissions accounting (e.g., emissions from automobile transportation, manufacturing, power generation).

The methods for estimating GHG emissions from fuel combustion sources were applied in accordance with the guidance provided in Subpart C of the EPA GHG Reporting Rule for Tier 1 units. The CO_2, CH_4, and N_2O emission estimates were calculated for all stationary and mobile equipment on an individual basis using Equation C-1 from 40 CFR 98. The per-equipment volume of fuel combusted was determined by assuming continuous operation at the equipment's maximum capacity, or according to any federally enforceable restrictions limiting the unit's annual operation.

During operations, a total of approximately 302,000 metric tons of CO_2-e would be emitted annually, including nonroad engine sources. Of this total 238,000 tons of CO_2-e would be emitted annually from stationary sources (Appendix D, RFI 111). Total annual CO_2-e emissions during construction would be similar, but would vary slightly depending on the year.

4.3.4 Potential Primary Drivers of Climate Change Impacts in the Arctic

As previously noted, the impacts of global climate change are already manifesting themselves within the Arctic. Discussion of potential impacts resulting from climate change are summarized in this EIS from a variety of sources, depending on resource, but the two primary references for discussion of climate change are the Arctic Climate Impact Assessment (ACIA 2005) and the Intergovernmental Panel on Climate Change (IPCC) Fourth Annual Report (2007).

Atmospheric-ocean global climate models (AOGCMs) suggest that two parameters of climate change could drive impacts to the proposed project alternatives or resources within the project area: an increase in surface air temperature and sea level rise. These two components will be addressed in the sections below, and then referred to as they relate to the individual resources and proposed action and alternatives that are discussed in detail in resource sections of Chapter 5.

4.3.4.1 Surface Air Temperature Changes

The primary environmental variable addressed in this discussion of climate change is mean annual air temperature. This section will introduce and discuss the primary tools (namely AOGCMs) and inputs used to determine future long-range climate. Much of the information for this discussion is derived from the 2005 ACIA produced by the ACIA Secretariat and the Cooperative Institute for Arctic Research (CIFAR) located at the University of Alaska Fairbanks. This particular assessment of future changes in climate is derived largely from AOGCM output that was used as part of the IPCC report produced in 2001. The IPCC has a more recent global report issued in 2007; however, the 2005 ACIA report is exclusively focused on the Arctic with input from scientific experts on Arctic environmental conditions and biological systems. With this regional-specific focus in mind, the 2005 ACIA document was chosen as the primary reference for this EIS, with respect to potential climate change and related variables and impacts.

Observed temperature trends in the Arctic have been increasing over the observed period of record for the region, approximately 100 years. The ACIA document recognized that there is a limited dataset of reliable long-term observations, given the sparsely inhabited expanse of the Arctic. Recognizing the limited dataset available, an analysis was performed with annual mean observed temperatures in Barrow, Alaska for concurrent periods where temperature trends were analyzed (as a proxy for North Slope or near-coastal conditions). For the period between 1966 and 2003, as selected in the ACIA document, the observed warming of the Arctic (60° to 90° N) was 0.7°F per decade: a 1.2°F per decade increase at Barrow, and an approximately 1.8° to 3.6°F per decade increase over the Arctic regions of northwestern North America. A brief seasonal comparison of Barrow temperature data for the period between 1950 and 2009 indicates that winter warming (December to February: 1°F per decade) is occurring at twice the rate of warming during the summer (June to August: 0.5°F per decade). This result is consistent with broader analyses of Arctic climate observations cited in the ACIA report.

To model potential future changes in surface air temperature, the ACIA report selected a set of five AOGCM output scenarios, with two separate long-range GHG emission scenarios, each to assess the magnitude and range of potential climate changes in the Arctic out to the year 2100. The AOGCM output assessment indicates continued increases in surface annual average temperatures for a set of projected periods (2011 to 2030, 2041 to 2060, and 2071 to 2100). The rate of change for the first two periods are virtually at the same rate as recent observed warming over the Arctic (0.7°F per decade) for both emission scenarios. This rate of warming remains constant (0.7°F per decade) for the lower of the two emissions scenarios (termed B2) through 2100 for a mean air temperature of about 7°F above 1981-to-2000 average values. Output from the higher GHG emissions scenario (termed A2) indicates warming accelerated by approximately 3.6°F over the B2 scenario in the last 40 to 50 years of the 21st century. The models indicate that, as has been observed, the increase in average temperature would be greater in autumn and winter than in spring and summer. The projected trend over the North Slope of Alaska is similar to these overall projected trends with more of the net warming trend projected for the fall-to-spring period. The ACIA-preferred AOGCM output also projects precipitation increases over the 21st century in the Arctic, and the North Slope in general. The seasonal distribution of the projected increase predicts increases in summer and winter precipitation in the period from 2011 to 2060, after which wintertime increases are projected to be more dominant.

These AOGCM models considered the Arctic as a whole, and at publication of the 2005 ACIA report there was no “downscaled” modeling to specific regions of the Arctic, such as Alaska or the North Slope. Downscaling the broad-range projections of a globally-scaled model to a regional scale is challenging because of the nuances of the processes being modeled, such as development or melting of sea ice, snow or rainfall, and surface snow cover. There is greater confidence in the AOGCM model data for the extent of general warming projected over Alaska over and near the Arctic Ocean. That projection might be extrapolated to nearshore locations such as the North Slope, recognizing increasing uncertainty as projections are extrapolated further inland.

Despite the long-term, widespread increase in surface temperatures projected by AOGCM projections, it is not yet possible to isolate the impact of those changes to the local, coastal environment in the project area. The ACIA acknowledged that climate change manifests differently in various regions of the Arctic, depending on the suite of processes at work in that region, such as naturally-occurring, cyclical influences of climate variability including the Arctic Oscillation (AO), the Pacific Decadal Oscillation (PDO), and the North Atlantic Oscillation (NAO). While in the last century there have been multidecadal periods of large-scale cooling and warming (ACIA 2005) occurring within the overall trend of increasing Arctic temperatures, additional research will be required to better understand and predict temperature changes within the context of cyclical phenomena, for specific regions of the Arctic.

4.3.4.2 Sea Level Rise

Sea level rise due to climate change has been of worldwide concern, particularly to island and coastal nations. It is natural to presume that sea level rise would be the climate change effect of greatest concern in the Arctic, much of which is at or slightly above current sea level. However, while other effects of climate change have been observed, the limited data available on sea level rise in the Arctic cannot support a determination of whether sea level has been increasing or decreasing due to climate change.

Proshutinsky et al. (2001) analyzed records collected over 40 years at 60 tide gauges along the Russian arctic coast and observed an average upward trend of 0.07 inches per year from the 1950s to the 1990s, which increased to 0.23 inches per year from the 1970s to the 1980s. Proshutinsky et al. (2004) further analyzed several climatic effects (e.g., salinity, barometric pressure, wind) that contribute to changes in sea level, and they demonstrated that sea level rise in the Arctic may be more a net result of many individual effects of environmental forcing than itself a direct indicator of climate change in the Arctic. They concluded that, because some effects of environmental forcing may offset effects of others, “the cause of the sea level response to climate change remains somewhat uncertain.”

On the North American side of the Arctic Ocean, tide gauge records are few and far between. Sultan et al. (2010) analyzed the 17-year record from the Prudhoe Bay tide gauge, which was established in 1993. With all the admitted limitations of such a short record, they determined a small upward trend of 9.1 inches per 100 years but which, with a 95-percent confidence interval of ± 10.2 inches per 100 years, could not be regarded as statistically significant.

Manson and Solomon (2007) analyzed hourly water levels obtained at the Tuktoyaktuk tide gauge between 1961 and 1997. While they report that, overall, approximately 45 percent of the data for the entire period are missing or spurious, they found that the record was most complete and accurate during the open-water seasons on which they focused their analysis. Their linear regression of the monthly mean water levels for months with more than 90 percent complete data indicated that a relative sea level upward trend of 13.8 (± 4.3) inches per 100 years (95 percent confidence interval) had occurred at Tuktoyaktuk from 1961 to 1997.

The Tuktoyaktuk tide gauge was re-established in 2003 after an apparent 16-year hiatus. Sultan et al. (2010) analyzed the entire data record, 1961 to 2010, and determined a statistically-significant sea level rising trend of 9.8 (± 3.5) inches per 100 years, while acknowledging the complicating factors resulting from large gaps in the water level time series. For the 7-year period, 2003 to 2010, since the tide gauge was re-established, Sultan et al. (2010) found a downward sea level trend of 47.2 (±51.2) inches per 100 years which cannot be regarded as statistically significant.

The 1961-to-1997 portion of the Tuktoyaktuk water level record suggests a net sea level rise during that period. However, the substantial data gap between 1997 and 2003, as well as possible uncertainties about the tidal datum used for the two periods, provide ample reason for skepticism about an analysis based on the entire 1961-to-2010 record. While the analyses for the shorter records from Tuktoyaktuk (2003 to 2010) and Prudhoe Bay (1993 to 2010) both suggest a negative trend in sea level, neither is statistically significant so it cannot be concluded that there is either a positive or negative sea level trend for the Beaufort Sea in the Point Thomson Project area. The difference between the rate of sea level rise worldwide and in the Arctic may be explained by the drivers of that rise. Thermal expansion of warming ocean waters is primarily responsible for the observed global sea level rise of approximately 3.9 inches during the last century. In the Arctic, because colder seawater expands minimally in response to warming, sea level would likely have a minor response to increasing atmospheric temperatures. Rather, influences from the Atlantic and Pacific Oceans (e.g., warmer surface currents from the Pacific through the Bering Straight, changes in salinity from increased freshwater inputs), among other potentially-influential processes, may be a greater driver than atmospheric temperature (ACIA 2005).

Quantifying sea level rise for a specific region of the globe is extremely complicated, particularly so in the Arctic. ACIA (2005) provides guidance for sea level rise derived from a compilation of studies of global sea level rise and Arctic-specific differences due to influences such as changes in salinity, ***post-glacial rebound***, thermal expansion, and amount and longevity of sea ice. The AOGCMs referenced in the ACIA (2005) report reflect a wide level of variability and uncertainty across AOGCMs. The ACIA projections, while acknowledging the uncertainty inherent in attempting to model dynamic and incompletely-understood processes, indicate a 2-inch rise by 2020, 6 inches by 2050 and 10 inches by 2080, which is within the cited ranges of AOGCMs used. These projected rises in sea level will be used in this Final EIS as a basis for potential impacts from sea level rise.

4.3.5 Resources Affected by Climate Change, the Proposed Action, and Alternatives

This Final EIS analyzed resources affected by climate change that were identified through public and agency scoping and recent scientific literature. The existing effects resulting from climate change and the reasonably foreseeable climate change impacts to these resources are presented briefly below. More detailed discussion of existing and potential effects of climate change are discussed in Chapter 5 under the various resources. For each of the alternatives, climate change will be addressed as a reasonably foreseeable future effect, where applicable.

4.3.5.1 Water Resources

Water resource impacts from warming temperatures in the project area could include increases in snow pack, coastal erosion, reduction in closed-basin freshwater lakes, loss of wetlands, and increase in coastal storms. Specific water resources to be evaluated with regard to the proposed project and climate change effects include:

- Physical Oceanography and Coastal Processes (Section 5.5)
- Hydrology (Section 5.6)
- Water Quality (Section 5.7)

4.3.5.2 Ecosystems

Thawing permafrost and changes in snow cover, sea ice thickness, and sea ice extent would potentially affect a variety of ecosystems in the project area. Climate change may alter the distribution or abundance of terrestrial and marine primary producers (e.g., lichen, plants, and phytoplankton) or useable habitat (e.g., reduced sea ice extent, reduced terrestrial winter foraging grounds). These changes could result in species displacement or eventual extinction, depending on a species’ resiliency to habitat alteration. Specific ecosystem resources to be evaluated with regard to the proposed project and climate change effects include:

- Soils (Section 5.2)
- Vegetation and Wetlands (Section 5.8)

- Birds (Section 5.9)
- Terrestrial Mammals (Section 5.10)
- Marine Mammals (Section 5.11)
- Fish, EFH and Invertebrates (Section 5.12)
- Threatened and endangered species within the bird, marine mammal, and terrestrial mammal sections

4.3.5.3 Society

Many communities, seasonal hunting and fishing camps, and oil and gas infrastructure are located along the Arctic coastline and as such are particularly vulnerable to climate change. Increased wave run-up due to a reduction in coastal sea ice may accelerate erosion and increase flooding risks to coastal communities and structures. Warmer temperatures also threaten traditional lifestyles in Alaska Native communities. Livelihoods and subsistence living may be impacted by reduction in the availability and accessibility of traditional food sources. Because the majority of North Slope residents are Alaska Natives, there could be disproportionate impacts to economically disadvantaged and minority groups.

Atmospheric warming has also resulted in a shorter cold season, impacting the oil and natural gas industries on the North Slope. A shortening of the winter ice road season could impact oil and gas exploration and extraction activities. Thawing of permafrost could also increase the cost of maintaining infrastructure such as pipelines and gravel roads and pads. However, longer periods of warm temperatures have allowed for longer ocean transport and recreation seasons.

Specific social conditions and resources to be evaluated with regard to the proposed project and climate change effects include:

- Land Ownership, Use, and Management (Section 5.13)
- Socioeconomics (Section 5.15)
- Environmental Justice (Section 5.16)
- Recreation (Section 5.18)
- Cultural Resources (Section 5.21)
- Subsistence and Traditional Land Use Patterns (Section 5.22)

4.3.5.4 Weather and Atmosphere

Over the past 4 decades the Arctic has experienced a nearly 3°F increase in average temperature (ACIA 2005). Climate models project that the Arctic temperatures will increase from average temperatures of 2010 by approximately 4.5°F before the end of the 21st century, and that precipitation in the area of the Beaufort Sea will increase by about 10 percent over a similar time period (ACIA 2005). Specific weather and atmospheric resources to be evaluated with regard to the proposed project and climate change effects include:

- Meteorology and Climate (Section 5.3)
- Air Quality (Section 5.4)

4.3.5.5 Transportation

Thawing permafrost, increased precipitation, and accelerated coastal erosion could increase the risk of temporary or permanent damage and closure of roads, airports, and other transportation infrastructure in the

Arctic. The ice road season will likely be reduced in the area, but reduction in sea ice could lengthen the ocean transport season. Specific transportation resources that could be affected with regard to the proposed project and climate change include roadways, bridges, airport infrastructure, and ocean transport and will be discussed in Section 5.17, Transportation.

4.3.5.6 Public Health

A warming Arctic could increase mental and social stress of the local indigenous populations resulting from changes in lifestyle as their environment changes. Health risks could increase as a result of bacterial and viral proliferation and vector-borne disease outbreaks, and due to changes from traditional diets to more western foods if local subsistence resource availability changes (ACIA 2005). Public health effects with regard to the proposed project and climate change will be discussed in Section 5.23, Human Health.

4.4 IMPACT AVOIDANCE, MINIMIZATION, AND MITIGATION

This section references applicable guidance, defines terminology, describes the process of identifying mitigation during the NEPA and permitting processes, and identifies measures committed to by the Applicant intended to avoid or minimize impacts. Further discussion regarding resource-specific mitigation components is provided in Chapter 5.

4.4.1 Guidance

NEPA requires federal agencies to describe alternatives' potential impacts to resources. Because one of the purposes of NEPA is to promote efforts that will prevent or minimize damage to the environment (42 USC Section 4321), mitigation and monitoring are important tools used to avoid, minimize, or compensate for potential adverse impacts. Early consideration of measures to avoid and reduce impacts is often integral to project design, and the effort to avoid, reduce, or offset impacts is a key component to the alternative development and decision-making process. Many federal agencies, laws, and regulations have specific guidance regarding required efforts to reduce impacts to resources, and the CEQ requires mitigation to be considered during the NEPA process. According to the CEQ (1981):

> *"Mitigation measures discussed in an EIS must cover the range of impacts of the proposal. The measures must include such things as design alternatives that would decrease pollution emissions, construction impacts, esthetic intrusion, as well as relocation assistance, possible land use controls that could be enacted, and other possible efforts. Mitigation measures must be considered even for impacts that by themselves would not be considered "significant." Once the proposal itself is considered as a whole to have significant effects, all of its specific effects on the environment (whether or not "significant") must be considered, and mitigation measures must be developed where it is feasible to do so. "*

CEQ regulations describe several ways an agency can use mitigation to reduce environmental impacts associated with proposed projects (CEQ 2011). These include:

- *Avoiding an impact by not taking a certain action or parts of an action;*
- *Minimizing an impact by limiting the degree or magnitude of the action and its implementation;*

- *Rectifying an impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating an impact over time, through preservation and maintenance operations during the life of the action; and*
- *Compensating for an impact by replacing or providing substitute resources or environments.*

33 CFR 325.4 (a) describes the Corps' mitigation requirements:

> *"District engineers will add special conditions to Department of the Army permits when such conditions are necessary to satisfy legal requirements or to otherwise satisfy the public interest requirement. Permit conditions will be directly related to the impacts of the proposal, appropriate to the scope and degree of those impacts, and reasonably enforceable."*

On January 14, 2011, the CEQ issued a memorandum to federal departments and agencies containing guidance on establishing, implementing, and monitoring mitigation commitments identified and analyzed in Environmental Assessments and EISs, and adopted in the final decision documents. It also clarified the use of mitigated "Findings of No Significant Impact," which is relevant to Environmental Assessments but not EISs. The Point Thomson Project EIS is compliant with federal guidance by considering mitigation during alternative development and by disclosing mitigation as components incorporated into project design, construction, and operations as efforts to avoid and minimize potential impacts.

4.4.2 Definitions and Process

Mitigation is considered by the Corps in three ways during the NEPA process: (1) impact avoidance, (2) minimization measures, and (3) resource-specific mitigation measures to compensate for unavoidable impacts.

Measures to avoid and/or minimize impacts to resources that are identified in this EIS include:

- Efforts made by the Applicant as part of the project design or as standard procedures during operation;
- Best Management Practices (BMPs), industry standards, or standard permit requirements;
- Alternatives (described in Chapter 2) or modifications to the Applicant's proposed project;
- Additional measures being considered by the Corps that further reduce, offset, or compensate for impacts; and
- Monitoring to ensure that mitigation is being performed and is achieving the expected results or monitoring for adaptive management.

Avoidance and minimization measures that the Applicant has committed to in its Environmental Mitigation Report are identified in this EIS as Design Measures. These design measures are included in Table 4.4-1 below and in Appendix A, Final 404/10 Permit Application.

Various alternatives to the Applicant's proposed project are discussed in Chapter 2. The Corps will further assess these alternatives (including the Applicant's proposed project) and their components during the Section 404/10 permit application review process to determine the LEDPA.

Resource-specific measures being considered by the Corps as conditions of the permit include additional measures to further reduce or avoid impacts (referred to in this EIS as Mitigation Measures) and measures that are intended to offset or compensate for unavoidable adverse impacts (referred to as Compensatory Mitigation). Compensatory mitigation is only applicable to unavoidable impacts after avoidance and minimization efforts have been made. Mitigation measures were developed after considering public and agency comments on the Draft EIS and are detailed in Table 4.4-2, below. Applicable design measures and mitigation measures are also described under "Mitigative Measures" within each resource section in Chapter 5 of this EIS.

The review process for the Department of the Army Permit (Section 404/10) is done concurrently with the NEPA review process. The final permit application for the Point Thomson Project is provided in Appendix A of this EIS, and includes the Applicant's Statement of Mitigation and their Environmental Mitigation Report. The Corps' determination under the Section 404(b)(1) Guidelines will rely on information presented in this EIS. Under the Section 404(b)(1) Guidelines, the Corps has a formal process and requirements that must be met, including identification of the LEDPA and practicable and appropriate mitigation. In determining which mitigation measures are practicable and necessary for the Section 404(b)(1) analysis and ROD, the Corps will include, but not be limited to, consideration of the potential mitigation measures presented in Table 4.4-2.

Other resource agencies were asked, as part of the NEPA process, to comment on and/or propose additional design and mitigation measures pertinent to their permitting or authorization processes. The Corps' regulatory authority encompasses waters of the U.S. and aquatic resources; however, the Corps permit would also include conditions necessary to comply with other federal laws (e.g., ESA, MMPA, and NHPA) and requirements imposed by conditions on state Section 401 water quality certifications.

Following publication of the Final EIS, the Corps will prepare the ROD, which will be the formal Corps decision on whether or not to issue the requested permit. If the Corps determines it will issue the permit, the ROD will also identify the conditions, including all required mitigation. The ROD will include appropriate Applicant-proposed design measures, and any additional mitigation measures considered by the Corps and other agencies with permitting authority, and agreed to by the Corps. The final measures included in the ROD will then be considered part of the project by the Corps during its permitting process.

4.4.3 Design Measures Proposed by the Applicant

The NEPA document serves to inform the public and review agencies of design measures, or project elements that are included to reduce or avoid impacts. The Corps views these elements as part of the project, and considers Applicant-proposed design measures as inherent to the Applicant's proposed project description (Alternative B) as well as applicable components of the other alternatives' descriptions. These measures become an inseparable part of the alternative description and are considered part of the alternative during the NEPA impact analysis and decision-making process.

The Applicant's design measures for the Point Thomson Project were submitted in its Environmental Mitigation Report. Table 4.4-1 below presents the Corps' inventory of design measures proposed by the Applicant as initial mitigation for potential impacts associated with their proposed project. These measures are described further in Chapter 5 under each applicable impact assessment topic. Measures from a number of categories in the table below may be applicable to a resource topic in Chapter 5. For example, certain design measures listed below under Wetlands, Hydrology, and Terrestrial Mammals may all avoid or reduce potential impacts to terrestrial mammals; therefore, in Chapter 5, measures from all these categories would be described in the Mitigative Measures section related to terrestrial mammals.

Table 4.4-1: Applicant's Proposed Design Measures to Avoid or Minimize Impacts
Permafrost
Placing a minimum of 5 feet of gravel fill.
Elevating heated buildings or structures on pilings.
Elevating off-pad pipelines containing warm (above freezing) fluids on VSMs.
Minimizing or avoiding impoundments by maintaining natural drainage.
Installing thermosyphons around wells to remove unavoidable heat transfer from wellbore fluids. Additionally, conductor piles will be insulated and the well annuli filled with an insulating gel to minimize heat transfer to the permafrost.
Implementing operating procedures and maintenance programs to ensure the design measures remain in effect throughout the life of the project.
Wetlands and Other Waters of the U.S.
Minimizing gravel fill by utilizing three existing gravel pads in the area to the greatest extent possible, thereby reducing overall new tundra footprint by more than 20 acres.
Minimizing the size of the gravel pads through optimizing project design and equipment layout.
Using a temporary barge-bridge system to avoid placement of fill for a module offloading causeway/dock.
Limiting module weights and barge loads, which eliminates the need to dredge an access channel for docking sealift barge, with associated offshore disposal of dredged materials.
Designing pads, roads, bridges, and culverts to maintain natural drainage patterns and streamflows to the extent possible.
Routing the infield gravel roads to minimize overall length and footprint, with consideration for hydrologic impacts and project needs.
Combining the East Pad Road with the Central Pad Road, minimizing hydrology impacts without increasing the tundra footprint.
Routing the West Pad Road to avoid coastal marshes and estuarine habitat, while minimizing the wetlands footprint and hydrologic impacts.
Utilizing ice roads and pads for project access, pipeline construction, and temporary storage of mine site overburden.
Watering gravel roads and pads, as necessary, to control dust generation.
Requiring strict guidelines for travel on ice roads to avoid tundra damage, including ice road training, establishing speed and weight limits, and installing delineators along both sides of the road.
Hydrology
Routing the infield gravel roads to minimize overall length and footprint, with consideration for hydrologic impacts and project needs.
Conducting field surveys during breakup and other times to identify natural drainage patterns and to measure streamflows at proposed road crossings.
Routing infield roads a sufficient distance inland to avoid major stream crossings.
Balancing the avoidance of lakes, ponds, and wetter tundra areas closest to the coast with avoidance of areas further inland where unconcentrated overland flow predominates.
Routing the export pipeline and gathering lines to avoid locating VSMs in lakes, and crossing streams at locations that minimize the need for VSMs in active channels.
Designing bridges and culverts at stream crossings for a 50-year flood design flow to reduce impacts to natural drainage to the extent practicable.
Amending design to lengthen the bridge at Stream 24B to accommodate intercepted sheet flow.
Installing cross-drainage culverts at approximately 500-foot intervals along the road system to maintain overland flow.
Inspecting all culverts periodically, removing debris as needed, and evaluating effectiveness of culvert network during spring breakup to determine whether additional cross-drainage culverts are needed to avoid water impoundment.

Table 4.4-1: Applicant's Proposed Design Measures to Avoid or Minimize Impacts
Using a sheet pile design for bridge abutments to minimize the tundra footprint, road embankment erosion, and stream scour.
Slotting ice roads at designated stream crossings to facilitate drainage during breakup.
Managing water withdrawal to protect water bodies, fish habitat, and the surrounding environment. These measures have been developed to address requirements of ADNR and ADF&G water use permits and avoid adverse impacts to water resources: • Monitoring water withdrawal volumes: A log will be kept to track water volume by source. When the withdrawal volume approaches 90 percent of the permitted water volume, use of the source will be stopped as a contingency to ensure appropriate water volumes remain. • Tracking: A water use preplanning chart will be used to identify water withdrawal lakes and locations for use in ice road construction. This assists in confirming there is enough water in strategic locations to support construction activity. A dispersing log will be kept in the field to track water sources and use information, including coordination with other water users, to ensure water withdrawal limitations are met. • Monitoring water body recharge, as needed or directed, by ADNR and/or ADF&G in the future.
Water Quality: Freshwater
Reducing surface discharge of wastewaters through use of a disposal well, including zero discharge of produced water and drilling wastes.
Managing snowmelt and runoff under site-specific Stormwater Pollution Prevention Plans (SWPPPs) to protect water quality.
Designing storage and transfer locations for fuels and other fluids with appropriate secondary containment systems and site-specific procedures (e.g., drip pans/duck ponds and pads underneath equipment).
Implementing various BMPs, such as the Drips and Drops Program, for road and pad maintenance (e.g., vehicle inspections).
Slotting ice roads at designated drainage paths to reduce the potential for erosion and sedimentation during breakup.
Implementing dust control measures for roads and construction areas to avoid impacts of dust on nearby water bodies.
Designing bridges and culverts to maintain existing surface drainage patterns and prevent erosion.
Water Quality: Marine Water
Optimizing module weight to eliminate the need to dredge a channel for barge access.
Constructing a permanent service pier on piles, not fill, for offloading coastal barges to reduce the number of barge trips and minimize disturbance to the ocean bottom and associated impacts to marine water quality.
Installing mooring dolphins and pilings through the ice in the winter to minimize potential suspended sediment effects on water quality.
Dredging the barge landing area through the ice during the winter preceding an open water sealift to minimize sedimentation effects on water quality.
Limiting summer dredging/screeding to the minimum amount needed to maintain the appropriate seabed profile for barge landing.
Using a temporary barge-bridge system to eliminate a solid fill causeway/dock and minimize effects on the ocean bottom, littoral drift, and marine water quality.
Physical Oceanography and Coastal Processes
Using long-range directional drilling to develop offshore resources without placing drilling structures in marine waters.
Using a barge-bridge system for module offloading to eliminate the need for a solid fill causeway/dock.
Limiting dredging/screeding for the barge-bridge system and service pier to a small area in the vicinity of the Central Pad.
Limiting structures in marine waters to six vertical piles for the service pier, eight mooring dolphins for barge landings, and a small boat launch at the shoreline.
Locating the sealift bulkhead and approach gravel ramp for the service pier above MHW to minimize the effect on sediment transport or deposition.
Maintaining the barge-bridge system in place for the minimum time period needed to offload the modules (estimated 2 to 4 weeks) each sealift open water season, which limits the effects on coastal sediment transport.

Table 4.4-1: Applicant's Proposed Design Measures to Avoid or Minimize Impacts
Locating East (new part) and West Pads sufficiently back from the coast to avoid impacts from coastal erosion, storm surge, and ice ride-up for the life of the project.
Providing slope protection for the Central Pad to protect against storm surge and wave run-up events.
Terrestrial Mammals
Elevating pipelines to provide a minimum clearance of 7 feet from the tundra for unimpeded wildlife movements.
Conducting on-tundra gravel placement activities primarily during the winter to reduce the impact on wildlife.
Constructing infield gravel roads to avoid aircraft and off-road vehicle travel between project locations.
Locating pipelines a half-mile or more away from roads except for short sections at the Central, West, and East Pads, to minimize visual disorientation affecting caribou movement patterns.
Employing operational controls (e.g., road travel restrictions) and rigorous training programs, including: • Implementing spill prevention and response programs (detailed later in this table). • Employing an onsite subsistence representative(s) from Kaktovik or other North Slope communities during periods of active construction and drilling. Use of subsistence representatives during long-term operations will be evaluated during the operational planning phase. • Prohibiting hunting and fishing by Applicant's employees and contractors while personnel are assigned to, and working in, the Point Thomson area. • Prohibiting feeding wildlife. • Maintaining a clear space under modules and buildings to prevent creation of artificial den sites for foxes. • Requiring workers to stay on gravel surfaces unless their job duties require them to be on the tundra. • Managing food materials and food wastes such that they are unavailable to wildlife, including the use of bear-proof dumpsters at project locations. • Applying dust control measures to roads, pads, and summer mining activities to protect vegetation and terrestrial and aquatic habitats. • Limiting speed on project roads and giving right-of-way to wildlife. • Training in site operations, deterrence and hazing, waste management, and ice road operations. • Using bear monitors to watch for wildlife and take proactive measures to avoid encounters with workers. Identifying specific actions to be taken in the event of an encounter. • Coordinating with the USFWS and/or ADF&G on known polar bear and grizzly bear den locations and procedures. • Proper handling and disposal of any animal carcasses encountered.
Eliminating the previously proposed aboveground waterline to mitigate agency concerns regarding potential effects on wildlife movement.
Implementing a Polar Bear and Wildlife Interaction Plan with detailed measures to avoid adverse encounters with wildlife.
Adopting strict management procedures specifically relating to the control and containment of waste containers and food.
Requiring routine aircraft flights (e.g., transportation of personnel and cargo) to generally fly at a 1,500-foot altitude following a path inland from the coast to avoid disturbance to wildlife, except as required for takeoffs and landings, safety, weather, and operational needs, or as directed by air traffic control.
Birds
Implementing operational controls to minimize nesting opportunities for predatory/nuisance birds, including the following: • Blocking off nooks and crannies with fabric/netting or other bird-nest deterrent. • Using scare devices to deter birds when they land in places likely to be nesting sites. • Removing nests as the birds try to construct them (before they have a chance to lay eggs).
Designing facilities to minimize potential for bird strikes, including the following measures: • Careful consideration will be given to facility lighting (e.g., light hoods to reduce outward radiating light) that reduces the potential for disorienting migrating birds and reduces bird strikes.

Table 4.4-1: Applicant's Proposed Design Measures to Avoid or Minimize Impacts
• Buildings and stack heights will be the minimum needed to perform their functions, with consideration for associated footprint. The flares will be freestanding (no guy wires). • The primary Central Pad communications tower will be freestanding (no guy wires). The tower will be lighted according to FAA requirements. • Other communications towers (e.g., at the airstrip or other pads) will avoid the use of guy wires and will be attached to camps or other, larger structures when possible. • Power lines and fiber optic cables will either be buried or placed on the pipeline VSMs. • Aircraft will generally maintain a 1,500-foot altitude to avoid impacts on ground nesting and foraging birds, except as required for takeoff and landing, safety, weather, and operational needs, or as directed by air traffic control.
Rehabilitating the gravel mine to enhance habitat for waterfowl.
Limiting removal of water from freshwater lakes during the summer (except for the primary water source, Alaska State C-1 pit), to minimize reductions in amount or quality of nesting and brood-rearing habitat through diminished water levels.
Gravel placement on the tundra will primarily occur during the winter; however, if site preparation and/or construction activities occur on the tundra during the summer, prior to July 31 (when most Arctic nesting birds have hatched), areas in the vicinity of such field activities will be searched for nesting birds by a qualified biologist prior to the start of work. If an active nest is found (even after July 31), the appropriate USFWS Field Office will be contacted for instructions on how to avoid or mitigate the potential loss of the active nest.
Marine Mammals: Whales and Seals
Minimizing offshore infrastructure.
Installing mooring dolphins and the service pier in winter and in less than 8 feet of water.
Using Marine Mammal Observers (MMOs) on barges, vessels, and convoys.
Planning sealift barging to be completed prior to the main fall bowhead whale migration and subsistence whaling.
Routing coastal barging inside barrier islands.
Constructing the service pier to reduce number of coastal barging trips.
Implementing applicable protective measures of the Conflict Avoidance Agreement with the Alaska Eskimo Whaling Commission (AEWC).
Constructing ice roads onshore or on the sea ice over shallow waters (grounded ice), avoiding seal habitat.
Dredging the barge landing area through the ice during the winter preceding an open water sealift, which will minimize disturbance to marine mammals. Maintenance dredging and screeding, if needed in the summer, is expected to be minor.
Marine Mammals: Polar Bears
Implementing spill prevention and response programs
Implementing and building on the successful experience of procedures developed during the 2008 through 2011 drilling program, including, but not limited to: • Obtaining LOAs from the USFWS for Incidental and Intentional Take by Harassment of polar bears. • Updating and implementing the project's Polar Bear and Wildlife Interaction Plan. • Conducting FLIR surveys for potential maternal polar bear dens along ice road routes. • Implementing procedures and communications protocols for wildlife encounters. • Closing and rerouting an ice road if an active polar bear den is discovered within 1 mile of the ice road route, or taking other action in consultation with the USFWS. • Conducting ice road closure drills to practice the ice road closure protocols. • Watching for polar bears using bear monitors and deterring polar bears from project activities, as necessary, using USFWS-approved deterrent methods. • Employing operational controls (e.g., road and air traffic restrictions). • Ensuring project workers attend appropriate training programs, such as Arctic Pass, which cover polar bear and wildlife

Table 4.4-1: Applicant's Proposed Design Measures to Avoid or Minimize Impacts
awareness. • Communicating with the workforce on polar bear issues through environmental bulletins, posters, safety meeting discussions, etc. • Developing project design and operational features to avoid or discourage wildlife encounters and to protect wildlife and human safety (e.g., building walkways and doors, lighting, snow management, and traffic control).
Fish/Fish Habitat
Minimizing impact to natural streamflow conditions through application of hydrology study results to bridge and culvert design using conservative criteria.
Constructing ice roads in a manner that protects fish habitat and slotting ice roads at designated stream crossings at the end of the season.
Limiting lake withdrawal volumes and using proper withdrawal methods to protect fish.
Implementing tracking systems, including coordination with other water users to ensure water withdrawal limitations are met.
Maintaining natural streamflow through the design of bridges and culverts to accommodate fish passage.
Air Quality
Using state-of-the-art Tier IV off-road and stationary engines for drilling and construction activities for nitrogen oxide (NO_x) control.
Implementing BACT for stationary emission units, including dry low NO_x (DLN) combustors on the turbines.
Using electric-powered injection compressors.
Where diesel-fired reciprocating engines must be employed, using engines that are compliant with the emission limits and other requirements of the applicable New Source Performance Standards in 40 CFR 60, Subpart IIII, Standards of Performance for Stationary Compression Ignition Internal Combustion Engines.
Using ultra-low sulfur diesel in all diesel-fired equipment, both stationary and mobile.
Using Waste Heat Recovery Units (WHRUs) for dual-fired turbines.
Using natural gas for the primary and emergency fuel systems, thus reducing the need for diesel fuel.
Designing production gathering lines for full wellhead shut-in pressure of the wells, thus avoiding potential vent/relief valve emissions.
Using state-of-the-art incinerator units meeting requirements of newly released 40 CFR 60 Subpart CCCC.
Watering gravel roads and pads, and enforcing speed limits to control dust generation during construction and operations.
Providing power outlets in parking areas for maintaining vehicle starting reliability during low ambient temperatures and reduce the need for extended periods of vehicle idling.
Maintaining equipment in accordance with manufacturer's recommendations to ensure emissions control equipment continues to operate as intended.
Land Ownership, Land Use, and Land Management
Consulting with land owners or managers within or adjacent to the project area, including the U.S. Department of the Interior (Arctic National Wildlife Refuge [Arctic Refuge]), U.S. Department of Defense (U.S. Air Force [USAF]; Bullen Point), ADNR, NSB, Iñupiat Community of the Arctic Slope (ICAS), community of Kaktovik, and Native Allotment owners/heirs.
Ensuring project activities do not encroach on Native allotments or traditional land use sites through survey and demarcation.
Facilitating traditional uses of the project area.
Socioeconomics
Providing employment opportunities for North Slope and other Alaska residents.
Providing contracting and business opportunities for North Slope and other Alaska companies.
Generating revenue for the state and NSB governments.

Table 4.4-1: Applicant's Proposed Design Measures to Avoid or Minimize Impacts
Making contributions and providing other support for local schools, social, and cultural needs.
Cultural Resources
Conducting field and literature surveys to identify all cultural resources in the project area.
Conducting interviews with local elders and others knowledgeable about potential resources.
Developing protocols to protect sites that are known or discovered during project construction or operations.
Conducting effective training for the workforce on the importance of protecting cultural sites and proper procedures to do so.
Subsistence and Traditional Land Use Patterns
Routinely consulting with subsistence users to understand current and changing subsistence activities and patterns, identifying impacts that may have occurred, and ways to prevent reoccurrence.
Employing local subsistence representatives during active construction and drilling.
Continuing to inform nearby Native allotment owners/heirs, AEWC, and tribal organizations of project activities that may affect subsistence use or access to subsistence resources or traditional use sites.
Implementing applicable protective measures of the Conflict Avoidance Agreement with the AEWC and Kaktovik and Nuiqsut Whaling Captains' Associations, which include support of Communications Centers (Com Centers) for improved communications and safety during periods of marine activity.
Avoiding interference with bowhead whales during the fall migration period by designating preferred routes inside the barrier islands for coastal barging and planning to complete sealift barging prior to the fall migration.
Conducting marine activities prior to or after the Kaktovik and Nuiqsut fall bowhead whale subsistence hunts, unless other arrangements are made with the Whaling Captains and AEWC.
Using MMOs for marine vessels as provided in the Conflict Avoidance Agreement.
Developing protocols and designing pipelines to facilitate the continuation of current hunting patterns.
Supporting subsistence access to the project area.
Requiring routine aircraft flights (e.g., transportation of personnel and cargo) to generally fly at a 1,500-foot altitude following a path inland from the coast to avoid disturbance to wildlife and subsistence activities, except as required for takeoffs and landings, safety, weather, and operational needs, or as directed by air traffic control.
Providing emergency assistance to subsistence hunters and other community residents traveling through the project area, in cooperation with Kaktovik Search and Rescue or by NSB Search and Rescue.
Developing guidelines in cooperation with the community on safe hunting in proximity to oil fields.
Designing the Point Thompson export pipeline to withstand accidental bullet strikes from coastal hunters.
Making subsistence-related training mandatory for the North Slope-based project workforce, including protection of subsistence resources, lands, wildlife, and cultural and archaeological awareness as part of Arctic Pass training.
Prohibiting hunting and fishing by Applicant's employees and contractors while personnel are assigned to, and working in, the Point Thomson area.
Designing project features (e.g., color, lighting schemes, and buried/suspended cables) to minimize visual impact to subsistence users and resources.
Implementing dust control BMPs to minimize impacts of dust fallout onto terrestrial and aquatic habitat.
Implementing the Applicant's Point Thomson Project Oil Spill Contingency Mitigation Agreement (Mitigation Agreement), with $25 million in funding currently in place to provide immediate assistance to subsistence communities and users in the event of a spill preventing access to subsistence resources.
Recreation
Mining gravel with blasting, installing offshore mooring dolphins and pilings, and constructing off-pad pipelines during winter when visitation to the project area and the Arctic Refuge is at the lowest level.
Designing project features to reduce offsite visual impacts, as described below under Visual.

Table 4.4-1: Applicant's Proposed Design Measures to Avoid or Minimize Impacts
Designing project features to reduce offsite effect of noise, as described below under Noise.
Implementing aircraft flight path and height protocols to minimize coastal effects associated with noise and visual impacts of aircraft.
Visual
Designing the lighting on pads to reduce off-pad and distance effects.
Painting project facility buildings a color that reduces offsite visual effect.
Designing buildings and stacks as the minimum needed to perform their functions.
Burying power lines and fiber optic cables, or placing them on pipeline VSMs.
Texturing and coating pipelines and gathering lines to reduce glare and contrast.
Noise
Installing turbine exhaust silencers of necessary length to provide calculated sound mitigation.
Installing silencers on turbine combustion air inlet filters.
Installing low-noise electrical generators for power generation package.
Installing low-noise design for cooling medium air cooler.
Installing acoustic panels on some module interior walls.
Installing noise enclosures around the instrument air compressors.
Installing noise enclosures around turbines.
Installing hospital grade silencers on the diesel engines driving the camp standby power generation packages and the emergency fire suppression packages.
Performing major construction activities in the winter to minimize impacts on sensitive receptors.
Waste Management
Recycling/reusing drilling mud to the extent practicable, and spent drilling muds and cuttings will be injected into an onsite or offsite disposal well. Tanks or lined pits will be used for temporary storage of drilling muds and cuttings.
Segregating and storing wastes using appropriate containers, including dumpsters, hoppers, bins, etc., for food waste, burnable (nonfood) waste, construction debris, oily waste, and scrap metal.
Segregating and securing hazardous waste in a hazardous waste central accumulation area. Satellite accumulation areas will be provided, as needed.
Incinerating camp waste (including food waste).
Identifying recyclable materials and associated proper handling and storage methods.
Recyclable accumulation areas will be provided, as needed.
Providing storage hoppers and bins for contaminated snow.
Providing domestic wastewater treatment system(s).
Providing Class I nonhazardous disposal well for approved liquid waste disposal.
Spill Prevention and Response
Spill Prevention and Response Plans: The Applicant has developed comprehensive prevention and response plans, including an Oil Discharge Prevention and Contingency Plan (ODPCP), Spill Prevention Control and Countermeasure (SPCC) Plans, and Facility Response Plans (FRPs). These plans provide the overall framework for prevention and response measures; they will be maintained and updated to reflect the evolving nature of the project operations. Key requirements under the plans include: • All facilities and pipelines will be designed to ensure safe containment of all hydrocarbons. • North Slope-based project workers will attend the project-specific "Arctic Pass" training program and the North Slope Training Cooperative "Unescorted Course," covering environmental excellence (among other topics) to ensure best practices of spill prevention. Contractors may also attend additional training provided by their respective employers.

Table 4.4-1: Applicant's Proposed Design Measures to Avoid or Minimize Impacts
• Special prevention programs will be developed where a need is identified. Examples include: o A special Barging Spill Management Program: An element of this program is that every team member is considered to be a "spill champion." As such, each individual is expected to be a steward of the environment, looking out for leaks on equipment, or for any other environmental hazards present during work activities. o A targeted Ice Road Spill Management Program: This includes a "Drips and Drops" Program to identify the causes/sources of small drips and drops, and learn from these observations to both reduce their number and avoid potentially larger spills. This program also includes strict vehicle maintenance and inspection requirements, and limiting the use of older vehicles. Construction equipment is inspected to help identify/prevent leaks or other mechanical defects of vehicles prior to leaving Deadhorse or Point Thomson.
Training: To implement effective response plans, it will be necessary to have sufficient numbers of properly trained personnel. Personnel are trained in the Incident Command System (ICS), Hazardous Waste Operations and Emergency Response, and other specialties as needed by position. The response drills and exercises to maintain readiness will include federal, state, and NSB personnel. There are currently estimated to be about 600 trained responders available within 24 to 48 hours, as summarized below (these numbers will vary over time): • Point Thomson Spill Response Team (SRT); approximately 10 people who are part of the onsite workforce. • An Anchorage-based Incident Management Team (IMT); approximately 60 people who are prepared to respond to any spill event. • The Applicant's North American Regional Response Team is comprised of about 130 personnel. Approximately 45 personnel can be mobilized to Alaska in less than 24 hours in the event of a major spill response effort, as needed. • The Applicant retains ACS as its Oil Spill Removal Organization (OSRO). ACS owns response equipment totaling over $50 million and has about 80 employees, all of whom are available to assist in an oil spill response at Point Thomson. • The North Slope Operators North Slope Spill Response Team (NSSRT) mutual aid program maintains over 115 volunteers on the North Slope who are trained and qualified to assist in spill response. • Through ACS, the Applicant has access to over 250 qualified spill responders through contracts with the Auxiliary Contract Response Team. • ACS Village Response Teams currently have over 15 qualified spill responders, and are continually recruiting new members.
Pipeline Design: The Point Thomson pipelines (PTEP and in-field gathering lines) will be based on state-of-the art Arctic designs, specifically tailored for the project. Prevention and leak detection measures common to both pipeline systems will include: • Pigging facilities to allow running in-line inspection, maintenance, and cleaning tools: o The in-line inspection tools (smart pigs) will be used to monitor both internal and external corrosion. o The maintenance and cleaning pigs will remove sediment from the lines, thereby reducing the potential for corrosion. • Internal corrosion will also be monitored through the use of corrosion coupons and electrical resistance (ER) probes that provide a measure of corrosion rate and activity. The ability to inject a corrosion inhibitor will be provided. • A wall thickness to withstand damage from incidental bullet strikes from coastal subsistence hunters. Additional wall thickness will be added, where necessary, to meet this criterion. • External corrosion prevention through use of shop-installed polyurethane foam insulation covered with a roll-formed, interlocked, and galvanized metal jacket. This insulation jacket system has a proven North Slope track record of preventing moisture ingress, which can lead to external corrosion. The pipeline will be shop fusion bonded epoxy (FBE) coated and field joints will be coated with field-applied coating, insulation, sealing, and jacketing to coincide with best available North Slope practices. • Pipeline hydrostatic testing to verify pipeline integrity in accordance with 49 CFR 195 (PTEP) and American Society of Mechanical Engineers B31.8 (gathering lines). • Visual inspections of the pipelines will typically be conducted weekly during operations via aerial surveillance, unless precluded by safety or weather conditions.

Table 4.4-1: Applicant's Proposed Design Measures to Avoid or Minimize Impacts
Spill Prevention Measures Unique to the PTEP include: • Isolation valves at pipeline inlet at the Central Pad and at pipeline outlet at Badami to allow rapid shut-in in the event of a leak or rupture. • Use of vertical loops at the East Badami Creek to limit the amount of liquid hydrocarbon that could be spilled in the event of a pipeline leak or rupture. The vertical loops eliminate the need for valve pads on either side of the creeks, thus minimizing gravel placement and possible leak source (valve). • An additional wall-thickness for corrosion allowance. • Internal corrosion of the PTEP will be controlled by dehydration of the liquid hydrocarbon product and injection of corrosion inhibitors, when needed. • The use of two half-shell, preformed weld pack field joints with small channel for water draining to minimize corrosion under insulation. • Two independent leak detection systems will be installed. The primary system will meet ADEC's requirement to detect a leak as small as 1 percent of the daily flow rate. This system will use meters on the inlet and outlet of the PTEP, with a state-of-the-art computational system that will perform real-time monitoring for pipeline leaks and will be continually updated via a supervisory control and data acquisition (SCADA) system. An Applicant proprietary leak detection system using different technology will provide another level of protection.
Spill Prevention Measures Unique to the Infield Gathering Lines will include: • Use of corrosion resistant alloy (CRA) materials to reduce the potential for internal corrosion. • Design to contain full shut-in pressure of the wells, avoiding the need for pressure relief devices and vent systems to prevent over pressure and associated release to the environment.
General Design, Construction and Operations Measures include: • Well pad locations were chosen to allow development of offshore portions of the reservoir from onshore pads, thereby avoiding placement of drilling structures in marine waters. Small spills that might otherwise escape the pads and enter marine waters will be contained on the onshore pads or adjacent land. • Formal Hazard and Operability for Process Hazard Analyses (HAZOPs), risk assessment, facility site reviews, design readiness review, independent project review, and constructability reviews will be used to identify potential spill risks and associated prevention or response measures. • Storage tanks for oil and hazardous substances will be located within impermeable secondary containment areas. These storage tanks will not be stored within 100 feet of water bodies, unless otherwise approved by the appropriate regulatory agencies • Spill response equipment and materials will be readily available at designated locations throughout the facility. • Hazardous waste storage will also be located within impermeable secondary containment areas. • Fuel transfers will follow BMPS, including using secondary containment devices. Refueling and transfer sites will be located away from the shoreline and river crossings and outside active floodplains.
Drilling-specific Prevention and Response Measures: Drilling operations at Point Thomson are unique to the North Slope and many special spill prevention and response measures are used. While some drilling mitigation measures are regulatory conditions (e.g., limiting drilling into hydrocarbon zones during certain seasons of the year or Alaska Oil and Gas Conservation Commission [AOGCC] drilling-related regulations), most of the following are based on the Applicant's drilling experience and practices. Measures implemented during drilling have included, and will continue to include as appropriate, the following: • Training: Drilling personnel will complete key training programs to understand procedures for safely maintaining control of the wells. This will include training in blowout prevention technology, well control, and training to reduce unexpected events (TRUE). TRUE involves a multifunctional team made up of the rig contractor, service company, and operator personnel prior to commencing operations, and focuses on increasing knowledge and awareness to prevent and deal with potential hazards at Point Thomson. The training is based specifically on Point Thomson wells, and its goal is to provide site-specific solutions to potential problems before they occur. Potential hazards are defined by the team, including well control and lost returns. Action plans are developed to identify roles and responsibilities, warning signs, how to react to an event, and lines of communication. Special emphasis is placed on abnormal pressure detection and well control. • Well Planning: The comprehensive well planning process for the Point Thomson PTU-15 and PTU-16 wells was the first step in preventing spills or releases and ensuring the safe drilling of the wells. This planning process will be applied to the

Table 4.4-1: Applicant's Proposed Design Measures to Avoid or Minimize Impacts

drilling of future Point Thomson wells, and includes:

- o During well planning, the Applicant uses an Integrated Pore Pressure Prediction (IP3) Team consisting of reservoir engineers, geologists, drilling engineers, and computer modelers. The IP3 Team analyzes seismic data, data from exploration wells, and geologic models to predict pore pressure and fracture gradients, and to develop a detailed understanding of the reservoir. The use of advanced technology enables accurate prediction of formation behavior as wells are drilled, and allows the engineer to plan a well that minimizes the risk of a well control incident. In addition, bottom-hole pressure data from other wells in the area and seismic data are reviewed to ascertain the expected bottom-hole pressure at the proposed well location.
- o The bottom-hole pressure predictions are used to design a drilling mud program with sufficient hydrostatic head (determined by the mud density or "weight" and height of the mud column) to overbalance the formation pressures from surface to total well depth. Other factors influencing the mud weight design are shale conditions, fractures, lost circulation zones, under-pressured formations, and stuck-pipe prevention. The well casing program is designed to allow for containment and circulation of formation fluid influx out of the wellbore without fracturing open formations.

- Drilling Rig and Well Control/Blowout Prevention Equipment: More and higher pressure-rated blowout prevention equipment (BOPE) than other North Slope drilling will be used for Point Thomson. During drilling operations below the surface-hole, the Point Thomson BOPE will consist of:
  - o A minimum of four, 13-5/8-inch, 10,000 pounds per square inch (psi) working pressure, ram-type preventers.
  - o One 13-5/8-inch annular preventer (rated to 10,000 psi).
  - o Choke and kill lines that provide circulating paths from/to the choke manifold.
  - o A two-choke manifold that allows for safe circulation of well influx out of the wellbore.
  - o A hydraulic control system with accumulator backup closing capability.
  - o The addition of a fifth blowout preventer (BOP) was incorporated into the BOP stack arrangement to manage the risk at Point Thomson. (Most North Slope drilling operations use four BOPs – three ram-type and one annular type.) A BOP stack with four sets of rams and one annular preventer will be used to drill below surface casing, providing one more preventer than required by AOGCC regulations. This arrangement allows two preventers to close on the casing and liners and, in the case of liners, permits two ram-type and one annular preventer to be used on the drill-pipe running-string without having to stop and change out rams. The extra ram preventer will also provide added redundancy.
  - o Prior to acceptance of the drilling rig, comprehensive inspection and testing will be performed on the BOPE, including:
    - ▪ Testing BOPE to the full rated working pressure (10,000 psi).
    - ▪ Testing choke manifold equipment to the full rated working pressure.
    - ▪ Testing the BOP accumulator unit to confirm that closing times meet American Petroleum Institute standards and meet or exceed AOGCC requirements.
    - ▪ Verifying precharge pressure and total volume of the accumulator bottles.
    - ▪ Installing new ring gaskets and seals between each BOP component.
    - ▪ Testing pressure integrity of the high-pressure mud system.
    - ▪ Inspecting drill string and bottom-hole assembly (BHA) components to the most stringent "T.H. Hill DS-1 Category 5 level." (This refers to an inspection and qualification document written by T.H. Hill Associates, Inc., that is considered industry standard for drill string and BHA inspections, as well as quality control of the drill string equipment.) While operating, the BOPE will be tested according to AOGCC and Applicant requirements, which is typically every 7 or 14 days. AOGCC field inspectors may witness these pressure tests.

- Well Control While Drilling Below the Surface Hole: The following summarizes measures for well control while drilling below the surface hole:
  - o Well Control Monitoring and Procedures: Each well will be drilled according to a detailed well plan. While drilling, the well will constantly be monitored for pressure control. The mud weight (the primary well control mechanism) will be monitored and adjusted to meet actual wellbore requirements. A range of mud weights will be used as the well is drilled to provide the proper well control for the formation conditions encountered. Automatic and manual monitoring equipment will be installed to detect abnormal variation in the mud system volumes and drilling parameters.
  - o If an influx of formation fluid (kick) occurs, secondary well control methods will be employed. Constant monitoring of the total fluid circulating volume and other drilling parameters will ensure that a kick is quickly detected. The well annulus will be shut-in using the BOPE. The drill pipe will be shut-in by a down-hole check valve near the bit and a surface-

Table 4.4-1: Applicant's Proposed Design Measures to Avoid or Minimize Impacts
mounted valve. This will contain the influx and associated build-up of surface pressure and prevent further influx of formation fluid into the wellbore. After the well is stabilized, a well kill procedure will be developed and implemented to circulate kill-weight mud and safely remove formation fluids from the hole. Mud-gas separators and degassers will be used to remove gas from the mud as it is circulated out of the hole. After this procedure is completed, the kill effectiveness will be confirmed and the well will be opened up and the fluid levels monitored. Drilling operations will not resume until conditions are normal. o BOP drills will be performed on a frequent basis to ensure the drilling crews can quickly and properly shut-in the well. Certified training of Point Thomson personnel will include hands-on simulator practice at recognizing kicks, well shut-in, and circulating the kicks out of the wellbore. o Bottom-Hole Pressure Measurements: The Applicant will measure bottom-hole pressure while drilling, with computer-assisted analysis of drilling fluids circulation. State-of-the-art technology will be used to enhance drilling performance and mitigate risk. Several of the technologies are known as logging while drilling (LWD) and pressure while drilling (PWD). The LWD system enhances early detection of over-pressured intervals or possible lost circulation zones. The PWD system directly monitors bottom-hole pressures to maintain sufficient overbalance without compromising the formation integrity. Early detection of overpressure and maintaining sufficient overbalance while drilling will minimize the chance of incurring a well control event. o Overbalanced Drilling Confirmation Technique: The "10/10/10 Test" developed by the Applicant is an analytical technique to help evaluate whether an overbalanced situation exists in the wellbore. Testing using the 10/10/10 Test can provide accurate and early diagnostics of the formation pressure before the potential kick interval is reached. The 10/10/10 Test involves circulating the well for 10 minutes to establish background gas, discontinuing mud circulation for 10 minutes to reduce equivalent circulating density, and circulating the wellbore for an additional 10 minutes. Mud is then circulated from the bottom of the well, without further drilling, to the surface. Gas concentrations are measured, and an evaluation is done to determine whether the overbalance is sufficient. o Computer-aided Management of Inspection, Maintenance, and Repair: The Applicant will use a computerized preventive maintenance program to help manage inspection, maintenance, and repair of the drilling rig and associated equipment. The drilling contractor's preventive maintenance program will be reviewed, a gap analysis performed, and an agreed-upon computer-aided system will be followed. The contractor will have the responsibility to maintain the program, while the operator closely monitors the inspection, maintenance, and repair program. o Well Control Blowout Contingency Plan: The Applicant has developed a Well Control Blowout Contingency Plan (BCP) to address controlling a potential blowout in the shortest possible time. The BCP relies on well capping as the primary means of controlling a blowout. Well capping is proven and will normally control a blowout in far less time than a relief well. The BCP address critical logistical elements of bringing the well capping equipment to the location. A key element of the BCP is ignition of a Thomson Sand gas condensate blowout. This is an effective method of "source control." Air quality modeling has demonstrated that such a blowout would burn cleanly and would not violate national ambient air quality standards. ADEC has granted preapproval for wellhead ignition and the Applicant will be prepared to implement well ignition within 2 hours of a blowout occurring, if that is the chosen response measure.

4.4.4 Best Management Practices and Permit Requirements

The Applicant would follow BMPs and industry standards required to comply with regulations and standard permit requirements that are designed to reduce impacts to the environment. Many of these are reflected above in the Applicant's design measures. The Corps took these BMPs and permit requirements into consideration when assessing the impacts of the project on the resources as described in Chapter 5.

Appendix F describes in detail the federal, state, and local statutes and regulations that are applicable to the Point Thomson Project. Among these are the CWA, which requires water quality permits for wastewater discharges and the CAA, which requires air quality permits.

The ADNR's Division of Oil and Gas (DO&G) is responsible for leasing state lands for oil and gas exploration and development. The DO&G develops best interest findings, which include mitigation measures and lessee advisories for each oil and gas lease. The DO&G will place conditions on plans of operation, exploration, or development and other permits based on these mitigation measures. Lessee advisories alert lessees to additional restrictions that may be imposed at the permitting stage of a proposed project or activity where entities other than DO&G have permitting authority. Lessees must comply with all applicable local, state and Federal codes, statutes, and regulations, as amended, as well as all current or future ADNR area plans and recreation river plans; and ADF&G game refuge plans, critical habitat area plans, and sanctuary area plans within which a lease area is located. The best interest findings pertinent to the Point Thomson Project include the following:

- North Slope Areawide Oil and Gas Lease Sale, Final Best Interest Finding, Chapter 7: Mitigation and Lessee Advisories, July 15, 2008, with supplements dated July 8, 2010 and July 14, 2011.
- Beaufort Sea Areawide Oil and Gas Lease Sale, Final Finding of the Director, Chapter 9: Mitigation Measures and Other Regulatory Requirements (Lessee Advisories), November 9, 2009, with supplements dated July 8, 2010 and July 14, 2011.

An important aspect of the DO&G mitigation measures for the North Slope is that they address decommissioning and site rehabilitation at the end of the project as follows:

> *Dismantlement, Removal, and Rehabilitation (DR&R): Upon abandonment of material sites, drilling sites, roads, buildings, or other facilities, such facilities must be removed and the site rehabilitated to the satisfaction of the Director, unless the Director, in consultation with DMLW, ADF&G, ADEC, NSB, and any non-state surface owner, determines that such removal and rehabilitation is not in the state's interest.*

The ADNR's State Pipeline Coordinator's Office (SPCO) issues ROW leases for pipeline transportation systems that are on or cross state lands. Applicants for a ROW lease are required to prepare a plan detailing a comprehensive array of topics, including surveillance and monitoring, incident reporting, completion of use, changes in condition, fire prevention and suppression, health and safety, protection of cultural resources, hunting, pollution control, disturbance of natural waters, erosion and sedimentation, excavated material, restoration and revegetation, fish and wildlife protection, use of explosives, contingency plans, corrosion, lighting protection, seismic, fault displacement, soil and ice movement, land and surface disturbance, pipe/soil interaction, and rivers, streams, and floodplains. The SPCO reviews plans in coordination with other state agencies and develops project-specific stipulations that are required as part of the ROW lease.

An ODPCP, required by the ADEC under 18 AAC 75.425, describes the response actions, equipment, procedures, and other required elements necessary to rapidly respond to and manage an oil spill response.

The NSB has established Resource Development Districts to address large-scale resource extraction and related activities. These activities must 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.

Where appropriate, discussions of BMPs and permit requirements relative to specific resources are provided in Chapter 3 and Chapter 5.

4.4.5 Corps-considered Mitigation

The Corps is considering measures to further avoid and reduce project impacts. These include measures developed by the Corps based on: analysis of project impacts and consideration of public comments on the

Draft EIS, input from federal cooperating agencies, or input from the state (see Table 4.4-2). For unavoidable impacts to aquatic resources, the Corps is proposing compensatory mitigation. All mitigation required by the Corps must be directly related to the impacts of the proposed project, appropriate to the scope and degree of those impacts, and reasonably enforceable.

4.4.5.1 Mitigation Measures

The additional measures that the Corps is considering to avoid or minimize project impacts to the environment are listed below according to the resources that would be impacted. The Corps will continue to refine required mitigation during the Section 404/10 permit application review process. Additional mitigation identified during that process may include minor project modifications that are considered feasible from a cost and constructability perspective.

Table 4.4-2: Mitigation Measures being Considered by the Corps

Resource Area	Impact Addressed	Mitigation
Soils and Permafrost	Potential for decreased albedo, increased thermal conductivity, and promotion of earlier spring thaw due to dust	Prepare and implement a plan for dust suppression that addresses gravel roads/pads, and year-round mining activities. As applicable, include use of environmentally safe chemical palliatives and use of chip-seal on the infield roads. The plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.
	Thermokarst formation	• Align roads to avoid ice-rich permafrost, if possible. • Direct discharge of mine dewatering water and hydrostatic test water toward a natural drainage gradient to minimize warming of the near-surface soils and ponding of surface water. Control the discharge flow rate to avoid erosion of tundra or tundra vegetation.
	Power cable trenching impacts	• Use trenching, cable placement, and backfilling methods that minimize snow in the trench. Remove snow from the trench before backfilling to minimize impacts and the subsequent effort needed for rehabilitation. • Use material removed from the trench as backfill. Avoid chunks of sand and gravel larger than approximately 3 inches in diameter. Mound material over the trench following backfill to ensure that the trench is filled to ground level after settlement. • Hand rake or shovel excavated material that remains on the adjacent tundra back into the trench during the first summer following trenching completion. • Perform remedial work as needed to restore natural ground contours, to prevent surface water from flowing along the surface of the backfilled trench, and to ensure revegetation success.
	Soil and permafrost disturbance	If summer tundra travel is necessary using tundra-safe low-pressure vehicles, limit traffic as much as possible, avoid tight turns, use different tracks with each pass, and follow the shortest path from origination to destination.

Table 4.4-2: Mitigation Measures being Considered by the Corps

Resource Area	Impact Addressed	Mitigation
Air Quality	Fugitive dust	Prepare and implement a plan for dust suppression that addresses gravel roads/pads, and year-round mining activities. Consider use of environmentally safe chemical palliatives, use of chip-seal on the infield roads, and other methods, as applicable. This plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.
	Exceedance of air quality standards	Prepare and implement a monitoring and adaptive management plan (see Section 4.4.6).
Physical Oceanography and Coastal Resources	Erosion of pads from coastal processes	Prepare and implement a monitoring and adaptive management plan (see Section 4.4.6). The plan would include monitoring of the pads for erosion and implementation of corrective action if necessary.
Hydrology	Impacts to stream channels	If the location of a VSM within a stream channel cannot be avoided, VSM construction should be completed following the guidance described in Section 4.5 River and Stream Crossings of the *Eastern North Slope Gas Pipeline Design Basis* (ADNR 2006). This guidance includes completing a hydrology report for the pipeline and analyzing hydrologic and hydraulic characteristics that are specific to the individual crossing.
	Ponding and sheet flow diversion associated with gravel roads	To reduce impacts during high flow events, prepare and implement a culvert maintenance plan. This plan should be reviewed and approved by the Corps, in consultation with others, and include the following: • Criteria for placing additional culverts after completion of road construction • Annual removal of packed snow and ice • Placement of an end-cap and removal before breakup • Consideration of installing steam pipes inside culverts to aid ice thaw.
Water Quality	Increased turbidity due to barge ballast water discharge	Direct barge ballast water discharge away from the seafloor to avoid disturbance of seafloor sediments.
Vegetation and Wetlands	Damage to tundra vegetation	• Direct discharge of mine dewatering water and hydrostatic test water toward a natural drainage gradient to minimize warming of the near-surface soils and ponding of surface water. Control the discharge flow rate to avoid erosion of tundra or tundra vegetation. • Maintain slopes of gravel roads and pads to prevent sloughing. • Grade roads without pushing material off the embankments. • If summer tundra travel is necessary using tundra-safe low-pressure vehicles, limit traffic as much as possible, avoid tight turns, use different tracks with each pass, avoid vegetation communities most sensitive to damage from tundra travel (e.g., tussock tundra), and follow the shortest path from origination to destination.

Table 4.4-2: Mitigation Measures being Considered by the Corps		
Resource Area	Impact Addressed	Mitigation
	Invasive species	Prepare and implement an invasive species plan that addresses plants and aquatic species. The plan should include monitoring of gravel pads and roads for nonnative plant species and eradication of invasive species before populations become well established and implementation of measures to prevent import of weed seed on equipment and materials brought to Point Thomson. This plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.
	Effects from dust	Prepare and implement a plan for dust suppression that addresses gravel roads/pads, and year-round mining activities. Consider use of environmentally safe chemical palliatives, use of chip-seal on the infield roads, and other methods, as applicable. This plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.
	Unauthorized off-road travel impacts	Restrict public access to the gravel access road to prevent off-road vehicle use and spread of nonnative plant species.
Birds	Bird disturbance	• Prepare an air traffic plan to be reviewed and approved by the Corps, in consultation with others, prior to start of construction. Include the following measures to minimize bird disturbance: o During the waterfowl molting period, route helicopter flights away from the lagoon and stay at altitude until landing. Approach the landing area as far away from the lagoon shoreline as possible. o Route fixed-wing aircraft and helicopter traffic 5 miles south of the Beaufort Sea shoreline east of Bullen Point and approach the airstrip from the south, weather permitting, to avoid low-level flights over concentrations of waterfowl in coastal lagoons. • Limit vehicle speeds on roadways and reduce speed during early spring when geese are attracted to early green vegetation along roads and again when brood-rearing waterfowl are present to avoid and reduce bird-vehicle collision mortality. • Keep crews on gravel surfaces and watching for nesting birds (gravel-nesting plovers, common eiders, snow buntings). • Limit personnel access to tundra, shoreline, and barrier island habitats whenever possible. • Conduct surveys of buff-breasted sandpiper lek, breeding, and nesting habit along the gravel access road route prior to construction and adjust the route as needed to avoid the habitat. • Coordinate vessel, aircraft, and vehicle trips during construction, drilling, and operations to minimize the number of trips.
	Bird-aircraft collision mortality	Haze waterfowl and seabirds from the vicinity of the airstrip.

Table 4.4-2: Mitigation Measures being Considered by the Corps		
Resource Area	**Impact Addressed**	**Mitigation**
	Bird mortality associated with facilities	Design and construct facilities such as towers, flare stacks, and lighting to minimize the potential for bird strikes and mortality: • Develop facility lighting plans with the Corps and USFWS as part of the visual impact and lighting mitigation plan (see Visual Aesthetics) to minimize the attraction of facilities to birds during inclement weather. The plan should include methods for pointing light downward and directional shielding for outdoor lighting, and methods for shading windows to minimize attraction to indoor lighting. • Develop a bird survey and reporting plan with USFWS to assess bird mortality associated with project facilities. Report documented bird mortalities to the Corps and USFWS. • If warranted based on survey results, modify facility design in consultation with USFWS.
	Predator impacts	• Design facilities to prevent access and use by common ravens for nesting sites, including use of anti-roosting devices as appropriate. • Monitor facilities for arctic fox dens and common raven nests and remove or block access to used sites.

Terrestrial Mammals	Disturbance due to air/road traffic	• Prepare an air traffic plan to be submitted to the Corps and cooperating agencies for review and approval prior to start of construction. Include the following measures to minimize impacts to terrestrial mammals:
		  o Route flights to avoid calving areas during the caribou calving period, large post-calving caribou aggregations, and insect-relief habitats.
		  o Restrict overflights to more than 1,000 feet during caribou calving and to more than 500 feet in spring and fall.
		• Coordinate aircraft and vehicle trips during construction, drilling, and operations to minimize the number of trips.

	Brown bear den disturbance	Consult with ADF&G to locate and avoid any active brown bear dens prior to winter construction.
Fish, EFH, and Invertebrates	Fish habitat enhancement	Where appropriate, consider placing gravel mine sites developed during construction of the 44-mile-long gravel access road at locations that enhance potential for colonization by fish species of interest such as Arctic grayling. Locations should be within floodplains of larger streams or connected to the floodplains.
	Invasive species	Prepare and implement an invasive species plan that addresses plants and aquatic species. The plan should include a simple analysis of the physical environment (salinity, temperature) of the likely ports of origin and a comparison provided between these data and similar data for the project area. BMPs for controlling invasive aquatic species should include measures to address species that can travel on the infrastructure of the vessel or be discharged from other waste streams, as well as ballast water exchange. This plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.

Table 4.4-2: Mitigation Measures being Considered by the Corps		
Resource Area	Impact Addressed	Mitigation
Arctic National Wildlife Refuge	Various	See measures under Terrestrial Mammals, Recreation, Visual Aesthetics, Noise, and Subsistence and Traditional Land Use Patterns.
Transportation	Vehicular accidents	See measures under Human Health.
Recreation	Visual impacts	See measures under Visual Aesthetics.
	Marine traffic disturbance	Avoid use of boats and barges east of the Central Pad and avoid use of small boats in the coastal corridor.
Visual Aesthetics	Project components would be visible from key observation	Prepare and implement a visual impact and lighting mitigation plan that includes specific measures such as nonreflective paint/coatings that blend in with natural landscape, keeping infrastructure as short as practicable, shielded lighting, installation of shaded windows on east sides of buildings, shielding pilot flames for gas flares and establish them as low as possible on towers, and minimizing large flares and smoke plumes associated with flaring. This plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.
Noise	Excessive noise	Prepare and implement a noise mitigation plan that includes: • Noise monitoring thresholds that would trigger mitigation requirements • The latest technology to muffle the compressors • Minimization of noise-causing activities such as outdoor public address systems and roadway maintenance and snow removal activities when winds are calm (less than 11 mph). This plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.
Cultural Resources	Undiscovered resource impacts	Prepare and implement an unanticipated discovery plan describing the protocols that would be followed should cultural resources be discovered during project construction or operations. This plan should include a stop work protocol, reporting, documentation, and assessment of eligibility for listing in the NRHP. This plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.
Subsistence and Traditional Land Use Patterns	Caribou harvest impacts	As part of the air traffic plan, limit helicopter traffic during the primary caribou hunting season (July and August) or consult with local hunters regarding modification of helicopter routes during that time.
	Avoidance impacts	• Maintain close communication and coordination with subsistence harvesters as project activities progress. • Develop formal hunting policies and communication of policies to local hunters to help avoid confusion about hunting access.
Human Health	Changes in prevalence of depression and anxiety due to fear of catastrophic incident on the NSB	Increase community education about safety measures for arctic projects.
	Vehicular accidents associated with the gravel access road and annual ice access road	Restrict road access during project construction, increase security and safety patrols, and enforce speed limits.

Table 4.4-2: Mitigation Measures being Considered by the Corps		
Resource Area	Impact Addressed	Mitigation
Waste Management and Spills	General spill impacts	Require all contractors to review and follow permit conditions related to waste management and spill prevention.
	Pipeline spills	Where practicable, locate onshore pipelines on the upslope side of roadways and construction pads to facilitate the containment and cleanup of spilled fluids.

4.4.5.2 Compensatory Mitigation

Compensatory mitigation is a critical tool to help the federal government meet the longstanding national goal of "no net loss" of wetland acreage and function. For projects authorized under Section 404, compensatory mitigation is not considered until after all appropriate and practicable steps have been taken to first avoid and then minimize adverse impacts to the aquatic ecosystem pursuant to 40 CFR part 230 (i.e., the CWA Section 404(b)(1) Guidelines). Compensatory mitigation is used for resource losses that are specifically identifiable, reasonably likely to occur, and of importance to the human or aquatic environment. Compensatory mitigation can be carried out through restoration of an existing wetland or other aquatic site, enhancement of an existing aquatic site's functions, creation of a new aquatic site, or preservation of an existing aquatic site.

Compensatory mitigation being considered for the Point Thomson Project includes payment of an in-lieu fee to the Conservation Fund for the purchase of at-risk habitats. This land could be located elsewhere in the state because little private land is available on the North Slope for "in-kind" purchase. Similarly, a wetland mitigation bank has not yet been established for the North Slope. Alternatively, gravel fill areas (such as abandoned pads and airstrips) in wetlands within the vicinity of the proposed project may be appropriate for use as restoration sites for compensatory mitigation. The applicant is attempting to locate potential properties to use as part of its proposed compensatory mitigation.

During scoping, the State of Alaska recommended that consideration be given to rehabilitation of legacy stream crossing sites within the Prudhoe Bay oilfield as part of the mitigation program for the Point Thomson Project. Potential rehabilitation projects include replacing inadequate culverts with bridges where the Spine Road crosses Little Putuligayuk River and Putuligayuk River.

Specific compensatory mitigation for the Point Thomson Project will be determined by the Corps during its review of the Section 404/10 permit application. As part of this process, the Corps will use its 2009 Alaska District Regulatory Guidance Letter (RGL ID No. 09-01). This guidance contains the steps necessary to determine the level of mitigation that is appropriate based upon the wetland functions lost or adversely affected by permitted activities. Table 4.4-3 contains sample ratios for wetland compensation that are provided as a guideline. However, the Corps may deviate from these ratios based on project-specific conditions.

Table 4.4-3: Sample Ratios for Compensatory Mitigation		
Wetland Type	Preservation	Restoration and/or Enhancement
Low Functioning (Category III or IV)	1.5:1	1:1
Moderate Functioning (Category II or III)	2:1	1:1
High Functioning (Category I or II)	3:1	2:1

4.4.6 Mitigation Monitoring and Adaptive Management

Monitoring is an important part of mitigation strategy so the effectiveness of mitigation efforts can be assessed. A monitoring program should clearly describe monitoring objectives, performance standards, monitoring methods, a schedule, and reporting. If performance standards are not being met, mitigation can be adjusted as appropriate.

The Corps is considering a requirement that the Applicant prepare a mitigation monitoring and adaptive management plan to monitor success of mitigation efforts that includes a process for making changes to or adding mitigation as needed. This plan would be submitted to the Corps and cooperating agencies for review and approval prior to start of construction. The mitigation monitoring and adaptive management plan should address mitigation for impacts due to gravel and ice roads and pads, power cable trenching, water withdrawal, noise, air emissions, barging, and coastal erosion. The plan should clearly identify monitoring goals and objectives and include:

- What parameters will be monitored
- Where and when monitoring will take place
- Who will be responsible for monitoring
- How the information will be evaluated
- What actions (contingencies, adaptive management, corrections to future actions) will be taken based on the information
- How the public can get information on mitigation effectiveness and monitoring results

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Chapter 5. Environmental Consequences

This chapter describes the potential effects that could result from the selection of any of the alternatives presented in this EIS, including the No Action Alternative. This chapter is organized by resource. Each resource section starts with a brief discussion of methodology and includes definitions for impact assessment criteria. Section 4.1 contains the direction that specialists received to develop the resource methodologies.

Within each alternative, direct and indirect impacts are discussed together with respect to the phases of the project (construction, drilling, and operations). Mitigation measures, where applicable, are identified or suggested for each alternative. Following the direct and indirect impacts sections, cumulative impacts, which include a discussion of how climate change may affect the resource within context of that alternative, are presented. The climate change discussions under the No Action Alternative describe the baseline manner in which climate change may be affecting a resource without any added impacts from an action alternative. The guidance used to determine the cumulative impacts for this EIS is described in Section 4.2.

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5.1 GEOLOGY AND GEOMORPHOLOGY

The key findings of effects for geology and geomorphology are summarized below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

Action Alternatives: Minor, long-term impacts would probably occur to geologic resources and geomorphologic features within the project footprint. Impacts to the Point Thomson Reservoir from hydrocarbon production would be major and permanent. Impacts to paleontological resources would be unlikely, but if they did occur, they would be long-term, minor, and limited to the area of a project component.

Alternative A: No impacts.

Differentiators:

- Impacts to geomorphologic features under Alternative C would be more extensive due to its greater footprint.
- Alternative C would use more than double the gravel resources of other alternatives.

5.1.1 Methodology

As described in Section 3.1, the geomorphology, geology, and paleontology of the project area are closely related and likely to be impacted by similar activities. The analysis of potential impacts to geomorphology, geology, and paleontology was conducted by reviewing the Applicant's project description (ExxonMobil 2009a), Applicant-proposed voluntary mitigation measures, data collected by the Applicant, information provided by the Applicant through the RFI process (Appendix D), and previous publications within and near the project area. The Applicant's information was verified by independently reviewing reference sources and previous publications on geomorphology, geology, and paleontology within and near the project area. The information regarding existing conditions (as presented in Section 3.1, Geology and Geomorphology) was then assessed relative to the Applicant's proposed action and the other alternatives (described in detail in Chapter 2, Alternatives) to determine impacts to geomorphology, geology, and paleontology.

The impact criteria for these resources are defined in Table 5.1-1, and each alternative has been evaluated to determine the impacts of project activity on each resource.

Table 5.1-1: Impact Criteria—Geologic Resources		
Impact Category*	Intensity Type*	Definition
Magnitude	Major	Changes in geological conditions cause adverse effects on geological or mineral resources, paleontological resources, or deep groundwater for which no mitigation is available.
	Moderate	Changes in geologic conditions cause adverse effects on geological or mineral resources, paleontological resources, or deep groundwater that could be mitigated.
	Minor	Changes in geologic conditions with no adverse effect.
Duration	Long term	Impact exceeds the life of the project.
	Medium term	Impact lasts the life of the project.
	Temporary	Impact lasts during a phase of the project.
Potential to Occur	Probable	Measureable changes in geologic conditions would be unavoidable.
	Possible	Measurable changes in geologic conditions could occur but could be avoided.
	Unlikely	No anticipated measurable changes in geologic conditions.
Geographic Extent	Extensive	Throughout the project area and beyond.
	Local	Within the project footprint.
	Limited	Footprint of some project components.

* Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology

This section focuses on onshore geomorphology, the deep permafrost and underlying bedrock formations, deep groundwater, and paleontology. The active (seasonally thawed) layer and the permafrost immediately underlying the active layer are addressed in Section 5.2, Soils and Permafrost. Earth materials at and immediately adjacent to the beach area, including the wave-cut bench, the beach itself, and the near-shore sea floor, are addressed in Section 5.5, Physical Oceanography and Coastal Processes. Shallow groundwater is addressed in Section 5.6, Hydrology. In addition to the project's impact to geologic resources, the potential impact of geologic hazards on the project is discussed in Section 5.1.6.

5.1.2 Geology

Geology could be impacted by project activities that use geologic resources or alter geomorphologic features.

5.1.2.1 Alternative A: No Action

Alternative A would include monitoring of the two wells at the existing PTU-3 pad. These activities would have no impact on geomorphology or geologic resources.

5.1.2.2 Action Alternatives

Construction and Drilling

Under all action alternatives, the primary geologic resource impacted by the project during construction would be gravel resources. Gravel would be mined at a new primary gravel mine located 2 miles south of the Central

Pad and just north and east of the proposed airstrip under Alternatives B, D, and E and near the proposed Central Processing Pad under Alternative C. Alternative C would require five additional gravel mines, each located approximately every 10 miles along the gravel access road corridor. The quantities of gravel required for each alternative are provided in Table 5.1-2. Because gravel is plentiful in the project area, the impacts of gravel use would be negligible.

Table 5.1-2: Gravel Quantities Required for Each Alternative

Alternative	Gravel Required (million cubic yards)
Alternative B	2.2
Alternative C	5.4
Alternative D	2.5
Alternative E	1.7

Excavation at the gravel mines would alter the ground surface both within the excavated pit and where stockpiling of overburden materials would occur adjacent to the pit (Appendix G, North Slope Construction Methods). After gravel extraction, the sidewalls would be stabilized, contouring would occur, and the overburden would be replaced, but a permanent surface depression would remain. The pits would be allowed to fill with water naturally, except under Alternative D, where water would be diverted from Stream 24 to the infield gravel mine to speed the infilling. The infield gravel mine reservoir would be the primary water source for the project during operations under Alternative D and a backup water supply under the other alternatives.

Gravel construction would consist of placing gravel fill a minimum of 5 feet thick to create roads and gravel pads on the existing ground surface. These features would remain for at least the life of the project.

Impacts to existing geomorphological features from construction of project infrastructure would likely include reshaping of local surface depressions occupied by thaw lakes and streambanks associated with seasonally active drainages. Other geomorphological features that could be impacted include oxbow lakes, eolian dunes, and the wave-cut beach bench. Impacts to geomorphological features would be more extensive for Alternative C than for the other action alternatives, primarily due to construction of the 44-mile-long gravel access road. Alternative E would have the least impact on geomorphologic features due to its reduced infrastructure, as described in Chapter 2.

Impacts on geomorphological features have been minimized by designing the project to avoid features such as lakes and streams to the extent possible. Natural processes of wind transport freeze/thaw cycles, and seasonal hydrologic activity would also provide a gradual but steady restoration of modified ground back to natural landforms.

Drilling activities would not impact geologic resources.

Operations

The action alternatives would include a minimum of 5 wells, with capacity for 24 wells in the future. Production of petroleum hydrocarbons from subsurface reservoirs constitutes an irreversible impact to geological resources (hydrocarbons). The facility would be designed to process approximately 10,000 bbl per day of condensate and up to 10,000 bbl per day of oil, if oil rim production is viable. Direct impacts to petroleum hydrocarbon resources would be major under all action alternatives, and no mitigation measures need to be considered for these impacts because they comprise the purpose for the project.

The Class I disposal well would not impact a source of potable groundwater in the project area because the salinities of aquifers beneath the permafrost exceed the 10,000 mg/l threshold required for USDW (40 CFR 144.3 and 40 CFR 146.3).

Table 5.1-3 summarizes the impacts to geology for construction, drilling, and operations.

Table 5.1-3: Action Alternatives—Impact Evaluation for Geology

Phase	Magnitude	Duration	Potential to Occur	Geographic Extent
Construction and Drilling	Minor	Long term	Probable	Local
Operations	Major	Long term	Probable	Extensive but limited to reservoir

5.1.3 Paleontology

The occurrence of fossils at and near the surface in the project area would be limited to those taxa found in late Quaternary sands and gravels across the North Slope. These might include marine and terrestrial mammals and birds that have been found in Quaternary deposits on the North Slope (BLM 2002a).

5.1.3.1 Alternative A: No Action Alternative

Alternative A would not impact paleontological resources.

5.1.3.2 Action Alternatives

Potential impacts to paleontological resources would be similar for all of the action alternatives. Under all action alternatives, a survey for cultural resources at the surface would be conducted prior to any ground-disturbing activities. Damage to, or destruction of paleontological resources would be remotely possible during ground-disturbing construction activities such as gravel mining, gravel construction, installation of barging facilities, or installation of VSMs for the export pipeline.

Impacts to paleontological resources arising from the continuation of ongoing drilling would be limited to the pulverization of fossils in the wellbore itself, in addition to destruction of incidental fossils in near-surface eolian silts and granular outwash materials due to ground disturbance.

Damage to, or destruction of paleontological resources would be remotely possible during ground-disturbing activities associated with maintenance and repair during operations. Paleontological resources also could be affected by a hydrocarbon spill during operations (see Section 5.24, Spill Risk and Impact Assessment).

Table 5.1-4 summarizes the impacts to paleontology for construction, drilling, and operations.

Table 5.1-4: Action Alternatives—Impact Evaluation for Paleontology

Phase	Magnitude	Duration	Potential to Occur	Geographic Extent
Construction and Drilling	Minor	Long term	Unlikely	Limited
Operations	Minor	Long term	Unlikely	Limited

5.1.4 Mitigative Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on geology and geomorphology.

- Routing infield roads a sufficient distance inland to avoid major stream crossings.
- Designing bridges and culverts to maintain existing surface drainage patterns and prevent erosion.
- Using a sheet pile design for bridge abutments to minimize the tundra footprint, road embankment erosion, and stream scour.

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on paleontological resources.

- Conducting field and literature surveys to identify all cultural resources in the project area.
- Developing protocols to protect sites that are known or discovered during project construction or operations.
- Conducting effective training for the workforce on the importance of protecting cultural sites and proper procedures to do so.
- Implementing spill prevention and response programs, as detailed in Section 5.24, to reduce the risk of damage to fossils at or near the surface.

5.1.5 Climate Change and Cumulative Impacts

5.1.5.1 Climate Change

Climate change has the potential for far-reaching changes in soils and surface permafrost, and in the coastal region surface geology within the project area. Increases in MAAT in the Arctic could result in loss of permafrost or deepening of the active layer. These impacts could result in greater interaction of groundwater hydrology in the region and, in turn, accelerate the thawing processes within the deep permafrost layer. As described in the ACIA (2005), the thawing of this deep permafrost layer could allow any subpermafrost water to freely interact with above permafrost (suprapermafrost and intrapermafrost) water, potentially altering groundwater hydrology within the region.

Climate change could impact paleontological resources within the project area in both beneficial and detrimental ways. In each of the alternatives, changes in soils, hydrology, and melting permafrost could lead to the exposure of previously buried paleontological resources and result in beneficial scientific discoveries. However, fossils uncovered by this action could more rapidly decay when exposed to weathering processes.

5.1.5.2 Cumulative Impacts

Past and present oil and gas exploration, development, use of the Badami Development, and use of the Bullen Point SRRS military site could affect the geologic and geomorphic environment. RFFAs include continued exploration and development of the oil and gas resources within the area, including restart of Badami operations, offshore exploration, and further development of Point Thomson (including expanded gas cycling or gas sales) that could result in additional onshore pipeline and processing facilities.

The primary impact to North Slope geology of past, present, and reasonably foreseeable development has been the extraction of oil reserves. Since production on the North Slope began, the North Slope units have produced 16,193.570 million bbl of oil (includes condensate) and 6,463.875 billion ft^3 of gas. State forecasts estimate that Point Thomson will produce 416.6 million bbl of oil between 2010 and 2050. This would be about 2 percent of total North Slope production projected for this time (21,325.9 million bbl). At its height of production (likely around 2025), Point Thomson production could represent about 20 percent of production (35.5 million bbl out of 173.3 million bbl); however, this high production period is only expected to last approximately 10 to 15 years. North Slope production is generally in decline (ADNR 2010b).

Through 2001 approximately 13.6 billion bbl of oil had been extracted from Prudhoe Bay and other existing fields, more than 70 percent of the estimated original reserves of the past and presently developed fields (NRC 2003a). Given the project objectives as well as past, present, and reasonably foreseeable development, cumulative effects to the geologic environment are unavoidable. The proposed project, in combination with past, present, and reasonably foreseeable developments, would remove a potentially substantial percentage of total economically recoverable petroleum resources available within the area of known reserves. All of the action alternatives would have a similar contribution to the cumulative effect.

Over the past several decades, developments on the North Slope, ranging from the Colville River to the Canning River, have required the extraction of hundreds of millions of cubic yards (cy) of sand and gravel (primarily gravel), with these extraction areas covering more than 6,400 acres (NRC 2003a). The project would require the development of new gravel mine site(s) and extraction of approximately 2 to 5 million cy of gravel, depending on the alternative. Taken as a whole, sand and gravel resources are abundant on the North Slope. The project material site would be centrally located and, by volume, negligible in comparison to the amount of gravel locally available. Sand and gravel underlies the entire project area. The proposed development would not deplete these resources. RFFAs within or near the project area would likely consist of more oil and gas development projects with similar sand and gravel needs. Therefore, no concerns related to adverse cumulative effects to sand and gravel resources have been identified.

Cumulative impacts to paleontological resources for any of the action alternatives are likely to be inconsequential, considering the small scale of the proposed project relative to other developments on the North Slope and to the vast areal extent of potential fossil-bearing strata. There could be a greater overall impact due to Alternative C because of the additional areal disturbance from construction of the gravel access road. For all action alternatives, cultural resource surveys and inventories would be conducted prior to any exploration and development activities, in addition to the Point Thomson Project. These studies may identify fossil remains of value, thereby minimizing the potential for future cumulative effects to occur. In addition, if remains are encountered over time, they can be reported and preserved, if deemed to be of high-enough value. In summary, no concerns related to adverse cumulative effects to paleontological resources have been identified.

5.1.6 Geologic Hazards

As described in Section 3.1.8, the primary geologic hazards in the project area are associated with seismicity. These include ground motion and liquefaction. The North Slope has low-to-moderate seismic risk.

Under all alternatives, earthquakes have the potential to cause damage to structures. This would be addressed by compliance with the IBC, which requires structures to be designed to withstand ground accelerations expected to occur at the site location based on seismic hazard analysis. Further, modern steel pipelines have a history of performing well during seismic events and are generally vulnerable to earthquake damage only at locations of large and abrupt, permanent ground deformations (i.e., surface faults; Hall et al. 2003, McDonough and Strand 2002, O'Rourke and Palmer 1996). No active faults are recognized at the surface in the project area (USGS 2010a). Because most of the soils in the project area are continuously frozen all year and those that are seasonally thawed are limited to a thickness of a few feet (see Section 3.2, Soils and Permafrost), potential effects from soil liquefaction would be minor. Therefore, no special mitigation would be necessary for earthquake shaking.

5.1.7 Alternatives Comparison and Consequences

All of the action alternatives would develop petroleum hydrocarbons from the Point Thomson Reservoir, which would be an irreversible impact to geologic resources. The main difference among the alternatives relative to impacts on geologic resources is that under Alternative C more than twice the amount of gravel would be used than under Alternative B. Because gravel is plentiful in the project area, the use of gravel would not have a measureable effect on gravel supplies. Alternative C would have more extensive changes to geomorphologic features compared to the other alternatives due to the all-season gravel access road and associated gravel mines, which would become reservoirs. The gravel mine reservoirs would be a permanent change to the landscape. Impacts to paleontological resources would be unlikely

The North Slope is considered an area with low-to-moderate seismic risk. None of the alternatives would cross or be located near active surface faults.

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5.2 SOILS AND PERMAFROST

The key findings of effects for soils and permafrost are summarized below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

All Action Alternatives: Construction activities that disturb soils and permafrost, particularly gravel mining and gravel fill placement, would probably result in major impacts across a large portion of the project area. Some of these impacts could last for 100 years or more.

Alternative A: No impacts

Differentiators:

- Alternative C, with its gravel access road, would have three times more gravel fill than Alternative B and require five additional gravel mines.
- Alternative E would have about 20 percent less gravel infrastructure.

5.2.1 Methodology

This analysis is an evaluation of the potential direct, indirect, and cumulative impacts to soils and permafrost within the project area. Analysis was conducted by reviewing the Applicant’s project description, voluntary proposed mitigation measures, information provided by the Applicant through the RFI process. The Applicant’s information was verified by independently reviewing reference sources and previous publications on soils and permafrost within and near the project area. The available information was used to determine how each of the alternatives would impact soils and permafrost relative to existing conditions. GIS was used to calculate acreages of direct impacts. Geotechnical investigations completed to date in the project area provide depth to permafrost in a limited number of locations, but depths were determined based on winter borings and may not reflect the accurate current depth to permafrost as measured in the summer months.

The impact evaluation criteria used to assess impacts during construction, drilling, and operations phases of the project are defined in Table 5.2-1.

Table 5.2-1: Impact Criteria—Soils and Permafrost		
Impact Category*	Intensity Type[a]	Specific Definition for Soils and Permafrost
Magnitude	Major	Disturbance such that the resulting ground surface is below tundra grade and backfilling with overburden is required to prevent ponding and/or flow of water for restoration to be successful.
	Moderate	Disturbance is such that revegetation by seeding or sodding with native tundra is required to prevent degradation of the thermal regime, erosion, or ponding or water flow for restoration to be successful.
	Minor	The thermal regime is maintained and disturbance of vegetative cover such that successful site rehabilitation can be accomplished through natural recolonization.
Duration	Long term	Irreversible impact on soil and permafrost thermal regime or soil quality at any depth such that tundra restoration and/or rehabilitation would not be possible in 100 years.
	Medium term	Impact would last for 10 to 100 years.
	Temporary	Impact would last less than 10 years.
Potential to Occur	Probable	Unavoidable.
	Possible	Might occur (avoidance may be possible).
	Unlikely	Not likely to occur.
Geographic Extent	Extensive	Extends beyond the project area.
	Local	Extends beyond project component footprints and/or covers all or a large portion of the project area.
	Limited	Confined to the project component footprints.

[a] Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology.

5.2.2 Alternative A: No Action

Alternative A consists of monitoring the two wells at the existing PTU-3 pad. Alternative A does not include any construction or ground-disturbing activities and would not result in impacts to soils or permafrost.

5.2.3 Alternative B: Applicant's Proposed Action

Development of Alternative B would include multiple project components and activities during construction, drilling, and operations that have the potential to impact soils and permafrost.

5.2.3.1 Alternative B: Construction

Activities on or disturbing soil and permafrost that would occur during Alternative B construction include gravel mining; placement of fill on tundra; construction of ice roads and pads; tundra travel; installation of buried power cables by trenching; construction of culverts, VSMs, and other support structures; and wastewater discharge. Direct effects include removal and burial of soil and permafrost (Table 5.2-2). The primary indirect effect of construction activities on soil and permafrost would be permafrost degradation. Gravel extraction, fill placement, and culvert installation are the construction activities most likely to cause permafrost degradation. In ice-rich permafrost, such as found in the project area, degradation would be likely to cause thermokarst (Walker et al. 1987b). Changes in surface hydrology, fill placement on tundra, inundation, changes in surface albedo, and removal or alteration of vegetative cover all may contribute to formation of thermokarst or permafrost degradation.

Table 5.2-2: Alternative B—Direct Impacts to Soils and Permafrost	
Component	Acres
Construction	
Gravel Mine Site	57.2
Fill Placement	213.0
Seasonal Ice Roads and Pads	985.1
Cable Trenching[a]	0.5
VSM Installation[b]	0.2
Operations	
Dust Fallout, Snowplow Spray Deposition, Gravel Spray[c]	134.9

[a] The power line cable trench would be 1.5 feet wide and 2.9 miles long covering an area of 0.53 acres.

[b] Maximum diameter for VSMs would be 18 inches, with a 0.5-foot zone of impact around the pile. Area multiplied by 3,270 VSMs.

[c] Dust fallout was determined by placing a 35-foot buffer around all gravel infrastructure and calculating the total area. Walker and Everett (1987) determined that the majority of dust falls out within 35 feet.

Gravel Mining and Storage

A new gravel mine site would be excavated to provide gravel for construction of roads, pads, and an airstrip. Specific engineering and geotechnical approaches to pit excavation and partial backfilling would be required to preserve the permafrost thermal regime, especially in areas with large volumes of near-surface ice.

At the mine site, organic and inorganic overburden would be removed and stockpiled separately on adjacent ice pads for backfilling into the excavated section of the pit each year before spring melt (see Chapter 2, Alternatives, for construction details). Massive ice would be excavated and stockpiled on an ice pad adjacent to the gravel pit and allowed to melt in the spring (Appendix D, RFI 46). Gravel would be excavated and directly applied in construction. Some gravel would be stockpiled for maintenance use. Pit run gravel would be extracted (i.e., no separation of fines is planned) and utilized for construction applications (Appendix D, RFI 46).

Flooding of the gravel mine for use as a secondary water reservoir would occur naturally and constitute a loss of overburden and active layer soils, and an alteration of near-surface hydrology and surface microtopography. This could cause erosion to the embankments along the perimeter of the gravel pit. The effect would be localized to the footprint of the gravel mine and ice pads. Impacts would be minimized by replacing the mine site overburden along the margins of the mine with mineral overburden laid down first and organic overburden on top to allow for natural colonization. The gravel mine margin would be revegetated to restore the insulative capacity of the active layer and allow reaggradation of permafrost where thaw occurred.

The degree of permafrost degradation initiated by gravel extraction largely depends on the depth of the final excavation. Lakes of depth greater than 6 feet, such as the one that would be formed when the gravel mine is inundated, may cause a talik (i.e., a layer of ground that remains unfrozen year round) that grows downward into the permafrost. The lake may continue to deepen from thaw settlement as the talik grows (NRC 2003a). Thermal conductivity is greater in water than for tundra with vegetation, further increasing the likelihood of permafrost thaw. This impact would be geographically limited to the gravel mine footprint and immediate surrounding area.

Fill Placement

The construction of gravel roads, pads, and an airstrip requires a thickness of gravel greater than or equal to the depth of summer thaw. Such depths of fill prevent destructive thaw settlement (NRC 2003a). Gravel roads and pads would be a minimum of 5 feet thick.

Placement of fill on tundra would be a direct loss of the underlying soil (Table 5.2-2). Placement of fill on tundra would cause indirect impacts associated with soil compaction, alteration of permafrost thermal regime, alteration of surface hydrology, and road dust effects. Some of these effects could extend beyond the gravel footprint. The most important consideration for roads and pads would be minimizing changes to surface drainage that might cause permafrost thawing and subsidence. Vegetation would be compacted by excess gravel and construction operations along the edge of the road fill footprint, resulting in greater heat conductivity, potential thaw, and subsidence parallel to road beds. Road fill effectively dams surface water flow, creating impoundments that increase heat transfer to the underlying soil (Auerbach 1997). Section 5.6, Hydrology, describes stream crossing structures and culvert placement to allow sheet flow drainage.

Dust from the gravel roads settles on surrounding vegetation and snow (Everett 1980, Walker and Everett 1987, Walker et al. 1987a), increasing soil alkalinity, decreasing albedo and increasing thermal conductivity, and promoting earlier thaw in spring than for surrounding undisturbed areas. These impacts may cause greater thaw depth of the active layer. Road dust has the greatest impact within 35 feet of a road, but the dust can settle as far as 300 feet downwind (Walker and Everett 1987).

Ice Roads and Pads

Several studies have found little change in the thermal regime or compaction of soil as the result of ice road construction along the TAPS (Walker et al. 1987b, BLM 2002a). Single season ice pads are thicker than ice roads and may take longer to melt; however, according to Guyer and Keating (2005), impacts from ice roads and ice pads would be similar. Winter water withdrawal from natural ponds and lakes for use in building ice roads and pads would not be expected to affect the soil and permafrost thermal regime along the shoreline of such water bodies, as complete recharge and normal water levels would be expected to return during spring snowmelt runoff. If complete recharge does not occur, exposed dark soil would decrease surface albedo and increase heat transfer to the soil and permafrost. As an indirect impact, thawing of the lakeshore permafrost would possibly result in subsidence, slumping of lakeshore soils, and potentially alter thaw lake drainage patterns and the thaw lake cycle. If aquatic vegetation along the lakeshore margin dies, the loss of vegetative insulation may cause erosion and degradation of the permafrost regime. Water use permits require monitoring of lake and reservoir recharge and if complete recharge does not occur at a given source, the permitted water use would be reduced or eliminated the following year.

Power Cable Trenching

The installation of power cables buried in tundra would require trenches to be dug. The cables would be buried at a depth sufficient to protect the cables and the permafrost, anywhere from 3.5 feet to 12 feet and approximately 1.5 feet wide, but at the smallest width possible. Potential impacts from trenching include erosion and subsidence of disturbed and surrounding soils.

Support Structures

The installation of culverts, VSMs, and other support structures (bridge foundation pipe piles, and anchor pile for the barge offloading bulkhead) would require excavation, grading, drilling, alteration of soil physical and biological properties, and destruction of the overlying vegetative cover. Loss of the vegetative cover and compaction of soil during installation may increase thermal transfer to the subsurface.

The impact due to VSM installation (see Table 5.2-2) was determined by assuming a 6-inch area of disturbance around each 18-inch-diameter pile. The maximum area impacted by each VSM installation would be 1.13 square feet.

The high moisture content of the soils in the project area could make these soils susceptible to ice lens formation, a common process in freeze-thaw cycles in soil (Bruggers and England 1982). Though not commonly observed on the North Slope, ice lens formation could be magnified due to the thermal conduction differences between human-made structures and the soil and cause frost heave (frost-jacking of the structures) or cause the structures to sink into the ground over time.

Culverts would be used under roads to serve two purposes: preserve natural waterway drainage at stream crossings, and allow surface water flow to cross roads. Culverts act as a thermal magnifier, conducting warm air in summer to the subsurface soils on which they rest, which could cause permafrost degradation. Conversely, in winter, if not filled with snow, culverts provide conduits for extremely cold air, potentially causing ice ***aggradation*** under the structure. Culverts would not be capped in winter, which could lead to blockage by snow and ice, further restricting flow of spring breakup water.

Structural pipe culverts would be used to minimize the potential for culvert bowing, which could raise the ends of the culvert above the level of impounded water. Because the available gravels for road construction in this project are high in ice content, differential thaw settlement would be likely if the roads are not properly compacted or the gravel has excessively high moisture content when placed. Changes in thermal regime caused by culvert installation would be limited to the area immediately surrounding the structure, but includes the length of all roads in the project area. The design and placement of culverts is further addressed in Section 5.6, Hydrology.

Wastewater Discharge

Discharge, especially in a concentrated area, may erode surface soil, create drainage patterns, and initiate thermal erosion. Discharge of hydrostatic test water directly to the tundra would likely exceed the water storage capacity of the active layer soil such that some of the discharge would not be absorbed. Impoundment or flooding by surface discharge may cause subsidence or initiate thermokarst by increased heat conductivity through the surface water to the active layer. If water were discharged in winter, it could cause an ice sheet that would increase soil moisture in spring and delay spring thaw. This may induce changes in vegetation communities that could eventually change the thermal regime of the soil.

Drilling

The impacts from drilling would be limited to soil disturbance immediately surrounding the wellheads.

5.2.3.2 Alternative B: Operations

Impacts to soils and permafrost during operations would include direct effects from ongoing project activities, indirect effects resulting from gravel fill and other structures that occur over time, or a combination of direct and indirect effects.

Direct effects on soil and permafrost would result from dust fallout, snowplow spray deposition, gravel spray, tundra travel, and transmission of warm fluids.

Vehicle traffic on gravel roads can produce dust that settles on the roadside; the majority of dust settles within 35 feet of the road (Walker and Everett 1987). In summer, this dust can increase soil alkalinity which reduces plant vigor in acidic tundra (Walker and Everett 1987), thus reducing the insulating effect of the vegetative cover to the underlying soil. Due to the project's proximity to the coast, soils may naturally be slightly alkaline and thus the impacts due to dust may be lessened. During winter, the dust reduces the albedo of roadside snow, which initiates earlier melting and increases the cumulative heat absorption of the active layer. Snow acts as an insulator for the soil as well, and accelerated snowmelt reduces the insulating effect (Auerbach 1997). Loss of surface insulation, either by loss of vegetation or snow, causes earlier spring thaw and earlier freeze-up at the end of summer.

Road grading and snowplowing may deposit gravel onto tundra adjacent to the roads and pads. Over time, accumulation of gravel may compact or smother vegetation, reducing active layer insulation and increasing thaw. Thin deposits of dark-colored gravel may slightly reduce surface albedo, increase surface soil temperatures, and promote vegetation growth, which would better insulate the active layer. Overall, dust fallout, snowplow deposition, and other gravel spray onto the tundra could impact 134.9 acres adjacent to gravel roads assuming a 35-foot-wide corridor of impact on each side of the road.

Culvert maintenance and replacement would occur as needed. Potential effects due to culverts during operations would be downstream erosion and disturbance of the surface vegetation and soils in the work area.

Tundra travel would occur for regular and emergency maintenance of pipelines and other infrastructure and to facilitate construction of seasonal ice roads. The impacts associated with winter travel of tundra-safe, low-pressure vehicles would be the potential for soil compaction and the alteration of the thermal regime of the permafrost. Summer travel by tundra-safe, low-pressure vehicles would be allowed by special permit only, although exceptions could be made for emergency situations. Tundra-safe, low-pressure vehicle travel in the summer would be much more likely to compact soil and disturb the insulating surface vegetation than travel in the winter. The degree of impact depends on vegetation type and organic layer depth, surface and soil moisture levels, and the number of passes and use of the same tracks made by a vehicle. Wet tundra would be especially susceptible to compaction and disturbance and multiple passes in a single track has the most noticeable impact (Walker et al. 1987c).

The use of heavy equipment on the tundra associated with pipeline repairs (particularly emergency repairs) and spill response would directly impact soils and permafrost, potentially causing permafrost degradation, thermokarst, and hydraulic erosion. The magnitude of the impact would depend on the season, extent, and duration of these activities. .

Off-pad pipelines carrying warm fluids would be elevated on VSMs and would not pose a thaw risk to permafrost. However, warm production and injection wells can form thaw chimneys, which are thawed areas surrounding the well. Closely spaced directional wells can thaw the underlying permafrost that supports the well pads. Thaw at depths of greater than 40 feet may slowly develop, causing thaw settlement over time. Settlement may cause difficulty during site rehabilitation at the end of field life and result in permanent depressions on the landscape (NRC 2003a). This type of thaw would be minimized by installing thermosyphons around wells to remove unavoidable heat transfer from wellbore fluids. Additionally, conductor piles extending to depths of about 100 feet or more would be insulated and the well annuli filled with an insulating gel to minimize heat transfer to permafrost.

Indirect effects of operations on soil and permafrost would be associated with project infrastructure and may cause permafrost degradation over time. Primary indirect effects include snow drift accumulation and interruption of natural surface sheet flow.

Snow drift accumulation has been observed in association with oil field structures in Prudhoe Bay (Klinger et al. 1983) and results in increased local soil moisture levels (Brown et al. 1984). Because of the prevailing northeasterly wind in the project area, snow drift accumulation would be likely to occur on the downwind sides of structures and roads, especially on the east-west roads described in Section 5.2.3.1, Alternative B: Construction. The downwind sides of these roads would be hydraulically upgradient. The inundation and ponding of surface water from the melting of accumulated drifted snow would increase heat transfer to the subsurface and potentially induce permafrost degradation and erosion of surface sediments (Walker et al. 1987c). This impact would be compounded with other structure and roadside effects.

Interruption of natural surface sheet flow by roads and structures or improperly functioning culverts (e.g., blocked with snow and ice or bowed by differential ice settlement of road gravel) may cause ice wedge polygon degradation or the transformation of flat and low-centered polygons to degraded high-centered polygons. In addition, if surface sheet flow were interrupted, aquatic vegetative cover in the polygon troughs would decrease, exposing the wedge ice to greater thermal radiation, which could induce ice melting (Walker and Everett 1987). A sudden release of impounded water caused by the melting of ice dams in culverts could lead to washouts (Brown et al. 1984, McDonald 1994).

5.2.3.3 Alternative B: Impacts Summary

The extraction and placement of gravel material and long-term movement of dust and gravel have the greatest potential to impact soils and permafrost under Alternative B (Table 5.2-3). The direct impacts of gravel extraction and placement of fill for pads and roads would have a major impact, but would be limited in extent to the gravel footprint and associated area of influence. Over time, dust and gravel spray from roads and pads onto the surrounding tundra may lead to impacts on adjacent soils and permafrost. Changes to soils and permafrost could result in changes in or disturbance to vegetation and hydrology, which could lead to changes in wildlife habitat.

Table 5.2-3: Alternative B—Impact Evaluation for Soils and Permafrost

Component	Magnitude	Duration	Potential	Extent
Gravel Mine Site	Major	Long term	Probable	Limited
Fill Placement	Major	Long term	Probable	Local
Seasonal Ice Roads and Pads	Minor	Temporary	Probable	Limited
Cable Trenching	Moderate to major	Temporary to medium term	Probable	Limited
Support Structures	Moderate	Long term	Probable	Limited
Wastewater Discharge	Moderate	Temporary	Probable	Limited
Well Operations	Minor	Long term	Possible	Limited
Tundra Travel	Moderate to major	Medium term to long term	Possible	Local
Dust Fallout, Snowplow Spray Deposition, Gravel Spray	Moderate	Medium term	Probable	Local

5.2.4 Alternative C: Inland Pads with Gravel Access Road

Alternative C is described in detail in Chapter 2, Alternatives, and would include multiple project components and activities with the potential to impact soils and permafrost.

5.2.4.1 Alternative C: Construction, Drilling, and Operations

Direct and indirect impacts of Alternative C would be similar in all project phases to those presented for Alternative B, but would occur over greater spatial and temporal extents because the project area would extend to the south and include a 44-mile-long gravel access road from Point Thomson to the Endicott Spur Road. Bridges would be constructed to cross the major rivers and gravel mines would be located approximately every 10 miles along the gravel access road.

Measurable impacts to soils and permafrost from Alternative C are presented in Table 5.2-4.

Table 5.2-4: Alternative C—Direct Impacts to Soils and Permafrost

Component	Acres
Construction	
Gravel Mine Sites (six total)	130.9
Fill Placement	604.7
Seasonal Ice Roads and Pads	1,125.8
VSM Installation[a]	0.3
Operations	
Dust Fallout, Snowplow Spray Deposition, Gravel Spray[b]	590.5

[a] Maximum diameter for VSMs would be 18 inches, with a 0.5-foot zone of impact around the pile. Area multiplied by 4,122 VSMs.

[b] Dust fallout was determined by placing a 35-foot buffer around all gravel infrastructure and calculating the total area. Walker and Everett (1987) determined that the majority of dust falls out within 35 feet.

The gravel road would require construction of 21 culvert batteries, 27 bridges, and 2 bridges or culverts at 50 stream crossings. Installation of bridge support infrastructure would require overburden removal and permafrost disturbance. Depending on the bridge support material used, heat may be conducted into the permafrost, causing thaw and subsidence in the immediate area. If flow is constricted, sedimentation could occur upstream of the water body crossings, and potentially increase the area on which vegetation may colonize and decrease summer thaw. Any erosion associated with the crossing structures would constitute soil loss, potentially expose ground ice, and precipitate further erosion of the exposed ice and permafrost.

The multiple gravel mines along the gravel road would be deep excavations (greater than 6 feet deep), and would be likely to create a talik as described for Alternative B, especially if constructed over permafrost with a high volume of pure ice.

5.2.4.2 Alternative C: Impacts Summary

The extraction and placement of gravel material and long-term movement of dust and gravel have the greatest potential to impact soils and permafrost under Alternative C (Table 5.2-5). The addition of a gravel access road and associated gravel mines would result in greater impacts to soils and permafrost relative to Alternative B, including long-term impacts from dust and gravel spray.

Table 5.2-5: Alternative C—Impact Evaluation for Soils and Permafrost

Component	Magnitude	Duration	Potential	Extent
Gravel Mine Site (six total)	Major	Long term	Probable	Limited
Fill Placement	Major	Long term	Probable	Local
Seasonal Ice Roads and Pads	Minor	Temporary	Probable	Limited
Support Structures	Moderate	Long term	Probable	Limited
Wastewater Discharge	Moderate	Temporary	Probable	Limited
Well Operations	Minor	Long term	Possible	Limited
Tundra Travel	Moderate to major	Medium term to long term	Possible	Local
Dust Fallout, Snowplow Spray Deposition, Gravel Spray	Moderate	Medium term	Probable	Local

5.2.5 Alternative D: Inland Pads with Seasonal Ice Access Road

Alternative D is described in detail in Chapter 2, Alternatives, and would include multiple project components and activities that have potential to impact soils and permafrost.

5.2.5.1 Alternative D: Construction, Drilling, and Operations

Direct and indirect impacts to soils and permafrost from construction, drilling, and operations for Alternative D would be similar to but more extensive than those presented for Alternative B, as approximately 50 percent more gravel fill would be placed. Impacts would occur over a smaller spatial extent than Alternative C because of the absence of the gravel road.

Measurable impacts to soils and permafrost from Alternative D are presented in Table 5.2-6.

Table 5.2-6: Alternative D—Direct Impacts to Soils and Permafrost

Component	Acres
Construction	
Gravel Mine Site	65.7
Fill Placement	284.8
Seasonal Ice Roads and Pads	890.3
Cable Trenching[a]	<0.1
VSM Installation[b]	0.3
Operations	
Dust Fallout, Snowplow Spray Deposition, Gravel Spray[c]	185.7

[a] The power line cable trench would be 1.5 feet wide and 180.3 feet long covering an area of 0.01 acre.

[b] Maximum diameter for VSMs would be 18 inches, with a 0.5-foot zone of impact around the pile. Area multiplied by 4,090 VSMs.

[c] Dust fallout was determined by placing a 35-foot buffer around all gravel infrastructure and calculating the total area. Walker and Everett (1987) determined that the majority of dust falls out within 35 feet.

5.2.5.2 Alternative D: Impacts Summary

Similar to Alternative B, the extraction, placement, and long-term movement of dust and gravel have the greatest potential to impact soils and permafrost under Alternative D (Table 5.2-7).

Table 5.2-7: Alternative D—Impact Evaluation for Soils and Permafrost				
Component	Magnitude	Duration	Potential	Extent
Gravel Mine Site	Major	Long term	Probable	Limited
Fill Placement	Major	Long term	Probable	Local
Seasonal Ice Roads and Pads	Minor	Temporary	Probable	Limited
Cable Trenching	Moderate to major	Temporary to medium term	Probable	Limited
Support Structures	Moderate	Long term	Probable	Limited
Wastewater Discharge	Moderate	Temporary	Probable	Limited
Well Operations	Minor	Long term	Possible	Limited
Tundra Travel	Moderate to major	Medium term to long term	Possible	Local
Dust Fallout, Snowplow Spray Deposition, Gravel Spray	Moderate	Medium term	Probable	Local

5.2.6 Alternative E: Coastal Pads with Seasonal Ice Roads

Alternative E is described in detail in Chapter 2, Alternatives, and would include multiple project components and activities that have potential to impact soils and permafrost.

5.2.6.1 Alternative E: Construction, Drilling, and Operations

Direct and indirect impacts from construction, drilling, and operations for Alternative E would be similar to those presented for Alternative B. Impacts associated with dust fallout and gravel spray would be reduced because of the decreased length of roads. Multiseason ice pads, which would be used during drilling, would have a greater potential to impact soils and permafrost because of compaction of the underlying soil and inhibition of vegetation regeneration when use of the pad was complete. Along the margins of the ice pads, vegetation may break dormancy and die and the soils would warm, causing subsidence. Alternative E is the only alternative that includes multiseason ice pads. Measurable impacts to soils and permafrost from Alternative E are presented in Table 5.2-8.

Table 5.2-8: Alternative E—Direct Impacts to Soils and Permafrost	
Component	Acres
Construction	
Gravel Mine Site	43.2
Fill Placement	153.3
Seasonal Ice Roads and Pads	888.2
Cable Trenching[a]	<0.1
VSM Installation[b]	0.2
Multiseason Ice Pads	22.0
Operations	
Dust Fallout, Snowplow Spray Deposition, Gravel Spray[c]	61.5

[a] The power line cable trench would be 1.5 feet wide and 704 feet long covering an area of 0.02 acres.
[b] Maximum diameter for VSMs would be 18 inches, with a 0.5-foot zone of impact around the pile. Area multiplied by 3,270 VSMs.
[c] Dust fallout was determined by placing a 35-foot buffer around all gravel infrastructure and calculating the total area. Walker and Everett (1987) determined that the majority of dust falls out within 35 feet.

5.2.6.2 Alternative E: Impacts Summary

Under Alternative E, gravel extraction impacts would be similar to Alternatives B and D; however, the gravel fill would be concentrated at pads and the potential for dust and gravel migration onto the tundra would be reduced because of the reduction in gravel access roads.

Table 5.2-9: Alternative E—Impact Evaluation for Soils and Permafrost

Component	Magnitude	Duration	Potential	Extent
Gravel Mine Site	Major	Long term	Probable	Limited
Fill Placement	Major	Long term	Probable	Local
Seasonal Ice Roads and Pads	Minor	Temporary	Probable	Limited
Cable Trenching	Moderate to major	Temporary to medium term	Probable	Limited
Support Structures	Moderate	Long term	Probable	Limited
Wastewater Discharge	Moderate	Temporary	Probable	Limited
Well Operations	Minor	Long term	Possible	Limited
Tundra Travel	Moderate to major	Medium term to long term	Possible	Local
Dust Fallout, Snowplow Spray Deposition, Gravel Spray	Moderate	Medium term	Probable	Local

5.2.7 Mitigative Measures

This section describes measures to mitigate impacts to soils and permafrost from the Point Thomson Project. The Applicant has proposed design measures that would be included as part of the project; BMPs and permit requirements would be stipulated by federal, state, and local agencies, and the Corps has considered additional mitigation measures.

5.2.7.1 Applicant's Proposed Design Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on soils and permafrost.

- Placing a minimum of 5 feet of gravel fill, to insulate the underlying permafrost.
- Elevating heated buildings or structures on pilings, to prevent or reduce heat transfer to underlying soils and preserve the thermal integrity of the permafrost.
- Elevating off-pad pipelines containing warm (above freezing) fluids on VSMs.
- Minimizing or avoiding impoundments (which can act as thermal sinks and create thermokarst) by maintaining natural drainage.
- Designing bridges and culverts to maintain existing surface drainage patterns and prevent erosion.
- Installing thermosyphons around wells to remove unavoidable heat transfer from wellbore fluids. Additionally, conductor piles will be insulated and the well annuli filled with an insulating gel to minimize heat transfer to the permafrost.
- Requiring workers to stay on gravel surfaces unless their job duties require them to be on the tundra, to minimize compaction and disturbance to surface insulating vegetation or snow.

- Applying dust control measures to roads, pads, and summer mining activities to protect insulating vegetation, and minimizing dust settlement on vegetation or snow which could increase thermal conductivity and promote earlier spring thaw in affected areas.
- Reducing surface discharge of wastewaters through use of a disposal well, including zero discharge of produced water and drilling wastes. Surface discharges could erode surface soil, create drainage patterns, and initiate thermokarst erosion.
- Implementing operating procedures and maintenance programs to ensure the design measures remain in effect throughout the life of the project. These include maintaining gravel depth according to design measurements, maintaining culverts and bridges to provide unimpeded water flow, and maintaining the well thermosyphons.
- Implementing spill prevention and response programs, as detailed in Section 5.24, Spill Risk and Impact Assessment.

5.2.7.2 BMPs and Permit Requirements

Erosion control measures would be included in the project SWPPP and project-specific stipulations that are required by the SPCO as part of the ROW lease. In addition, many of the measures designed to protect vegetation and wetlands (see Section 5.8.7.2) would also avoid or minimize impacts to soils and permafrost.

5.2.7.3 Corps-considered Mitigation

In addition to the Applicant's proposed design measures, BMPs, and permit requirements, the Corps, in consultation with others, is considering the following actions to avoid or minimize impacts to soils and permafrost:

- Prepare and implement a plan for dust suppression that addresses gravel roads/pads, and year-round mining activities. As applicable, include use of environmentally safe chemical palliatives and use of chip-seal on the infield roads. The plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.
- Align roads to avoid ice-rich permafrost, if possible.
- Direct discharge of mine dewatering water and hydrostatic test water toward a natural drainage gradient to minimize warming of the near-surface soils and ponding of surface water. Control the discharge flow rate to avoid erosion of tundra or tundra vegetation.
- If summer tundra travel is necessary using tundra-safe low-pressure vehicles, limit traffic as much as possible, avoid tight turns, use different tracks with each pass, and follow the shortest path from origination to destination.
- To minimize impacts from the power cable trenching:
  - Use trenching, cable placement, and backfilling methods that minimize snow in the trench. Remove snow from the trench before backfilling to minimize impacts and the subsequent effort needed for rehabilitation.
  - Use material removed from the trench as backfill. Avoid chunks of sand and gravel larger than approximately 3 inches in diameter. Mound material over the trench following backfill to ensure that the trench is filled to ground level after settlement.
  - Hand rake or shovel excavated material that remains on the adjacent tundra back into the trench during the first summer following trenching completion.

- Perform remedial work as needed to restore natural ground contours, to prevent surface water from flowing along the surface of the backfilled trench, and to ensure revegetation success.

5.2.8 Climate Change and Cumulative Impacts

5.2.8.1 Climate Change

Long-term observations in the Arctic have found a relationship between warmer winter air temperatures and deeper summer thaw depth of the active layer that is directly related to the abundance of ground ice and the magnitude of disturbance (Jorgenson et al. 2006, Brewer and Jin 2008, Lantuit et al. 2008). Warming temperatures can cause large-scale permafrost and ice wedge degradation (Jorgenson et al. 2006), which can cause substantial changes in surface hydrology (Woo et al. 2008). In the last several decades, temperatures have risen in the Northern Hemisphere, most notably in the arctic and subarctic regions (IPCC 2007), and there is evidence that this warming trend will continue unabated (Chapman and Walsh 1993, Serreze et al. 2003). The current warming trend in the Arctic is evidenced by permafrost degradation (Jorgenson et al. 2001, Pullman et al. 2007) and hydrologic changes (Morison et al. 2000).

Thermokarst is usually rare in areas of continuous permafrost and ***mean annual air temperatures*** (MAATs) between °F and 21°F. In the last few decades, MAAT has increased 3.6°F to 9°F in the Arctic (Osterkamp 2003), subjecting areas with a high volume of ground ice to a new thawing period. When even small portions of the landscape are directly affected by thermokarst, large areas of adjacent land can be impacted. The resulting drainage of surface and subsurface water into a newly created thermokarst trough network causes a positive feedback cycle, in which an increase in surface drainage flow in thermokarst troughs would increase thermal erosion (Jorgenson et al. 2006). Over the last several decades, permafrost temperatures have increased across the Arctic (Pavlov 1994, Osterkamp and Romanovsky 1999, Pavlov and Moskalenko 2002, Romanovsky et al. 2002, Couture et al. 2003, Smith et al. 2005). On average, temperatures in the upper 3.3 feet of soil and permafrost in arctic Alaska have increased by 0.9°F to 3.6°F (Osterkamp 2005), while in the Prudhoe Bay region, mean annual ground temperatures in the upper 10 inches have increased by up to 9.0°F since the mid-1980s (Romanovsky et al. 2003). Snow cover is decreasing in depth 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). If the Arctic becomes snow-free in the future, land surface albedo (reflectance) will be reduced and more solar energy will be absorbed, potentially accelerating warming of the permafrost soil (Curry et al. 1995).

MAATs throughout Alaska have shown a warming trend that, if it were to continue, would cause increased thaw depth of the active layer. A reversal of this trend would decrease summer thaw depth and increase permafrost thickness. The response of the soil and permafrost thermal regime from atmospheric warming is largely dependent on vegetation cover, soil texture, moisture content, wind exposure, and snow cover (Atkinson et al. 2006).

Degradation of the permafrost due to climate change would have the potential to impact the usability of infrastructure for the action alternatives. While gravel roads and pads insulate the permafrost directly beneath infrastructure, they cannot prevent thawing completely if the permafrost active layer around the infrastructure were to increase in thaw depth. Consequently, an increased thaw depth of the active layer could result in foundation failure in buildings on gravel pads, VSM sinking, or failure of the roadbed for gravel roads and deformation of culverts installed under roads.

5.2.8.2 Cumulative Impacts

Cumulative changes to soils on the North Slope would occur from natural processes (weathering and the annual freeze/thaw cycle) and human disturbance. Human-induced impacts have primarily occurred as a result of disturbance from industrial activities related to oil and gas exploration and transportation. Other disturbance has occurred from human settlements and subsistence living, archaeological excavation, cleanup of contaminated sites, overland moves, and the small amount of tourism and recreation that has occurred on the North Slope.

In 2001, the North Slope of Alaska consisted of 19 producing fields with a network of 115 gravel drill sites, 20 pads with processing facilities, 91 exploration sites, 16 airstrips, 1,395 culverts, 596 miles of roads and permanent trails, 450 miles of pipeline corridors, and 219 miles of transmission lines (NRC 2003a). Gravel roads and pads covered more than 8,800 acres and gravel mines covered nearly 6,400 acres (NRC 2003a). Approximately 17,700 acres of soils and permafrost would have been cumulatively affected from all past and present oil industry infrastructure on the North Slope (NRC 2003a). This quantity does not include potential secondary impacts that may occur adjacent to the infrastructure due to changes in thermal regime.

In the eastern portion of the North Slope, past and present oil and gas development has been relatively limited. Table 5.2-10 presents the cumulative acres of gravel infrastructure in the eastern portion of the North Slope (east of Foggy Island) and the additional gravel acreage each Point Thomson action alternative would contribute to the cumulative total (NRC 2003a).

Table 5.2-10: Acres of Oil Infrastructure on the North Slope East of Foggy Island

	Gravel Roads	Gravel Airstrips	Gravel Pads	Gravel Mines	Total Gravel Infrastructure
Existing Oil and Gas Infrastructure (acres)[a]	31	22	126	89	398
% of total area east of Foggy Island	—	—	—	—	0.20
Alternative B Infrastructure (acres)	80	43	89	57	267
% increase relative to existing infrastructure	259	189	70	65	67
% of total area east of Foggy Island	—	—	—	—	0.13
Alternative C Infrastructure (acres)	444	43	118	131	736
% increase relative to existing infrastructure	1,456	189	94	148	185
% of total area east of Foggy Island	—	—	—	—	0.39
Alternative D Infrastructure (acres)	121	43	122	66	351
% increase relative to existing infrastructure	396	189	96	74	88
% of total area east of Foggy Island	—	—	—	—	0.18
Alternative E Infrastructure (acres)	24	28	101	43	197
% increase relative to existing infrastructure	78	127	80	49	49
% of total area east of Foggy Island	—	—	—	—	0.10

Source: NRC 2003a

[a] Cumulative oil and gas infrastructure as of 2001. While some infrastructure at the Badami site may have been developed since 2001, the increase in footprint has not been quantified and is limited in extent.

The action alternatives would require the operation of facilities and support vehicles over an anticipated 30-year project life. Although the effects to soils and permafrost from oil- and gas-related activities that would occur under the Point Thomson action alternatives would be similarly localized as those occurring under many other past, present, and planned projects on the ACP, the Point Thomson Project could add to the cumulative effects on permafrost thermal regime across the landscape. The cumulative effects from gravel fill would be expected to be greater in Alternative C than in other alternatives, due to the greater quantity of gravel fill that would be placed on tundra. While Alternative C would represent an increase in acreage of industrial footprint on the eastern North Slope by 185 percent, oil and gas development would still represent a relatively small portion of the total acreage (roughly 200 million acres) of the eastern North Slope.

Land-based past, present, and reasonably foreseeable oil- and gas-related actions described in Section 4.2, Cumulative Impacts Methodology, including the Point Thomson Project, and other non-oil and gas activities, could result in a cumulative effect on soils and the permafrost thermal regime. Future projects in close proximity to Point Thomson that may have impacts on soils and permafrost include the development of other Brookian formation areas (e.g., Slugger, Sourdough, and Flaxman), the full-field development of Point Thomson, and a Point Thomson gas export pipeline. The extent of potential impacts from these future projects is not yet known. However, because the current Point Thomson Project is being designed to accommodate full field development, impacts to soils and permafrost from full-field development would likely be limited to the expansion of the Central Pad, the expansion of the existing or development of a new gravel mine, and additional impacts from VSMs needed for infield pipeline (see Section 4.2, Cumulative Impacts). The primary mechanism for impact would be the placement of gravel overburden to provide foundations for roads and pads. The overburden covers and eliminates tundra vegetation but insulates and protects permafrost. While soils and permafrost impacts are additive, the total and incremental amount of disturbed area is small compared to the total resource within the North Slope region, and no substantial concerns related to adverse cumulative impacts to soils and permafrost have been identified at this time.

5.2.9 Alternatives Comparison and Consequences

On the ACP, the thermal regime of the soil and permafrost drives soil formation and properties. Stability of the thermal regime is affected by climate and disturbance activities, with human disturbance having immediate and potentially long-term effects on permafrost stability. Permafrost strongly influences surface morphology and hydrology. Changes to soils and permafrost could result in changes in or disturbance to vegetation and hydrology, which could lead to changes in wildlife habitat.

Activities that would disturb soil and permafrost include gravel mining, gravel fill placement, trenching for power cables, and construction of support structures. Alternative C, with its gravel access road, would have three times more gravel fill than Alternative B and require six gravel mines. Alternative E would have about 20 percent less gravel infrastructure. Over time, dust and gravel spray from roads and pads onto the surrounding tundra could impact adjacent soils and permafrost.

Little change would occur in the thermal regime or compaction of soil as the result of seasonal ice pad or ice road construction. Multiseason pads proposed only for Alternative E could cause compaction of the underlying soil and inhibition of vegetation regeneration. If lake levels are lowered through water use for ice infrastructure, decreasing surface albedo and increasing heat transfer to the soil and permafrost could cause thawing of the lakeshore permafrost. However, water use permits would require monitoring of recharge, and continued use would not be allowed of a water source that did not adequately recharge during breakup following a given construction season.

Table 5.2-11 provides a comparison of the alternatives relative to impacts on soils and permafrost based on acres disturbed.

Table 5.2-11: Comparison of Soil and Permafrost Acres Impacted for Action Alternatives

Component	Alternative B	Alternative C	Alternative D	Alternative E	Environmental Consequences
Gravel Mine Sites	57.2	130.9	65.7	43.2	Extraction of gravel, which may lead to talik formation and permafrost degradation.
Gravel Fill Placement	213.0	604.7	284.8	153.3	Soil compaction and alteration of the thermal regime of the permafrost.
Power Cable Trenching	0.5	None (buried in road)	<0.1	<0.1	Subsidence and erosion.
Support Structures[a]	0.2	0.3	0.3	0.2	Soil compaction and heat transfer to permafrost.
Dust/Snowplow/ Gravel Spray	134.9	590.5	185.7	61.5	Decreased albedo, increased thermal conductivity, and promotion of earlier spring thaw.
Seasonal Ice Roads and Pads	985.1	1,125.8	890.3	888.2	If lake levels are lowered, decreasing surface albedo and increasing heat transfer to the soil and permafrost could cause thawing of the lakeshore permafrost. Water use permits require monitoring of recharge and reduced or discontinued use of the water source that would avoid or minimize these impacts.
Multiseason Ice Pads	None	None	None	22.0	Compaction of the underlying soil, inhibition of vegetation regeneration, and subsidence along pad margins.

[a] Support structures include culverts, VSMs, bridge foundation pipe piles, and anchor pile for the barge offloading bulkhead. Acreages are for VSMs only.

5.3 METEOROLOGY AND CLIMATE

The key findings of effects for meteorology and climate are summarized below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

All Action Alternatives: No impacts to weather or climate would result; however, the action alternatives could potentially contribute to global climate change through the emission of GHGs, primarily CO_2.

Alternative A: No impacts.

Differentiators:

- Differences in GHG emissions are described in Section 5.4, Air Quality.

5.3.1 Methodology

Meteorology is the study of physics, chemistry, and dynamics of the earth's atmosphere and, commonly, it is the science of weather and short-term weather prediction. Climate is the long-term (generally 30 years or more) condition of the atmosphere in a given region and is represented typically by "normal" values of specific meteorological variables including, but not limited to: temperature, precipitation, wind speed, wind direction, and pressure.

A qualitative analysis of project impacts to meteorology was conducted through review of historical climate data and the Applicant's project description.

A qualitative analysis of impacts of climate change on local meteorology was conducted through review of historical climate data, information provided by the Applicant through the RFI process, and the Applicant's project description.

5.3.2 Alternative A: No Action

Alternative A includes monitoring of the two wells at PTU-3. Under this alternative, Corps permits would not be issued and production of the Point Thomson petroleum hydrocarbon resources could not proceed.

Under this alternative, there would be no impact to the average weather or climate experienced in the area. Maximum and minimum temperatures on a given day would, on the average, remain near normal. Precipitation patterns would, on the average, remain near normal, which is quite arid in the project area. Other meteorological variables such as wind speed and direction, relative humidity, and air pressure would be unaffected and continue to be influenced by latitude and nearby terrain, and driven by the climate system's natural forcing mechanisms described in Section 3.3.

5.3.3 All Action Alternatives

All action alternatives, including Alternative B (the Applicant's Proposed Action), are described in detail in Chapter 2. The various alternatives include the development of and/or use of project components such as drilling pads, ice roads, gravel mines, bridges, culverts, central processing unit, and gravel or seasonal roads.

For all action alternatives, there would be no impact to the average weather experienced in the area, as described under the No Action Alternative. Likewise, there would be no substantive localized impact to the climate of the area. Large metropolitan areas experience a recognized urban heat island effect, which occurs when natural land cover is replaced with pavement, buildings, and other infrastructure, which can change the local climate. Because none of the action alternatives would convert more than 4 percent of the natural land cover in the total study area to developed land, a discernible change in local climate would not be likely to occur.

5.3.4 Climate Change and Cumulative Impacts

5.3.4.1 Climate Change

As described in Section 4.3, the effects of global climate change are being observed in the Arctic in the form of MAAT increases. Additionally, the ACIA models indicate probable narrowing in the difference between daytime and nighttime temperatures as nighttime temperatures rise faster than daytime temperatures. Changes in climate are also likely to impact weather patterns, with an increase in annual precipitation but in the form of more frequent extreme storms (ACIA 2005). While climate change effects cannot be accurately predicted specifically for the Point Thomson area, overall temperature increases in the Arctic have the potential to impact the construction of ice infrastructure in the action alternatives because ice infrastructure melts slightly during daylight, and refreezes in the lower nighttime temperatures (HDR 2011k), a decrease in the temperature difference between day and night could reduce the usability of ice infrastructure. Additionally, an increase in storm frequency and intensity could reduce the accessibility of the project area by aircraft or barge.

5.3.4.2 Cumulative Impacts

The action alternatives would result in the emission of GHGs from construction and power generation, as described in Section 5.4, Air Quality. As discussed in detail in Section 5.4, no adverse cumulative impacts to global climate have been identified at this time.

5.3.5 Alternatives Comparison and Consequences

The climate and weather conditions of the North Slope are unique and strongly influence construction scheduling and methods. There would be no measureable impacts to weather or climate associated with any of the alternatives, with the exception that GHG emissions could contribute cumulatively to climate change. GHG emissions are addressed in Section 5.4, Air Quality.

5.4 AIR QUALITY

The key findings of effects for air quality are summarized below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

All Action Alternatives: All action alternatives emit air pollutants, including GHGs, over the life of the project but would meet applicable state and federal air quality standards.

Alternative A: No impacts.

Differentiators:

- During construction emissions from vehicles would be higher under Alternatives C and D compared to the other alternatives; however, the difference in local air quality would not be measurable.
- Emissions produced during drilling would be of greater duration under Alternatives C, D, and E compared to Alternative B.

5.4.1 Regulatory Requirements

The CAA and its implementing regulations (42 USC 7401 et seq., as amended in 1977 and 1990) are the basic federal statutes and regulations governing air pollution in the U.S. The following requirements have been reviewed for applicability to the proposed project:

- Title I New Source Review (NSR)/PSD Permits
- Title I Minor Permits
- Title V Operating Permits
- New Source Performance Standards (NSPS)
- National Emission Standards for Hazardous Air Pollutants (NESHAPs)/Maximum Achievable Control Technology (MACT)
- Greenhouse Gases (GHG), measured as carbon dioxide equivalent (CO_2-e)

Those requirements that do not apply to the project, and justifications for their exclusion from this section, may be found in Appendix F, Laws, Policies, and Plans Applicable to the Point Thomson Project. They include:

- Regional Haze
- Chemical Accident Prevention Provisions
- Compliance Assurance Monitoring
- General Conformity Rule

5.4.1.1 Title I New Source Review/Prevention of Significant Deterioration Permits

The NSR permitting program was established as part of the 1977 CAA Amendments. NSR is a preconstruction permitting program that ensures that air quality is not significantly degraded from the addition of new or modified major emissions sources. In poor air quality areas, NSR ensures that new emissions do not inhibit progress toward cleaner air. Additionally, the NSR program ensures that any large new or modified industrial source would be as clean as possible, and that the best available pollution control would be utilized. The NSR permit defines allowable construction, emission source operation guidelines, and applicable emission limits. The three types of NSR permitting include:

- PSD permits, which are required for new major sources or major sources making a significant modification in an attainment area.
    - For a new major stationary pollutant source in PSD areas, the criteria pollutant threshold level is 100 tons per year (tpy) for sources classified in one of the 28 named source categories listed in Section 168 of the CAA, and 250 tpy for any other type of source.
    - For the newly regulated pollutant category of GHG (not a criteria pollutant), the PSD major threshold for a new source is 100,000 tpy measured as CO_2-e.
    - For a source that is major for at least one regulated pollutant (i.e., is subject to PSD review), all pollutants that are emitted in amounts equal to or greater than the significant emission rates are also subject to PSD review (i.e., 40 tpy nitrogen oxides [NO_x], 100 tpy carbon monoxide [CO], 40 tpy sulfur dioxide [SO_2], 25 tpy of particles [PM], 15 tpy of particles of 10 micrometers [microns] or less [PM_{10}], 10 tpy of particles of 2.5 microns or less [$PM_{2.5}$], 40 tpy volatile organic compounds [VOCs], 75,000 tpy of GHG measured as CO_2-e).
- Nonattainment NSR permits, which are required for new major sources or major sources making a significant modification in a nonattainment. A major stationary pollutant source in a nonattainment area has the potential to emit more than 100 tpy of any criteria pollutant.
- Minor permits for pollutants from stationary sources that do not require PSD or nonattainment NSR permits; states are able to customize the requirements of the minor NSR program under a fully approved SIP.

Under PSD permitting rules, attainment areas are categorized as Class I, Class II, or Class III. Each classification has a defined level of pollutant concentration for SO_2, NO_2, and particulate matter that can be added after a baseline date. Class I areas were established primarily in certain national parks and wilderness areas (those above a certain size), and receive special protections under the CAA to help maintain pristine air quality. If a new source or major modification to an existing source is subject to the PSD program requirements and is within 62 miles of a Class I area, the facility is required to notify the appropriate federal officials and assess the impacts of the proposed project on the Class I area. If a major source proposing to locate at a distance greater than 62 miles is of such size that the reviewing agency is concerned about potential emission impacts on a Class I area, the reviewing agency can ask the Applicant to perform an analysis of the source's potential emissions impacts on the Class I area.

Class II areas allow higher levels of added pollution. Class III designations, allowing an even higher level of added pollutants and intended for heavily industrialized zones, can be made only on request and must meet all requirements outlined in 40 CFR Part 51.166. There are currently no Class III areas, so apart from designated Class I areas, the remainder of the U.S. is designated as Class II. Regardless of Class I/II/III status, all areas must attain the NAAQS, or the delegated agency must put in place plans to attain the NAAQS.

The proposed project is located in an attainment area and would result in emissions greater than the PSD major source threshold of 100,000 tpy measured as CO_2-e. Consequently, PSD permitting would be required. Additionally, the proposed project would be located in a Class II area with the nearest Class I area (Denali National Park) located more than 500 miles to the southwest. Because the project would be a major source for PSD purposes, it would also trigger a federal Class I area impact assessment. However, given the large distance to the nearest Class I area, the project impact at that area would likely be negligible.

5.4.1.2 Title I Minor Permits

The State of Alaska requires minor permits under the Alaska Administrative Code, Title 18, Chapter 50, Article 5. The regulations provide procedures to ensure that construction or modification of a stationary source would not cause a violation of an NAAQS or any applicable portions of the control strategy. Alaska's minor NSR program was originally approved into the SIP by EPA on July 5, 1983, and has been revised several times. Under the current minor permit program, ADEC specifies source categories and size thresholds that need a permit, assuming a major/PSD permit is not needed. For instance, a minor permit is required for construction of a new stationary source with a potential to emit greater than the following size thresholds: 15 tpy PM_{10}; 40 tpy of NO_x; 40 tpy of SO_2; 0.6 tpy of lead; or 100 tpy of CO within 10 km of a nonattainment area. ADEC has also established thresholds for determining when a source needs a minor permit before a modification: 10 tpy PM_{10}; 10 tpy of NO_x; 10 tpy of SO_2; or 100 tpy of CO within 10 km of a nonattainment area.

The proposed project would have potential emissions that exceed the minor source thresholds. Additionally, portable oil and gas operation is one of the listed source categories that require a minor source permit. Portable oil and gas operation is defined as an operation that moves from site to site to drill or test one or more oil or gas wells, and that uses drill rigs, equipment associated with drill rigs and drill operations, well test flares, equipment associated with well test flares, camps, or equipment associated with camps. Portable oil and gas operation does not include well servicing activities; for purposes of this definition, test means a test that involves the use of a flare (18 AAC 50.990). Consequently, the proposed project would require minor permitting for scenarios and/or pollutants in which major/PSD permitting would not be triggered.

5.4.1.3 Title V Operating Permits

Title V of the CAA requires individual states to establish an air operating permit program. The requirements of Title V are outlined in 40 CFR Parts 70 and 71, and the permits required by these regulations are often referred to as Part 70 or 71 permits. The permit includes all air pollution requirements that apply to the source, including emissions limits and monitoring, record keeping, and reporting requirements. It also requires that the source annually report its compliance status with respect to permit conditions to the permitting authority. Operating permits (also known as Title V permits) are required for all major stationary sources. What constitutes a major source varies according to what pollutants are being emitted and the attainment designation of the area where the source is located. In general, a source is Title V-major if it emits or has the potential to emit 100 tpy or more of any criteria air pollutant, 10 tpy or more of any hazardous air pollutant (HAP), 25 tpy or more of total HAPs, or 100,000 tpy of GHG.

The proposed project would have potential emissions that exceed the Title V thresholds (see Table 5.4-2). Consequently, a complete Title V permit application would be required no later than 12 months after the start of operations of the major source subject to AS 46.14.120(b).

5.4.1.4 New Source Performance Standards

The NSPS, codified at 40 CFR Part 60, established requirements for new, modified, or reconstructed units in specific source categories. NSPS requirements include emission limits, monitoring, reporting, and recordkeeping.

Based on the types of emission units planned to be installed and the expected date of construction of each emission unit, the proposed project would be subject to the following:

- 40 CFR 60 Subpart KKK—The proposed facility would likely be considered a natural gas processing plant, and therefore subject to these standards of performance for equipment leaks of VOC from onshore natural gas processing plants.
- 40 CFR 60 Subpart CCCC—These standards of performance for commercial and industrial solid waste incineration units constructed after November 30, 1999, or modified/reconstructed on or after June 1, 2001, apply to the proposed 500-pound-per-hour operation and construction camp incinerators, and 130-pound-per-hour drilling camp incinerator.
- 40 CFR 60 Subpart IIII—The standards of performance for stationary compression ignition internal combustion engines constructed after July 11, 2005 apply to the various engines used on the project.
- 40 CFR 60 Subpart KKKK—These standards of performance apply to stationary gas turbines with a heat input at peak load equal to or greater than 10.7 gigajoules (10 million British thermal units [MMBtu]) per hour, based on the lower heating value of the fuel used, and for which construction, modification, or reconstruction occurs after February 18, 2005. Thus, these standards apply to the four production turbines proposed in each alternative.

5.4.1.5 National Emission Standards for Hazardous Air Pollutants/Maximum Achievable Control Technology

NESHAPs, codified in 40 CFR Parts 61 and 63, regulate HAP emissions. Part 61 was promulgated prior to the 1990 CAA Amendments and regulates only eight types of hazardous substances (asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride). The proposed project alternatives would not include facilities that fall under one of the source categories regulated by Part 61; therefore, the requirements of Part 61 are not applicable.

The 1990 CAA Amendments established a list of 189 additional HAPs, resulting in the promulgation of Part 63. Also known as the MACT standards, Part 63 regulates HAP emissions from major sources of HAPs and specific source categories that emit HAPs, as well as certain minor or “area” sources of HAPs. Part 63 considers any source with the potential to emit 10 tpy of any single HAP or 25 tpy of HAPs in aggregate as a major source of HAPs. The proposed project would not have the potential to emit HAPs at levels greater than HAP major thresholds (Appendix D, RFI 77).

The proposed project would be subject to 40 CFR 63 Subpart ZZZZ, which is the national emission standard for hazardous air pollutants for stationary reciprocating internal combustion engines. Subpart ZZZZ would apply to the various stationary reciprocating ignition internal combustion engines not already subject to 40 CFR 60 Subpart IIII.

The proposed project would also be subject to 40 CFR 63 Subpart JJJJJJ, which is the national emission standard for hazardous air pollutants for industrial, commercial, and institutional boilers located in area (minor) sources of HAPs. This recently-issued standard, which became effective May 20, 2011, would apply to any oil-fired boilers associated with the project.

5.4.1.6 Mobile Source Regulations

Gasoline and diesel engines must comply with the EPA mobile source regulations in 40 CFR Part 86 for on-road engines and 40 CFR Part 89 and 90 for nonroad engines; these regulations are designed to minimize emissions.

The proposed project would use both on-road and nonroad engines that would have to comply with the mobile source regulations. These requirements are imposed on the manufacturers of the engines.

5.4.1.7 Alternative Low-sulfur Diesel Fuel Transition Program for Alaska

EPA's Highway Diesel and Nonroad Diesel Rules, respectively, implement more stringent standards for new diesel engines and fuels. The rules mandate the use of lower sulfur fuels in diesel engines beginning in 2006 for highway diesel fuel, and 2007 for nonroad diesel fuel. Because Alaska has unique geographical, meteorological, air quality, and economic characteristics, EPA granted an alternative implementation schedule for the rural areas (those not served by the Federal Aid Highway System) of Alaska as follows:

- Rural areas of Alaska began transitioning all highway, nonroad, locomotive, and marine diesel fuel to 15 ppm sulfur content diesel fuel (i.e., ultra-low-sulfur diesel [ULSD]) on June 1, 2010.
- Rural retail facilities must supply 15 ppm sulfur content diesel fuel by December 1, 2010.
- All diesel fuel in Alaska remains exempt from the dyeing requirements in the highway and nonroad final rules.
- Fuel distributors in urban Alaska would be given the same transition schedule as distributors in the rest of the country for highway diesel fuel.

The proposed project would be located in rural Alaska and would have to comply with the ULSD requirements.

5.4.1.8 Greenhouse Gases

On October 30, 2009, the EPA promulgated the first comprehensive national system for reporting emissions of CO_2 and other GHGs produced by major sources in the U.S. Through this new reporting, the EPA will have comprehensive and accurate data about the production of GHGs in order to assess potential climate change impacts. Approximately 13,000 facilities, accounting for approximately 85 to 90 percent of GHGs emitted in the U.S., are covered under the rule. The new reporting requirements apply to suppliers of fossil fuel and industrial chemicals; manufacturers of certain motor vehicles and engines (not including light and medium duty on-road vehicles); and large direct emitters of GHGs with emissions equal to or greater than a threshold of 25,000 metric tpy. This threshold is equivalent to the annual GHG emissions from just over 4,500 passenger vehicles.

The direct emission sources covered under the reporting requirement include energy intensive sectors such as cement production, iron and steel production, and electricity generation, among others. The gases covered by the rule are CO_2, CH_4, N_2O, HFC, PFC, SF_6, and other fluorinated gases, including nitrogen trifluoride (NF_3) and hydrofluorinated ethers (HFE). Because CO_2 is the reference gas for climate change, measures of non-CO_2 GHGs are converted into CO_2-e values based on their potential to absorb heat in the atmosphere. The proposed project would have emissions of CO_2-e greater than the applicable reporting threshold of 25,000 metric tpy; therefore, based on estimated emissions detailed below, the project facilities would be subject to the federal GHG reporting rule.

EPA subsequently promulgated additional GHG reporting rules to cover three sectors that were excluded from the 2009 rule: petroleum and natural gas systems, injection and geologic sequestration of CO_2, and fluorinated GHGs (75 FR 74458, 75 FR 75060, 75 FR 74774). The rules became effective in December 2010, and require facilities to begin monitoring, recording, and reporting the GHG emissions annually beginning January 1, 2011. The final petroleum and natural gas reporting rule includes offshore petroleum and natural gas production, onshore petroleum and natural gas production, onshore natural gas processing, onshore natural gas transmission compression, underground natural gas storage, liquefied natural gas (LNG) storage, LNG import and export, and natural gas distribution.

On June 2, 2010, the EPA issued a final rule that establishes an approach to addressing GHG emissions from stationary sources under the CAA permitting programs. These facilities would be required to obtain permits that demonstrate their use of the best practices and technologies to minimize GHG emissions. The rule sets thresholds for GHG emissions that define when the CAA permits under the NSR PSD and the Title V Operating Permits programs are required for new or existing industrial facilities. The rule customizes the requirements to limit which facilities will be required to obtain NSR PSD and Title V permits and cover nearly 70 percent of the national GHG emissions that come from stationary sources, including those from the nation's largest emitters.

For sources that were permitted between January 2 and June 30, 2011, the rule required GHG permitting for only sources that were currently subject to the PSD permitting program (i.e., those newly constructed or modified in a way that significantly increased emissions of a pollutant other than GHGs) and that had GHG emissions of at least 75,000 tpy. Additionally, only sources that are major for PSD purposes for non-GHG pollutants were required to address GHGs as part of their PSD permitting before July 1, 2011. For sources constructed between July 1, 2011 and June 30, 2013, the rule requires PSD permitting for first time new construction projects that emit GHG emissions of at least 100,000 tpy even if they do not exceed the permitting thresholds for any other pollutant. Additionally, after July 1, 2011, sources that emit or have the potential to emit at least 100,000 tpy CO_2-e or major amounts of other pollutants and that undertake a modification that increases net emissions of GHGs by at least 75,000 tpy CO_2-e will also be subject to PSD requirements. Under this scenario, operating permit requirements will, for the first time, apply to sources based on their GHG emissions even if they would not apply based on emissions of any other pollutant. Facilities that emit at least 100,000 tpy CO_2-e will be subject to Title V permitting requirements. The proposed project would be permitted after July 1, 2011 and would have potential emissions of CO_2-e greater than the applicable thresholds; therefore, it would be subject to the federal GHG permitting rule.

The EPA plans further rulemaking that would possibly reduce the permitting thresholds for new and modified sources making changes after June 30, 2013. For further information on GHGs and climate change, refer to Section 4.3, Climate Change.

5.4.2 Methodology

To assess air quality impacts from the project, the results of the dispersion analysis prepared by the Applicant's consultant (SLR 2011a) were reviewed by the third-party EIS preparer's subject matter expert. The third-party review included review of emission estimates for comparison with PSD permit thresholds. Also, model inputs and outputs provided by the Applicant's consultant were reviewed for consistency with the emission estimates. Finally, a confirmation model run was performed by the third-party subject matter expert as a check to make sure that model results were consistent with those produced by the Applicant's consultant (SLR 2011a).

Impact evaluation categories for assessing air quality environmental consequences of the proposed project and alternatives are based on the following:

- Magnitude (major, moderate, or minor)
- Duration (long term, medium term, or short term)

- Potential (probable, possible, or unlikely)
- Geographical Extent (extensive, local, or limited)

These four impact evaluation categories were used to assess both beneficial and detrimental impacts. See Table 5.4-1 for the impact criteria as they relate to air quality. The potential effects of air emissions on human health are addressed in Section 5.23, Human Health.

Table 5.4-1: Impact Criteria—Air Quality

Impact Category*	Intensity Type*	Specific Definition for Air Quality
Magnitude	Major	Causing annual stationary source criteria pollutant emissions of ≥250 tpy, and/or modeled pollutant concentrations of greater than or equal to the NAAQS/AAAQS.
	Moderate	Causing annual stationary source criteria pollutant emissions of ≥40 tpy but <250 tpy, or modeled pollutant concentrations of >50% but <100% of the NAAQS/AAAQS.
	Minor	Causing annual stationary source criteria pollutant emissions of <40 tpy, or modeled pollutant concentrations of <50% of the NAAQS/AAAQS.
Duration	Long term	Irreversible impacts to air quality that extend beyond the life of the project.
	Medium term	Impacts last longer than 24 months through the life of the project.
	Temporary	Impacts last 24 months or less.
Potential to Occur	Probable	Unavoidable.
	Possible	Potential to occur (may be able to mitigate).
	Unlikely	May occur, but unlikely to occur.
Geographic Extent	Extensive	Project area and beyond.
	Local	Within Point Thomson Project area footprint.
	Limited	Within 100 yards of project pad ambient air boundaries.

* Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology.

5.4.3 Alternative A: No Action

Under Alternative A, the two existing wells at the PTU-3 gravel pad would be monitored. No construction activities or operation would occur. There would be no impacts to air quality under Alternative A.

5.4.4 Alternative B: Applicant's Proposed Action

The construction, drilling, and operation of Alternative B would have air emissions leading to air quality impacts associated largely with the combustion of fossil fuels.

5.4.4.1 Construction Emissions

Alternative B construction emissions would be released in the exhaust of heavy equipment used in site preparation to excavate gravel, build gravel pads and an airstrip, and construct gathering lines and export pipelines. Additionally, small electric power generators, heaters, and other fuel-burning equipment as well as fugitive dust sources such as gravel excavation, storage, and placement would contribute to emissions during construction. Three construction seasons would be required. Figure 2.4-12 in Chapter 2.0 provides the details of the construction seasons for Alternative B. Drilling emissions would also be released into the atmosphere concurrently with the construction phase of the project. The Applicant would apply dust suppression measures to fugitive dust sources.

Estimated construction emissions for Alternative B are conservatively shown as the “Total” in Table 5.4-2 and include emissions from drilling sources. The construction emissions also include emissions from building roads and pipelines from the Deadhorse area to the project site. The construction emissions estimates are quite conservative (high) because they are based on 8,760 hour/years of operation for many of the temporary construction-related emissions sources. Therefore, construction emissions would likely be much less than shown in the “Total” column in Table 5.4-2, given that the construction equipment would not need to run at full capacity for 8,760 hours/year.

The “Stationary Sources” column actually represents the emissions from the permanent production facility emissions, after completion of construction, and is the appropriate data for comparison against PSD permitting threshold. The emissions from nonroad engines and vehicles used in the construction process, which make up the majority of the maximum “Total” emissions shown in Table 5.4-2, are by federal law and rules not included in the assessment of whether PSD is triggered. Only stationary emissions sources, which exclude on-road and nonroad equipment, are included in the PSD applicability analysis. Detailed emission inventories are provided in the Applicant’s air quality permit application (SLR 2011b).

Table 5.4-2: Alternative B—PSD Permitting Applicability

	Potential Emissions (tpy)		PSD Major		PSD Significant Increase[c]	
Pollutant	Total[a]	Stationary Sources[b]	Threshold (tpy)	Triggers PSD?	Threshold (tpy)	Triggers PSD?
NO_x	1,804.8	162.1	250	No	40	Yes
CO	3,463.0	118.8	250	No	100	Yes
PM	2,154.3	14.5	250	No	25	No
PM_{10}	946.0	14.5	250	No	15	No
$PM_{2.5}$	334.9	13.1	250	No	10	Yes
VOC	687.2	31.1	250	No	40	No
SO_2	95.7	24.3	250	No	40	No
GHG (CO_2-e)	312,056.1	238,061	100,000	Yes	75,000	Yes

Sources: SLR 2011a; Appendix D, RFI 30-Rev 2; RFI 57-Rev 2; RFI 111

[a] Total potential emissions include emissions from stationary emission units, mobile sources, and fugitive dust during the construction phase, which overlaps the primary drilling phase, and the start of production operations.

[b] Production/operation phase stationary source emissions subject to permitting. Emissions from fugitive dust and mobile sources (on-road and nonroad) are not included in the emission estimates for permit applicability. Nonroad engines are portable and transportable engines that remain at any single location for 12 months or less and otherwise meet the nonroad engine criteria in 40 CFR 89.2.

[c] If emissions of one or more pollutants would be “major” for PSD (in this case CO_2-e is major), then all other pollutants are compared to the “PSD Significant Increase” threshold to determine whether PSD review is triggered for each pollutant.

As indicated in Table 5.4-2, the project would trigger PSD permitting for GHGs (measured as CO_2-e) based on project stationary source emissions over 100,000 tpy. Once one pollutant triggers “Major” status for PSD review, all other pollutants would be compared against the PSD Significant Increase thresholds to determine whether they trigger PSD review. As shown above, based on estimated emissions, the pollutants triggering PSD review include GHG, NO_x, CO, and $PM_{2.5}$. PSD review generally requires a Best Available Control Technology (BACT) analysis for each affected pollutant and emission source, and an ambient air impact analysis (usually via dispersion modeling) for each affected pollutant with an applicable NAAQS or PSD allowable concentration increment. In this case, BACT applies for all four pollutants listed, while an ambient air impact analysis is required for NO_x, CO, and $PM_{2.5}$.

Because the permitting process has not yet been completed by ADEC, the BACT determination, which establishes permitted emission rates for affected pollutants, has not been completed. Therefore, this air quality assessment currently relies on emissions rates provided by the Applicant through its consultant, SLR (2011a). These emissions rates are based on either requirements of federally applicable emissions standards for each type of equipment, EPA emission factors from Publication AP-42, or on vendor estimates. Presumably, the ADEC would use these emission rates as a starting point or ceiling in its BACT assessment. Final permitted emissions could be lower depending on ADEC's final BACT determinations. As such, the air quality impact analysis presented in Section 5.4.4.4 should represent the upper-bound of potential air quality impacts due to the proposed project.

When an applicant submits a permit application to ADEC, they must include an updated modeling analysis to demonstrate that the stationary source and associated activities would not cause or contribute to a violation of any ambient air quality standards or air quality increment standards. Consistent with ADEC Policy and Procedure Document 04.02.104, emissions from temporary construction activities (completed within 24 months from the date construction begins in accordance with 18 AAC 50. 990[107]) would not be required to demonstrate compliance with the air quality increment standards, but would be required to demonstrate compliance with NAAQS/AAAQS. Furthermore, ADEC recognizes that characterizing small, near-ground emission units/activities can be difficult and that modeling results can be questionable. Therefore, applicants who agree to fuel sulfur limitations (less than or equal to 15 parts per million by weight [ppmw]) need not include construction-related internal combustion units rated at less than 400 bhp, and construction-related boilers/heaters with a heat input rating of less than 2.8 MMBtu per hour, in their modeling analysis (ADEC 2006).

5.4.4.2 Drilling Emissions

Under Alternative B, drilling would continue for a minimum of five production/injection wells from the three pads over 2.5 years. Drilling activity impacts would result from operation of reciprocating internal combustion engines, heaters, and boilers associated with the drill rig. Additionally, impacts would result from operation of portable and mobile equipment used to support the drilling operations. This fuel-burning equipment would be powered by diesel or gasoline and would be sources of combustion-related pollutants, including NO_x, CO, PM, VOCs, SO_2, and lead. This drilling phase would overlap with some of the initial construction activities, and would cease for a time during a second project phase during which construction is completed and initial operations are commenced. Finally, drilling would again resume for ongoing production, after construction has been completed, thus beginning the third project phase which includes "operations and drilling."

5.4.4.3 Operations Emissions

Under Alternative B, operations impacts would result from operation of stationary equipment such as turbines for power generation, gas compression, oil pumping, and water injection as well as reciprocating internal combustion engines, heaters, boilers, and mobile sources. This equipment would combust fossil fuels and emit combustion-related pollutants such as NO_x, CO, PM, VOCs, SO_2 and GHG. VOC emissions also would result from evaporative losses from tanks, pumps, compressor seals, and valves. Safety flares could also be used to burn gas released from the production process during emergencies and equipment shutdowns, emitting combustion pollutants. Additionally, drilling emissions would also be released into the atmosphere concurrently with the operations phase of the project.

Estimated operations emissions from the production facility at the Central Pad are shown in Table 5.4-2, under the "Stationary Sources" column. Additional emissions during routine operations would occur from nonroad engines associated with drilling at other locations, and from transport of people and materials to the site. However, the emissions outside of the Central Pad would be much more scattered and, therefore, the modeling analysis in the following section is focused on emissions from the Central Pad, which is expected to generate the greatest level of localized impacts. The modeling analysis in the following section assesses impacts from the Central Pad area during the three project phases described earlier: construction with drilling, construction with (initial) operations, and operations with drilling.

5.4.4.4 Air Quality Impacts

The air quality impacts of production (operations with drilling) for Alternative B were assessed through dispersion modeling using the EPA's AERMOD modeling system. One year of Point Thomson meteorological data along with estimated emissions data for the construction with drilling phase, construction with operations transition phase, and operations with drilling phase were used to assess air quality. The meteorological data collected at Point Thomson are shown graphically by the wind rose in Figure 5.4-1. The strong predominance of east-northeast and west-southwest winds is consistent with other wind measurement sites on the North Slope, as shown in Section 3.3, Meteorology and Climate. The Point Thomson meteorological data were processed using the EPA's AERMET program to make them suitable for input to AERMOD. While the Point Thomson data were over 95 percent complete, the AERMOD model requires a full year of data. Therefore, Deadhorse meteorological data collected by the National Weather Service were substituted for the missing hours in the Point Thomson dataset.

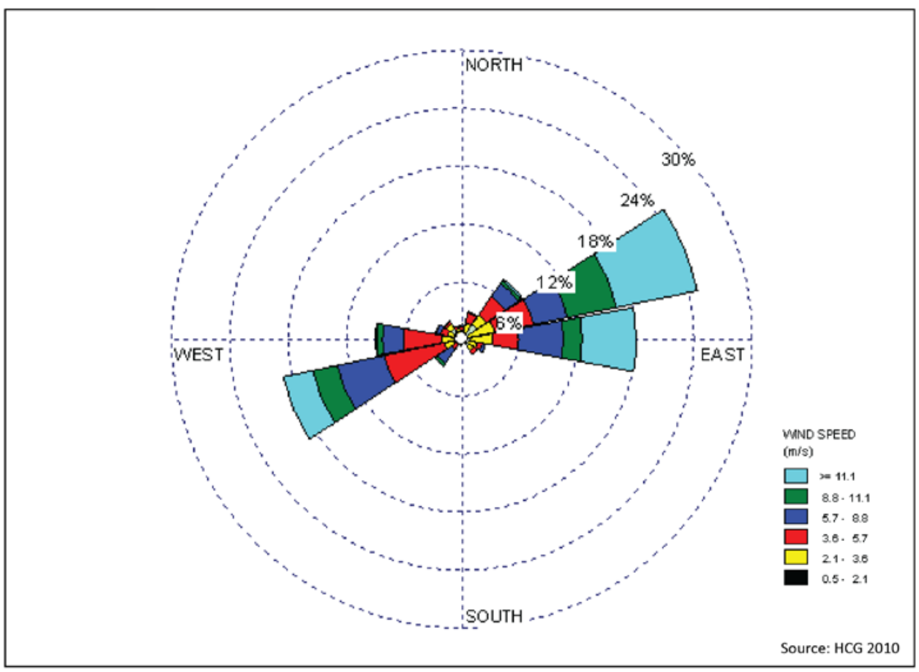


Figure 5.4-1: Point Thomson Wind Rose

While much higher emissions could occur during the construction phase of the project, such emissions would be spread over a much wider area with less concentration of the emissions as compared to the production phase, where emissions would come mostly from equipment at the Central Pad. The construction emissions would also be temporary. The production operations and drilling phase impacts are expected to generate the most sustained, longer-term localized impacts for this project. However, the construction with drilling phase, construction with operations transition phase, and operations with drilling phase were all modeled as presented below for comparison with the NAAQS and PSD allowable concentration increments.

The domain for modeling of the air quality impacts of the project is a 10 km by 10 km area centered on the proposed Central Pad location at Point Thomson, as shown in Figure 5.4-2. Receptors for calculation of modeled concentrations were placed at 20-meter intervals on the Central Pad boundary, in a 50-meter spaced grid out to 500 meters from the pad, in a 100-meter spaced grid out to 1,500 meters from the pad, and in a 250-meter spaced grid out to 5,000 meters from the pad, as shown in Figure 5.4-3. The preliminary modeling results indicated that the maximum impacts for all pollutants would be right at the Central Pad boundary, and would drop quickly with distance from there, with little or no impacts at the edge of the modeling domain. Thus, while more distant oil and gas developments were considered for incorporation on the model, they are too far away (approximately 30 miles) to have a meaningful added or cumulative impact in the Point Thomson Project area. Furthermore, the ambient air monitoring data collected at Point Thomson should be reflective of existing impacts of these distant sources, and the data show very low levels of air pollutants at Point Thomson.

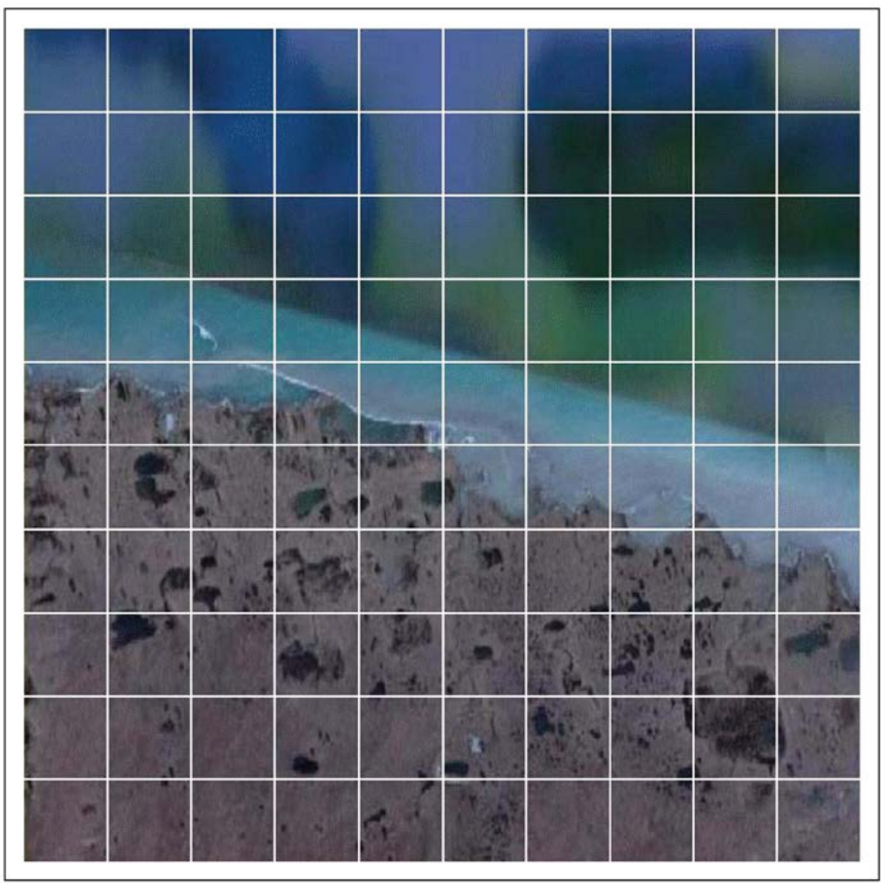


Figure 5.4-2: Modeling Domain

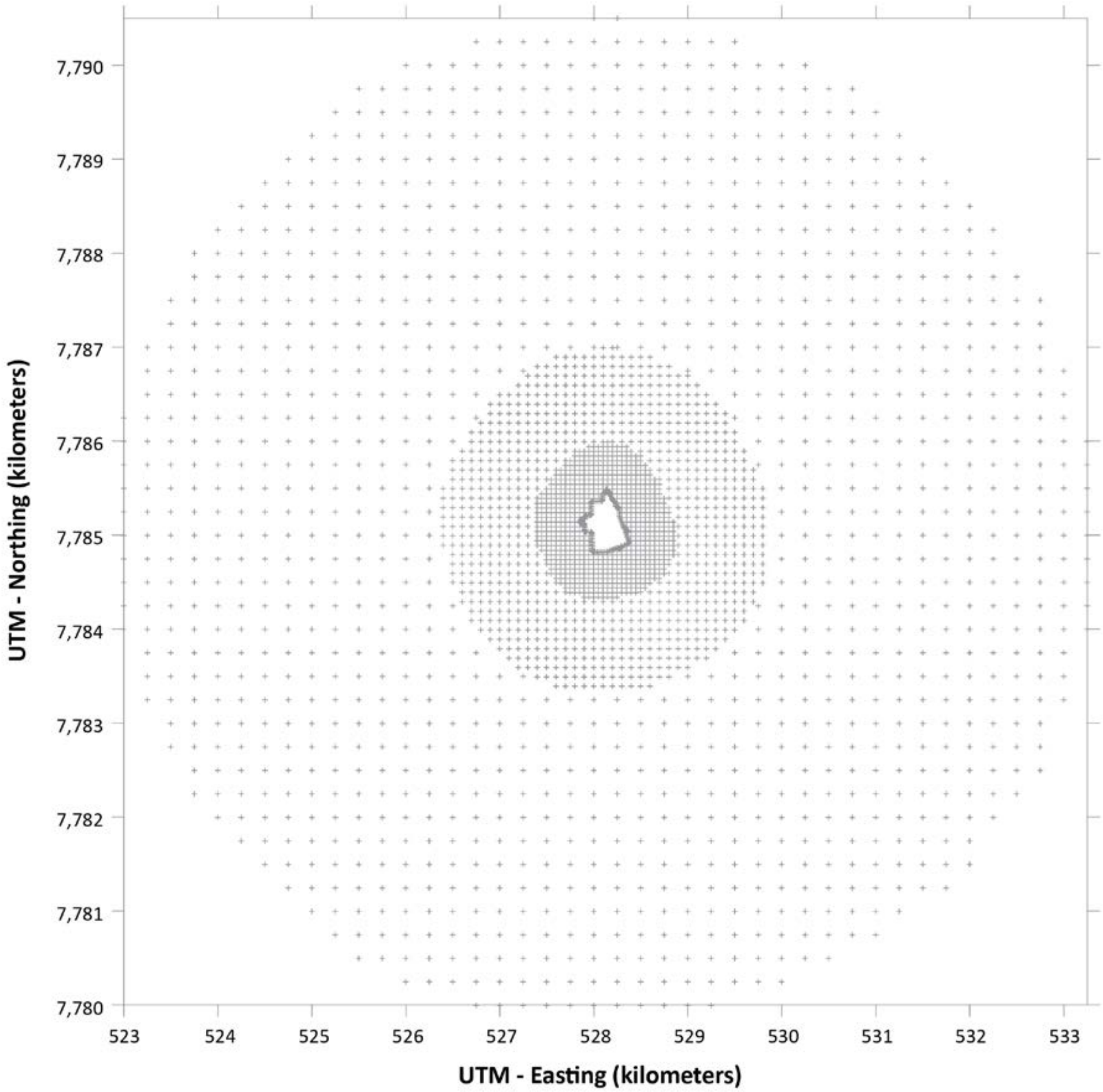


Figure 5.4-3: Receptor Grid

Because the proposed project would trigger PSD permitting review for NO_x, CO, and $PM_{2.5}$, the ambient air impact analysis would be required for these pollutants or their products (i.e., NO_x in the form of NO_2 is regulated under NAAQS and PSD concentration increments). While PSD review would also be triggered for GHG (CO_2-e) emissions, there are no ambient air standards for CO_2 or other GHG, and therefore, ambient air concentrations of such emissions were not modeled.

The results of the dispersion analysis (SLR 2011a) show that the proposed project would meet applicable NAAQS for NO_2, CO, and $PM_{2.5}$, as well as PSD allowable Class II area concentration increments for NO_2, and $PM_{2.5}$ (there is no applicable PSD increment for CO). The comparison of maximum modeled impacts (plus background concentrations) and NAAQS is shown in Table 5.4-3. The 1-hour NO_2 values in Table 5.4-3 represent “design basis” values (based on the statistical form of the NAAQS) to allow direct comparison with this NAAQS which is explained in detail in Table 3.4-1. Thus, for example, the 1-hour NO_2 values listed represent the 98th percentile of daily maximum 1-hour NO_2 predictions (total concentration) over the year of modeled meteorology. Other modeled pollutant values shown in Table 5.4-3 represent the overall maximum values for any ambient air receptor in the analysis, thus providing a conservative demonstration of compliance, given that the short-term standards allow one or more exceedance per year.

Note that the 1-hour NO_2 background values vary for each of the three modeled emissions scenarios. That is because, uniquely for 1-hour NO_2, the analysis of total 1-hour concentration (modeled plus background) was done by adding the modeled concentration for each hour to the monitored value for the same hour, to obtain a more refined estimate of total 1-hour NO_2 impacts. For the other pollutants and averaging periods, the values listed for background under the three emissions scenarios are identical.

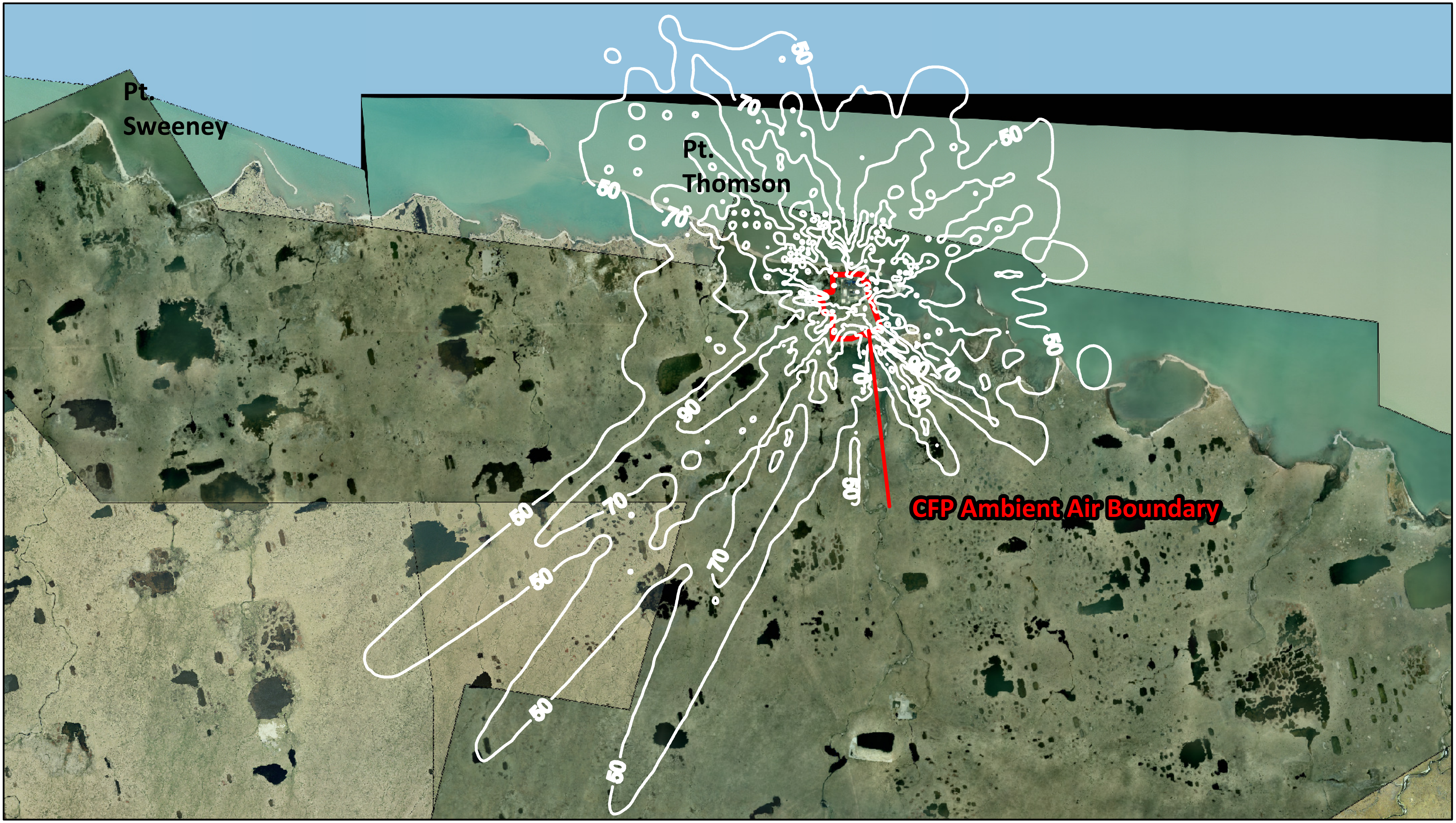
Figure 5.4-4 and Figure 5.4-5 show the modeled concentration contours for 1-hour and annual average NO_2 concentration, respectively. Figure 5.4-6 and Figure 5.4-7 show the modeled concentration contours for 24-hour and annual average $PM_{2.5}$ concentration, respectively. The values plotted in all these contour plots represent the "design basis" values with respect to the applicable NAAQS. For example, the 1-hour NO_2 impacts represent the 98th percentile of daily maximum 1-hour concentrations over the year of meteorology modeled. This is presented because compliance with the NAAQS for 1-hour NO_2 is determined based on the 98th percentile rank of 1-hour concentrations.

Table 5.4-3: Comparison of Modeling Results and NAAQS

Pollutant	Average Period	Modeled Concentration (µg/m^3)	Background Concentration (µg/m^3)	Total Impact (µg/m^3)	NAAQS (µg/m^3)
Construction with Drilling					
NO_2	1-hour	133.8	15.5	149.3	188
	Annual	23.9	7.5	31.4	100
CO	1-hour	1,904	2,171	4,075	40,000
	8-hour	1,481	1,278	2,759	10,000
$PM_{2.5}$	24-hour	9.6	12.7	22.3	35
	Annual	2.2	2.6	4.8	15
Construction to Operations Transition					
NO_2	1-hour	121.5	24.6	146.1	188
	Annual	7.5	7.5	15.0	100
CO	1-hour	1,099	2,171	3,270	40,000
	8-hour	714.7	1,278	1,993	10,000
$PM_{2.5}$	24-hour	7.4	12.7	20.1	35
	Annual	2.6	2.6	5.2	15

Table 5.4-3: Comparison of Modeling Results and NAAQS

Pollutant	Average Period	Modeled Concentration (μg/m³)	Background Concentration (μg/m³)	Total Impact (μg/m³)	NAAQS (μg/m³)
Operations with Drilling					
NO_2	1-hour	131.1	18.6	149.7	188
	Annual	17.7	7.5	25.2	100
CO	1-hour	1,559	2,171	3,730	40,000
	8-hour	821.6	1,278	2,100	10,000
$PM_{2.5}$	24-hour	7.3	12.7	20.0	35
	Annual	1.1	2.6	3.7	15



POINT THOMSON PROJECT EIS

Legend

NO2 Concentration Contours ($\mu g/m^3$)

N

0 0.5 1 Miles

Figure 5.4-4

Contour Plot of 98th Percentile of Daily Maximum 1-Hour NO_2 Concentrations

Date: 19 October 2011
Map Author: HDR Alaska Inc.
Sources: See References chapter for map source information

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POINT THOMSON PROJECT EIS

Legend

NO₂ Concentration Contours ($\mu g/m^3$)

N

0 0.5 1 Miles

Figure 5.4-5

Contour Plot of Annual Average NO_2 Concentrations

Date: 19 October 2011
Map Author: HDR Alaska Inc.
Sources: See References chapter for map source information

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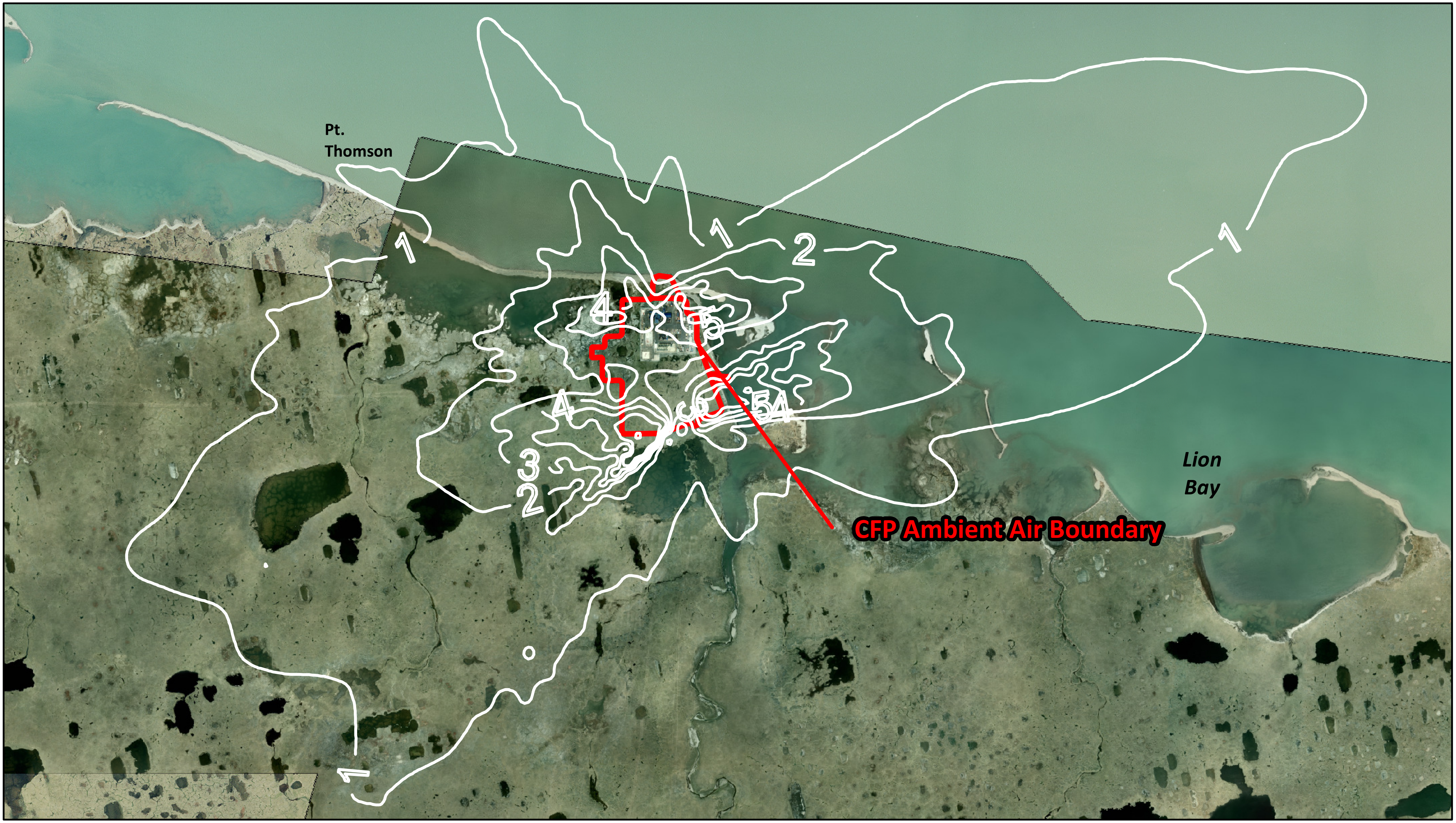

POINT THOMSON PROJECT EIS

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PM2.5 Concentration Contours in µg/m³

N

0 0.5 1 Miles

Figure 5.4-6

Contour Plot of 98th Percentile
24-hour Average $PM_{2.5}$ Concentrations

Date: 19 October 2011
Map Author: HDR Alaska Inc.
Sources: See References chapter for map source information

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POINT THOMSON
PROJECT EIS

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$PM_{2.5}$ Concentration Contours in µg/m^3

N

0 0.25 0.5 Miles

Figure 5.4-7

Contour Plot of Annual Average $PM_{2.5}$ Concentrations

Date: 19 October 2011
Map Author: HDR Alaska Inc.
Sources: See References chapter for map source information

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No contour plots of 1-hour and 8-hour average CO concentrations are provided, given that maximum modeled impacts are far below the respective NAAQS.

The comparison of maximum incremental project impacts and the PSD allowable Class II area concentration increments for NO_2, and $PM_{2.5}$ is shown in Table 5.4-4 for the operations with drilling phase. This scenario is presented because the increment analysis does not apply to temporary emissions as represented in the other two scenarios. Note that the $PM_{2.5}$ impacts represent only the direct stack $PM_{2.5}$ emissions, and do not account for any secondary conversion of stack gases such as SO_2 or NO_2 into fine particulate matter. However, given that the modeled maximum ambient impacts occur very close to the facility (at the fence line), there would be minimal time for secondary conversion to occur by the time the plumes reach this point. Impacts are predicted to occur very close to the Central Pad facility, right at the ambient air boundary, as apparent from Figure 5.4-5 and Figure 5.4-6, which show that impacts drop rapidly with distance. Even modest changes in project emissions could push the maximum incremental impacts over the respective allowable increments. However, given that the impacts are relatively high only very near the emissions sources (i.e., right at the Central Pad boundary), the typical means of mitigating such impacts is to simply increase slightly the stack heights from some of the generators that are the primary contributors to the impact. Thus, the Applicant can easily keep impacts in compliance with NAAQS and allowable PSD increments through slight stack height changes, if it makes design changes that require modest increases in emissions.

Table 5.4-4: Comparison of Modeling Results and PSD Allowable Concentration

Pollutant	Averaging Period	Modeled Concentration ($\mu g/m^3$)	Allowable PSD Increment ($\mu g/m^3$)
Operations with Drilling			
NO_2	Annual	17.7	25.0
$PM_{2.5}$	24-hour	6.8[a]	9.0
	Annual	1.1	4.0

[a] 24-hour concentration listed is the highest, second highest value, because one exceedance of the 24-hour increment is allowed per year. The overall highest modeled 24-hour incremental concentration at any receptor was 7.3 $\mu g/m^3$ for the operations with drilling scenario, as shown in Table 5.4-3.

Transboundary effects of project emissions are expected to be negligible, given that the nearest international border to the project site is the Canadian border, approximately 125 miles east-southeast of the project area. Atmospheric dispersion of pollutant emissions would render them immeasurable at this distance from the proposed project.

5.4.4.5 Impact Summary

The summary of air quality impacts is shown in Table 5.4-5. Air quality impacts from construction, drilling, and operations for Alternative B would be considered moderate, medium-term, probable, and local.

Table 5.4-5: Alternative B—Impact Evaluation for Air Quality

Phase	Magnitude	Duration	Potential	Extent
Construction	Moderate	Medium term	Probable	Local
Drilling	Moderate	Medium term	Probable	Local
Operations	Moderate	Medium term	Probable	Local

5.4.4.6 Other Potential Air Emission-related Impacts

Emissions of pollutants such as NO_x and SO_2 can form acidic compounds of nitrates and sulfates, which can deposit to land and water bodies and cause adverse effects on ecosystems. In the lower 48 states, acid rain regulations promulgated under Title IV of the CAA have helped to significantly lower NO_x and especially SO_2 emissions from power plants over the past two decades. This has significantly reduced the measured amounts of acid deposition in the eastern U.S. For the Point Thomson Project, SO_2 emissions would be minimal, so sulfate deposition would not be a concern.

The anticipated NO_x emissions from Point Thomson are significant in a permitting context, but are not large in the context of NO_x emissions for many projects in the lower 48 states. The maximum annual NO_x emissions during the construction and operations period are conservatively estimated at approximately 1,800 tons/year (Table 5.4-2). The 2008 emissions from the entire North Slope Borough as estimated by EPA in its National Emissions Inventory (NEI) database were approximately 37,000 tons/year (EPA 2012). Thus, maximum project NO_x emissions would represent less than 5 percent of total North Slope emissions. For comparison, total North Slope NO_x emissions in 2008 were approximately 10 percent of the 2008 NO_x emissions (per NEI) for the entire State of Minnesota, which has an area slightly less than the North Slope Borough. Recent (2010) nitrate deposition data available under the National Atmospheric Deposition Program (NADP) show that most sites in Minnesota and the rest of the eastern U.S. are measuring values between 5 and 15 kilograms/hectare/year (kg/ha/yr) (NADP 2012). There are only a few NADP deposition measurement sites in Alaska. The two Alaska NADP sites that have operated for over a decade are located in Denali National Park and in the Fairbanks vicinity. At both locations, measured deposition of nitrate has been averaging on the order of 0.5 kg/ha/yr. This is an order of magnitude or more lower than measured across most of the eastern U.S.

Given the much lower NO_x emissions density in the North Slope Borough, and the low existing nitrate deposition even near an urban area (Fairbanks), it is not expected Point Thomson Project emissions would add significantly to the presumably low nitrate deposition in the region. In addition, Section 7 of the Applicant's Air Quality Permit Application (SLR 2011b) contains an indirect impact discussion, including a table of soil and vegetation impacts summary. Consistent with the ADEC PSD Vegetation and Soil Assessments Policy dated December 11, 2007, modeled impacts were compared to the secondary air quality standards to determine if emissions from the Point Thomson Project would cause adverse impacts to soil and vegetation. These results are presented in Table 7-2 of the Air Quality Permit Application (SLR 2011b). Based on these modeling results, and the comparison of emission inventories and deposition measurements described above, the Point Thomson Project would not have an adverse impact to soil and vegetation.

5.4.5 Alternative C: Inland Pads with Gravel Access Road

The construction, drilling, and operations emissions and impacts for Alternative C would be similar to those described in Alternative B (see Table 5.4-2), although drilling impacts would be longer in duration and greater in volume due to the 4-year drilling program and the greater length of the wells. Alternative C would require 3,458 fuel trucks compared to 883 fuel trucks for Alternative B. On-road vehicles are not included in the PSD permitting review. Alternative C would require the same PSD construction air permitting as Alternative B, and would trigger the requirement for a Title V Operating Permit.

The summary of Alternative C impacts is shown in Table 5.4-6. Air quality impacts from construction and operation would be considered moderate, of medium-term duration, probable, and local for Alternative C.

Table 5.4-6: Alternative C—Impact Evaluation for Air Quality

Phase	Magnitude	Duration	Potential	Extent
Construction	Moderate	Medium term	Probable	Local
Drilling	Moderate	Medium term	Probable	Local
Operations	Moderate	Medium term	Probable	Local

5.4.6 Alternative D: Inland Pads with Seasonal Ice Access Road

The construction, drilling, and operations emissions and impacts, including permit requirements, for Alternative D would be similar to those described in Alternative B (see Table 5.4-2), although the 5-year drilling program and longer wells would increase the volume and duration of drilling impacts. Alternative D would require the same number of fuel trucks as Alternative C.

The Alternative D impacts are summarized in Table 5.4-7. Worst-case impacts from construction and operation would be considered moderate, medium term, probable, and local.

Table 5.4-7: Alternative D—Impact Evaluation for Air Quality

Phase	Magnitude	Duration	Potential	Extent
Construction	Moderate	Medium term	Probable	Local
Drilling	Moderate	Medium term	Probable	Local
Operations	Moderate	Medium term	Probable	Local

5.4.7 Alternative E: Coastal Pads with Seasonal Ice Access Road

The construction, drilling, and operations emissions and impacts for Alternative E would be similar to those described in Alternative B (see Table 5.4-2), although drilling impacts would be spread out longer due to the 5-year drilling program. Alternative E would also require the same Title I and Title V permits as the other alternatives.

The summary of Alternative E impacts is shown in Table 5.4-8. Air quality impacts from construction and operation would be considered moderate, medium term, probable, and local.

Table 5.4-8: Alternative E—Impact Evaluation for Air Quality

Phase	Magnitude	Duration	Potential	Extent
Construction	Moderate	Medium term	Probable	Local
Drilling	Moderate	Medium term	Probable	Local
Operations	Moderate	Medium term	Probable	Local

5.4.8 Mitigative Measures

This section describes measures to mitigate impacts to air quality from the Point Thomson Project. The Applicant has proposed design measures that would be included as part of the project; BMPs and permit requirements would be stipulated by federal, state, and local agencies, and the Corps has considered additional mitigation measures.

5.4.8.1 Applicant's Proposed Design Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on air quality.

- Using state-of-the-art Tier IV off-road and stationary engines for drilling and construction activities for NO_x control.
- Implementing BACT for stationary emission units, including Dry Low NO_x (DLN) combustors on the turbines.
- Using electric-powered injection compressors.
- Where diesel-fired reciprocating engines must be employed, using engines that are compliant with the emission limits and other requirements of the applicable NSPS in 40 CFR 60, Subpart IIII, Standards of Performance for Stationary Compression Ignition Internal Combustion Engines.
- Using ultra-low sulfur diesel in all diesel-fired equipment, both stationary and mobile.
- Using Waste Heat Recovery Units (WHRUs) for dual-fired turbines.
- Using natural gas for the primary and emergency fuel systems, thus reducing the need for diesel fuel.
- Designing production gathering lines for full wellhead shut-in pressure of the wells, thus avoiding potential vent/relief valve emissions.
- Using state-of-the-art incinerator units meeting requirements of newly released 40 CFR 60 Subpart CCCC.
- Watering gravel roads and pads, and enforcing speed limits to control dust generation during construction and operations.
- Providing power outlets in parking areas for maintaining vehicle starting reliability during low ambient temperatures and reducing the need for extended periods of vehicle idling.
- Maintaining equipment in accordance with manufacturer's recommendations to ensure emissions control equipment continues to operate as intended.

5.4.8.2 BMPs and Permit Requirements

As described in Section 5.4.1, the project would require air quality permits under the CAA and its implementing regulations. Emissions would be monitored and corrective action would be required if limits were exceeded. The project must also comply with the State of Alaska's ULSD requirements.

5.4.8.3 Corps-considered Mitigation

In addition to the Applicant's proposed design measures and BMPs and permit requirements, the Corps, in consultation with others, is considering the following actions to avoid or minimize impacts to air quality.

- Prepare and implement a plan for dust suppression that addresses gravel roads/pads and year-round mining activities. Consider use of environmentally safe chemical palliatives, use of chip-seal on the infield roads, and other methods, as applicable. This plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.
- Prepare and implement a monitoring and adaptive management plan.

5.4.9 Climate Change and Cumulative Impacts

5.4.9.1 Climate Change

Over the past 50 years, Alaska has warmed at more than twice the rate of the rest of the U.S. Its annual average temperature has increased 3.4°F, while winters have warmed by 6.3°F. The higher temperatures are causing earlier spring snowmelt, reduced sea ice, widespread glacier retreat, and permafrost warming. These climate-related changes are expected to continue while new ones develop (USGCRP 2009).

Climate change can be expected to influence all alternatives via the concentration and distribution of air pollutants through a variety of processes, including changes in the emissions from organic processes and chemical reaction rates, wash-out of pollutants by precipitation, and modification of weather patterns that influence pollutant buildup (CENRNSTC 2008). Consequently, a warming climate could have both beneficial and detrimental impacts to air quality in the project area.

The action alternatives would emit GHGs during construction, drilling, and operations. As shown in Table 5.4-9, the net annual change in CO_2 emissions due to the construction or operation of any of the action alternatives would be a tiny fraction of the total anthropogenic CO_2 emissions in the world. Based on estimates provided by the Applicant and shown in Table 5.4-9, the direct annual CO_2 emissions increase associated with construction, drilling, and operation phases of the alternatives would contribute approximately 0.001 percent to the global CO_2 emissions, assuming no increases in total world GHG emissions between 2008 and the first production year of the project. Over time periods of a year or longer, CO_2 emissions are essentially evenly distributed throughout the atmosphere across the globe. Therefore, the location of the GHG emissions would make little difference to any effects on global climate. Alternatives C and D, because of their reliance on truck transport for goods, equipment, and personnel, would be expected to have a slightly greater impact on global atmospheric GHG levels than Alternatives B and E.

Table 5.4-9: Annual Million Metric Tons of CO_2

Category	Emissions
World Total (2008)	30,377.313
U.S. Total (2008)	5,832.818
Action Alternatives – Total[a]	0.302
Action Alternatives – Stationary Sources	0.238

Sources: U.S. Energy Information Administration, RFI 111.

[a] Including nonroad engine sources. Numbers provided reflect operations phase but are similar for construction and drilling.

Indirect GHG emissions would occur as a result of the burning of project-derived hydrocarbon liquids in the U.S. and global marketplace. Although development of the Point Thomson Reservoir is intended by the Applicant to help the U.S. meet domestic hydrocarbon demand, production would be expected to help offset declining production from Alaska's North Slope reserves rather than increase the total fuels in the marketplace. Additionally, emissions from end use of the produced hydrocarbons would be included as direct impacts in the reporting for those emissions sources. Consequently, the indirect impacts of use of the product from Point Thomson are not included in this EIS, to prevent double counting of those emissions.

5.4.9.2 Cumulative Impacts

The magnitude and extent of the potential cumulative air impacts of the identified RFFAs would depend on the timing, extent, and design of activities. The effect on air quality from past actions that are no longer active in the study area is not measurable and would have no cumulative effect on resources. Past actions do not normally continue to produce air emissions after the actions are discontinued. Any air emissions from past actions have dispersed over time such that air quality would improve after these projects are ended.

Present effects on air quality from actions in the study area result primarily from pollutant emissions from oil and gas operations in the Prudhoe Bay/Kuparuk River Unit industrial complex and result primarily from the combustion of fossil fuels in stationary equipment at oil production facilities. In addition, fugitive dust emissions occur from road use and construction activities. These emissions are limited to the summer months because the ground is consistently snow- and ice-covered during winter, which reduces fugitive dust emissions. Fugitive VOC emissions may result from leaking oil and gas pipeline equipment such as flanges, valves, and pumps. The rural communities of Kaktovik and Nuiqsut contribute air pollutant emissions from the combustion of petroleum products in diesel-fired generator engines, heaters, and mobile vehicles.

The potential cumulative effects from RFFAs are difficult to anticipate; no new substantial oil and gas deposits have been identified in the immediate project area. Future oil and gas development is expected to occur within the already developed Prudhoe Bay/Kuparuk River/Alpine Unit industrial complex or to the west in the NPR-A. If it were to occur, this development would be outside a 6-mile radius of the project area and is not expected to contribute measurably to cumulative effects on air quality in the Point Thomson area.

Other development that has a strong possibility of occurring in the future in the project area may include a gas pipeline that has been proposed to deliver gas from the North Slope to markets in North America. If developed, a major component of the project would be a gas treatment plant that would be located at Prudhoe Bay more than 45 miles to the west of Point Thomson. Further development at Point Thomson would be needed to provide gas to the gas treatment plant and gas sales pipeline. Also, Shell has proposed conducting an exploration drilling program in the Beaufort Sea OCS. The proposed Shell drilling activity would likely be located more than 6 miles from the project area; however, any new or modified sources that would need air quality permits would be required to show compliance with the ambient air quality standards, via a cumulative impact analysis with prior developments, such as Point Thomson, if it preceded the Beaufort Sea OCS. Therefore, any potential long-term cumulative air quality impacts due to RFFAs in combination with various activities under the action alternatives would be limited and would not be allowed by the ADEC permitting procedures to result in deterioration that would exceed applicable air quality standards. Therefore, no adverse cumulative impacts to air quality are anticipated.

5.4.10 Alternatives Comparison and Consequences

Based on air dispersion modeling results, all action alternatives would meet applicable state and federal air quality standards. The main difference between the alternatives relative to impacts on air quality is that additional fuel would be required for construction and the longer wells would result in greater drilling emissions under Alternatives C and D. The additional fuel trucks for Alternatives C and D (about four times more) would directly create additional combustion and fugitive dust emissions, and additional emissions would be associated with combustion of the additional fuel in the construction equipment. Local air quality is not likely to be measurably changed for Alternatives C and D compared to Alternative B, because the trucking and construction equipment emissions tend to be scattered intermittently over a wide area and the drilling emissions would be spread out over a longer period (4 years and 5 years, respectively). The emissions for Alternative E would be similar to the emissions for Alternative B, except the emissions associated with drilling would be spread out over a longer period.

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5.5 PHYSICAL OCEANOGRAPHY AND COASTAL PROCESSES

The key findings of effects for physical oceanography and coastal processes are summarized below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

Alternatives B and E: The barge offloading facility and its associated dredging and screeding would result in minor, irreversible impacts. These impacts would extend less than 1,000 feet beyond the barge offloading facility.

Alternatives A, C, and D: Minor impacts due to differential shoreline erosion are possible under these alternatives but would generally be limited in geographic extent to within 100 feet of project components.

Differentiators:

- Alternatives C and D would not have a barge sealift facility with associated dredging and screeding.

5.5.1 Methodology

The analysis of potential impacts on physical oceanography and coastal processes was conducted by evaluating the Applicant's project description, proposed design measures, Applicant's data collection, and information provided by the Applicant through the RFI process. The information provided by the Applicant was assessed by the third-party EIS preparer's subject matter expert. Reference sources and previous publications on marine waters within, and near, the project area were reviewed. An understanding of existing conditions served as a basis for determining impacts to coastal processes from the Alternatives, which are described in detail in Chapter 2, Alternatives.

Construction and operation of the Point Thomson Project would not be likely to affect aspects of physical oceanography, as described in Section 3.5, beyond the project footprint. Therefore, impacts in this section focus primarily on coastal processes. The coastal processes impact analysis focuses on how marine-related components of the project interact and potentially modify the existing landforms. Other sections of the EIS discuss impacts to other resources associated with the coastal zone such as fisheries, wetlands, floodplains, and habitat.

The impact evaluation criteria used for this chapter are summarized in Table 5.5-1.

Table 5.5-1: Impact Criteria—Physical Oceanography and Coastal Processes

Impact Category*	Intensity Type*	Specific Definition for Coastal Processes
Magnitude	Major	Nearshore change sufficient to transform existing shoreline processes, use, or essential habitat.
	Moderate	Reduce or increase existing nearshore sedimentation.
	Minor	Slight modification of shoreline near pad and barge offloading facility.
Duration	Long term	Irreversible impact on lagoon shoreline.
	Medium term	Recovery to original condition within 10 years of work cessation.
	Temporary	Recovery to original condition within 2 years of construction completion.
Potential to Occur	Probable	No avoidance possible.
	Possible	Potential to occur (can minimize).
	Unlikely	Not likely to occur or can avoid.
Geographic Extent	Extensive	Project area and beyond (lagoon scale).
	Local	Project footprint + adjacent 1,000 feet.
	Limited	Project components + 100 feet.

* Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology.

5.5.2 Alternative A: No Action

Under the No Action Alternative, the current 12-acre PTU-3 pad would remain where it is located landward of the waterline. Over time, the consequence to the shoreline would likely be a localized "promontory" forming due to the less-erosive nature of the gravel that would slowly dissipate, contributing gravel to the nearshore adjacent beaches. Long-term (decadal) rates of shoreline retreat have been reported in the Canadian arctic of 3 to 7 feet per year (Reimnitz et al. 1988, Harper 1990, Jones et al. 2009, Jorgenson and Brown 2005, Solomon 2005, Vasiliev et al. 2005). Episodic rates associated with single events may be two to three times greater than long-term average rates, and maximum rates as much as 65 feet per year have been reported on the Canadian Beaufort Sea (Solomon and Covill 1995). Depending on the design life of the pad, ultimately the shoreline could retreat to the pad's location. Once this occurs, only physical intervention by replacing all lost material would restore the beach. However, such intervention could have detrimental environmental consequences as the natural erosion process is slow, and the biological community may adapt as the change occurs. Eventually shoreline retreat could encircle the pad, creating a promontory of land or island.

5.5.3 Alternative B: Applicant's Proposed Action

Alternative B is described in detail in Chapter 2, Alternatives. As it relates to coastal processes, Alternative B would include multiple project components (such as drilling pads, barge offloading facility, and emergency boat launch ramp) and activities that have potential to impact the shoreline in some form and are discussed below.

5.5.3.1 Alternative B: Construction and Operations

Impacts to coastal processes from the Applicant's Proposed Action would occur as a result of constructing and operating the project; these impacts are discussed below.

Barge Offloading Facility

The barge offloading facility consists of the sealift barge facility and a service pier for smaller coastal barges. The sealift barge facility would include an offloading bulkhead and four 48-inch diameter mooring dolphins oriented perpendicular to the shoreline. The bulkhead would be constructed with sheet pile above the MHW elevation. The bulkhead would then be backfilled with gravel to transition to the grade of the Central Pad.

The service pier would extend offshore approximately 70 feet and have a concrete deck supported by steel girders and six offshore vertical piles. Four mooring dolphins, in a line parallel to the shore, would also be included. These mooring dolphins would provide additional support for docking barges under adverse currents and wind conditions. As configured, barges can dock either perpendicular or parallel to the shoreline (HDR 2011d). Because the spacing of the piles and dolphins is large relative to their diameters, the barge offloading facility would not appreciably affect littoral transport.

During times of strong westerly storms with open water, storm surge in Lion Bay could rise to as much as 6 feet. Riding atop this storm surge, waves of 5 to 6 feet could impinge on the bulkhead and service pier. Under persistent winds and sustained wave conditions, standing waves could develop in front of the bulkhead, such that the runup on its vertical face could be as much as twice the incident wave height, or 10 to 12 feet. The height of the bulkhead would prevent most overtopping under such extreme storm conditions; however, the seabed at its base would be exposed to intense bottom-scouring capability of the waves. With a long and intense storm, significant scouring of the seabed could occur, perhaps even to the extent of exposing and cutting into the underlying permafrost.

Dredging and Screeding

To achieve an average 5-foot water depth necessary for barge access, dredging and screeding (leveling) of the seafloor would be required. The seafloor would be dredged and screeded approximately 300 feet northward of the service pier. For the sealift barge facility, dredging and subsequent screeding would begin approximately 40 to 60 feet from the bulkhead and proceed north approximately 500 feet. The proposed dredging would not extend deeper than the annual ice growth of 7 feet. Removed seafloor sediments would be placed along the shoreline to the west of the Central Pad location. Approximately 1,500 cubic yards would be dredged during each year of construction to support use of the service pier and sealift barge facility (ExxonMobil 2011b).

During operations, periodic screeding and dredging may be required for the area in front of the service pier (ExxonMobil 2011b). This maintenance work 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).

The dredged area may approach the permafrost zone, which could result in the formation of a ***thaw bulb*** around the dredged area. Due to the fine grained nature of the soils, the loss of thawed sloughing sediment to suspended- and bed-load transport would likely be permanent.

Emergency Response Boat Launch Ramp

An emergency response boat launch ramp would be located on the east side of the Central Pad away from the barging area. The facility would consist of a gravel ramp leading from the pad to a launch for trailered boats or landing-craft style vessels. The launch would be 24 feet wide, and would consist of gravel overlain by concrete planks to a point approximately 3.5 feet below MLLW. Grading of the beach face for the launch would do little, if anything, to the long-term coastal processes and geomorphology. Upon completion of the project, the concrete surface would be removed and the gravel would naturally disperse over time.

Pads

As described in Section 3.5.5, Coastal Processes, the Applicant conducted a coastal engineering assessment (PND 2009a) that evaluated shoreline erosion rates and ice ride-up potential for the proposed gravel pad sites. The results of the shoreline erosion analysis were used to determine pad placement relative to the shoreline and if any protection would be required.

Table 5.5-3 and Figure 5.5-1 show historic and projected shoreline locations using average historic erosion rates and maximum historic erosion rates. These rates are further described in Section 3.5.5, Coastal Processes. As shown, at the end of the project life (30 years), the West Pad and the new portion of the East Pad would be beyond the farthest advance of the shoreline under the maximum erosion rates. The northern part of the Central Pad and the North Staines River State No. 1 portion of the East Pad are fixed because they consist of pre-existing gravel pads. The northeast corner and eastern edge of the Central Pad would be seaward of the shoreline by the end of the project under the maximum erosion rates. About the eastern one-fourth of the current North Staines River 1 Pad would be seaward of the shoreline under the maximum projected erosion rates.

Table 5.5-2: Summary of Shoreline Erosion Analysis

Location	Historic Average Erosion Rate (feet/year)	Year Shoreline Reaches Toe of Gravel Pad	Historic Average Maximum Erosion Rate (feet/year)	Year Shoreline Reaches Toe of Gravel Pad
West Pad	4.1	2087	14.8	2040
Central Pad North Shore	1.2	2058	6.3	2039
Central Pad East Shore	0.8	2136	6.8	2029
East Pad[a]	2.1	2119	5.3	2059

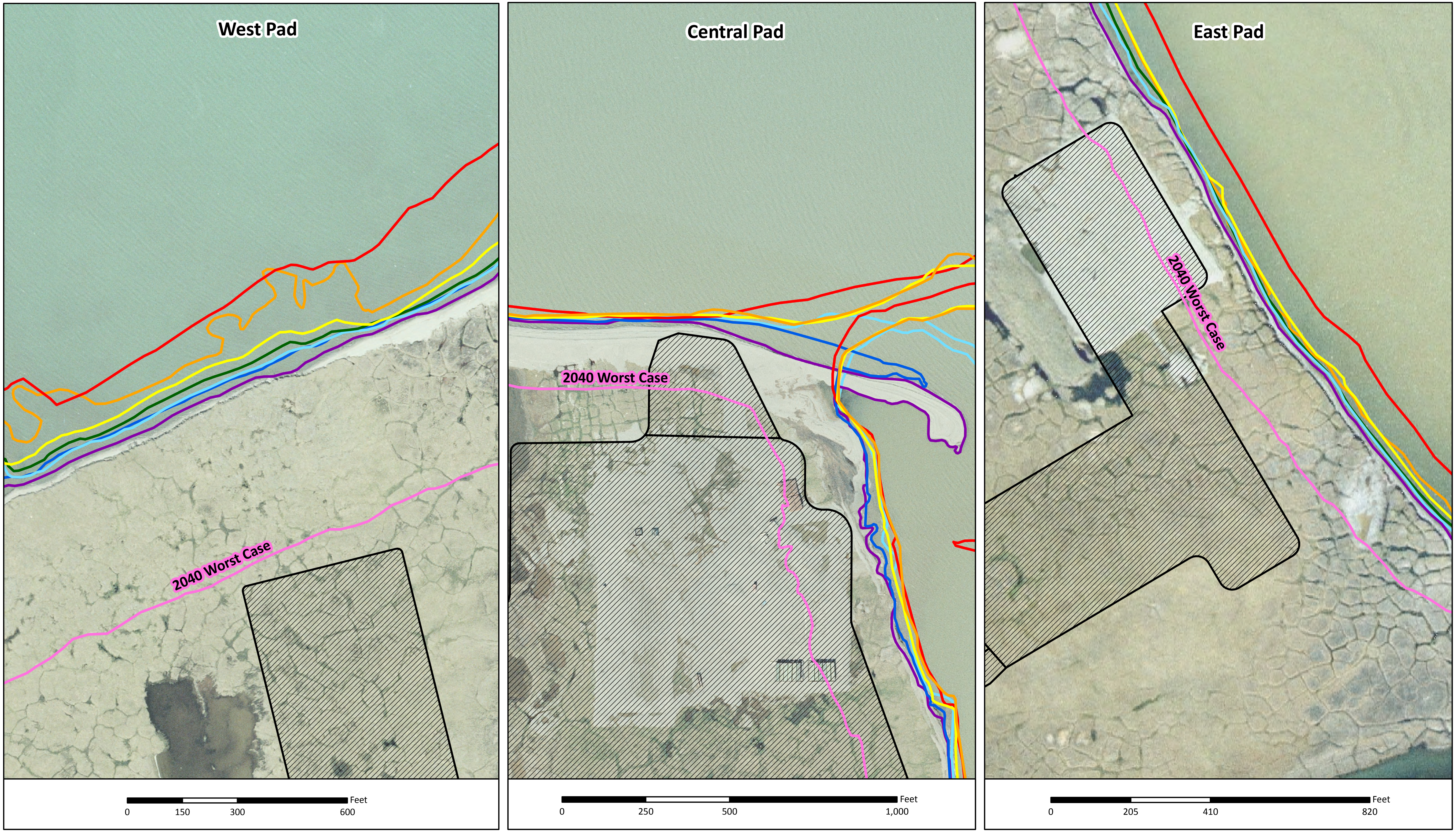
[a] East Pad refers to the part of the pad that would be built for the proposed project. The existing North Staines River State No. 1 Pad, which would be incorporated into the East Pad, is closer to the shoreline.

Source: PND 2009a

Central Pad

The Central Pad is currently in place near the shoreline facing the northeast. Armoring, consisting of gravel bags, would be added to the seaward facing slopes to minimize coastal erosion. Due to its orientation, and the generally lower wave exposure in that direction, the Central Pad would be less likely to be affected by nearshore processes than if it were facing west. The Central Pad could also experience some degree of ice ride-up during fall freeze and in early spring thaw. The armoring placed on the pad perimeter would also help protect the pad core from mechanical erosion by the ice.

If the gravel pad were left in place after the life of the project, ultimately the shoreline could retreat and a promontory could form as described under Alternative A.



POINT THOMSON PROJECT EIS

Legend

Shorelines (1955-2040)
- 1955
- 1977
- 1982
- 1991
- 1997
- 2001
- 2006
- 2040

Gravel Pads

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

N

Figure 5.5-1
Historical and Worst Case Projected Shoreline Erosion

Date: 23 March 2012
Map Author: HDR Alaska Inc.
Source: See References Chapter for source information

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East and West Pads

The East Pad would be located east of the Central Pad, on and adjacent to the existing North Staines River State No. 1 Pad. The West Pad would be located on an undeveloped site near the coastline west of the Central Pad. The West Pad and new part of the East Pad would be set back from the coast beyond the influence of coastal erosion, storm events, and sea ice ride-up. The design criteria were selected conservatively and are adequate to resist damages posed by storm waves and sea ice ride-up, except in extreme circumstances. The West Pad and new part of the East Pad would not require armoring and would not interfere with natural coastal processes. The seaward side of the existing North Staines River State No. 1 Pad would be armored with gravel bags for protection from wave erosion and sea ice ride-up.

Wells

The Corps received several comments expressing concern about coastal erosion and the integrity of the wells over the long term. After the wells are no longer in use, they would be plugged and abandoned in accordance with AOGC regulations (20 ACC 25.105-172). Plugging is accomplished by filling the well with cement so that hydrocarbons are prevented from migrating into other strata or to the surface. Even if the surface of the plug were subjected to coastal erosion as a result of a receding shoreline, the overall integrity and effectiveness of the plug would not be compromised.

Sea Ice Road

A sea ice road may be constructed to facilitate Alternative B construction. Utilization of ice roads constructed on the shorefast ice has been the usual practice for winter construction projects on the North Slope coast for more than three decades. Construction of ice roads begins as soon as the sea ice is thick enough to bear the weight of equipment needed to pump sea water from beneath the shorefast ice, usually mid- to late December. The ice road would be constructed by spreading sea water over the ice surface and then, as it freezes, reinforcing it with crushed freshwater ice in successive layers until it is sufficiently thick to support the massive loads required for mobilization of construction activities and transport of production modules. The ice road would be usable until early to mid-April. Upon abandonment, the sea ice road would be cleared of markers and other equipment and then allowed to melt along with the rest of the shorefast ice. The only evidence of an ice road’s prior existence would be the blocks of sea ice from the road that would require somewhat more time to dissipate and melt than the adjacent sea ice cover. There would be no lingering environmental consequences associated with the construction and use of sea ice roads for this or any other project alternative.

5.5.3.2 Alternative B: Summary of Impacts

Table 5.5-3 summarizes the potential impacts of Alternative B on oceanography and coastal processes.

Table 5.5-3: Alternative B—Impact Evaluation for Physical Oceanography and Coastal Waters

Project Component	Magnitude	Duration	Potential to Occur	Geographic Extent
Barge Offloading Facility	Minor	Long term	Probable	Local
Dredging and Screeding	Minor	Long term	Probable	Local
Emergency Response Boat Launch Ramp	Minor	Long term	Probable	Limited
Central Pad	Minor	Long term	Possible	Local
Sea Ice Road	Minor	Temporary	Probable	Local

5.5.4 Alternative C: Inland Pads with Gravel Access Road and Alternative D: Inland Pads with Seasonal Ice Access Road

Alternatives C and D are inland alternatives intended to minimize impacts to coastal resources. In these alternatives, project components such as the East and West Pads are relocated a half mile inland, and the activities of the Central Pad are divided so that only the drilling pad remains at the coast. Barging and the construction of barge offloading facilities would not occur. The primary difference between Alternatives C and D is that Alternative C would include construction of an all-season gravel access road. A sea ice road could be constructed for either alternative during the construction phase. After construction of an all-season gravel road in Alternative C, ice roads would no longer be constructed.

5.5.4.1 Alternatives C and D: Construction and Operations

The components with the greatest potential to impact coastal processes in Alternatives C and D would be the emergency response boat launch ramp, the Central Well Pad, and the possible construction of sea ice roads.

Emergency Response Boat Launch Ramp

On the east side of the Central Well Pad, the beach face would be graded and armored with gravel to provide a launch ramp for trailered boats or landing-craft style vessels in case of an emergency, as described under Alternative B. Grading of the beach face would do little, if anything, to the long-term coastal processes and geomorphology. Upon completion of the project, the concrete surface would be removed and the gravel would naturally disperse over time.

Central Well Pad

Under both Alternatives C and D the Central Well Pad would be located near the shore at the existing PTU-3 gravel pad. Alternative C would expand the PTU-3 pad. Alternative D would use the existing PTU-3 pad without expansion and the geometry of the pad would not change. 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 under either alternative. If the gravel pad were left in place after the life of the project, ultimately the shoreline could retreat and a promontory could form as described under Alternative A.

Sea Ice Road

As discussed for Alternative B, construction and operation of a sea ice road would have minor temporary effects on coastal processes.

5.5.4.2 Alternatives C and D: Summary of Impacts

Table 5.5-4 summarizes the potential impacts of Alternatives C and D on oceanography and coastal processes.

Table 5.5-4: Alternatives C and D—Impact Evaluation for Physical Oceanography and Coastal Waters

Project Component	Magnitude	Duration	Potential to Occur	Geographic Extent
Emergency Response Boat Launch Ramp	Minor	Long term	Probable	Limited
Central Well Pad	Minor	Long term	Possible	Local
Sea Ice Road	Minor	Temporary	Probable	Local

5.5.5 Alternative E: Coastal Pads with Seasonal Ice Roads

5.5.5.1 Alternative E: Construction and Operations

From the standpoint of coastal processes, Alternative E is similar in configuration to Alternative B. The project components and activities that have potential to impact the shoreline in some form are the same as Alternative B (drilling pads, barge offloading facility construction, emergency boat-launch ramp construction, and dredging). A unique project component for Alternative E would be a seasonal sea ice airstrip used until completion of the gravel airstrip. Impacts from the sea ice airstrip would be similar to the sea ice road under Alternative B.

5.5.5.2 Alternative E: Summary of Impacts

Table 5.5-5 summarizes the potential impacts of Alternative E on oceanography and coastal processes.

Table 5.5-5: Alternative E—Impact Evaluation for Physical Oceanography and Coastal Waters

Project Component	Magnitude	Duration	Potential to Occur	Geographic Extent
Barge Offloading Facility	Minor	Permanent	Probable	Local
Dredging and Screeding	Minor	Permanent	Probable	Local
Emergency Response Boat Launch Ramp	Minor	Permanent	Probable	Limited
Central Pad	Minor	Long term	Possible	Local
Sea Ice Road and Airstrip	Minor	Temporary	Probable	Local

5.5.6 Mitigative Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on physical oceanography and coastal processes.

- Using long-reach directional drilling to develop offshore resources without placing drilling structures in marine waters.
- Using a barge-bridge system for module offloading to eliminate the need for a solid fill causeway/dock and associated dredging of an access channel (Alternatives B and E only).
- Limiting dredging/screeding for the barge-bridge system and service pier to a small area in the vicinity of the Central Pad (Alternatives B and E only).
- Limiting structures in marine waters to six vertical piles for the service pier and eight mooring dolphins for barge landings (Alternatives B and E only), and a small boat launch at the shoreline (all action alternatives).
- Locating the sealift bulkhead and approach gravel ramp for the service pier above MHW to minimize the effect on sediment transport or deposition (Alternatives B and E only).
- Maintaining the barge-bridge system in place for the minimum time period needed to offload the modules (estimated 2 to 4 weeks) each sealift open water season, which limits the effects on coastal sediment transport (Alternatives B and E only).
- Locating East (new part) and West Pads sufficiently back from the coast to avoid impacts from coastal erosion, storm surge, and ice ride-up for the life of the project.
- Providing slope protection for the Central Pad to protect against storm surge and wave run-up events.

The Corps, in consultation with others, is considering additional mitigation to address coastal erosion impacts on the gravel pads, which would consist of preparing and implementing a monitoring and adaptive management plan. The plan would include monitoring of the pads for erosion and implementation of corrective action if necessary.

5.5.7 Climate Change and Cumulative Impacts

5.5.7.1 Climate Change

In the Arctic, the climate change effect that has received the greatest attention is potential alteration of sea level. Sea level change in the Arctic is especially complicated because it represents the combined effects of permafrost thawing, increased freshwater runoff, altered patterns of sediment deposition, and ongoing contributions from glaciers and ice sheets. Predicting changes in sea level for a specific region of the globe is extremely complicated, particularly so in the Arctic. The ACIA provides guidance for sea level rise derived from a compilation of studies of global sea level rise and Arctic-specific differences due to influences such as changes in salinity, post-glacial rebound, thermal expansion, and amount and longevity of sea ice. As noted in Section 4.3, Climate Change, these projections indicate a 2-inch rise by 2020, 6 inches by 2050, and 10 inches by 2080 (ACIA 2005).

Notwithstanding the above, it remains undetermined as to whether arctic sea level is increasing or decreasing due to climate change. Proshutinsky et al. (2001, 2004) analyzed 40 years of tidal gauge data and the several climatic effects that contribute to sea level change and demonstrated that the use of sea level rise as an indicator of climate change is inherently difficult because sea level change is the net result of many individual effects of environmental forcing. They concluded that, due to the offset of some effects of environmental forcing, there remains some uncertainty regarding the cause of sea level response to climate change.

Sultan et al. (2010) analyzed 17 years of records for the Prudhoe Bay tide gauge, which was established in 1993 and is one of few tide gages on the North American Arctic Ocean. While acknowledging the limitations of the gauge's short record, Sultan et al. determined an upward trend of 9.1 inches per 100 years that could not be considered statistically significant, due to a 95 percent confidence interval of ±10.2 inches per 100 years. At Tuktoyaktuk on the Canadian Beaufort Sea, however, a statistically-significant upward trend of 9.8 inches per 100 years, with a ±3.5 inches per hundred years confidence interval. This trend was calculated using data gathered between 1961 and 2009, with some multiyear gaps, from the Canadian Marine Environmental Data Service (FOC 2010).

While it is natural to presume that sea level rise is the effect of climate change that would be of greatest concern to physical oceanography and coastal processes, this is not the case in the Arctic. There are effects from climate change that warrant greater concern than sea level rise. Namely, the general warming of the Arctic appears to have lengthened the open-water period in Beaufort Sea coastal areas by 4 to 8 weeks over the past quarter-century. A longer open-water period allows a longer exposure of beaches to coastal processes, as well as increased thawing of frozen sediments within the beaches and coastal bluffs.

The substantial reduction of late summer sea ice cover of the Arctic Ocean creates longer fetches for generation of sea waves, and lengthens the season for coastal exposure to those waves. The larger waves thus generated have greater energy, which translates into increased coastal erosion and more rapid shoreline retreat, especially where the coast has greater exposure to the open ocean. However, in coastal areas that are protected by barrier islands, such as the project area, these effects would not be as pronounced.

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. However, other such "permanent" islands have been observed to undergo marked changes during unusually stormy open-water seasons, even to the extent of increasing exposure of the mainland coast that they protect. If the reduction in summer arctic sea ice cover continues, it is reasonable to expect longer open-water seasons as well as more erosive wave conditions for the reasons stated in Section 3.5. The processes that erode and reshape barrier islands proceed at a pace that effects can be easily monitored and actions can be taken to mitigate these effects, if necessary.

In the action alternatives, potential for increased wave run-up and sea level changes may increase the potential for adverse impacts to the infrastructure of the proposed project. Erosion of Flaxman Island also could increase with climate change. However, Flaxman Island is a durable feature of the coastline and whatever shoreline changes might occur, their time scale would be sufficiently long to allow remedial action at project facilities, such as additional protection from coastal processes, if that ever appears necessary.

5.5.7.2 Cumulative Impacts

The past and present effects of existing development facilities and activities within the region on physical oceanography and coastal erosion are generally limited to the localized area adjacent to a coastal structure. "Zones of influence" of coastal structures, such as the Prudhoe Bay causeways, are limited to 1 or 2 miles, so the latter are not past or existing actions that would affect coastal processes at Point Thomson in any alternative, whether action or no action (Niedoroda and Colonell 1990). In addition, because the coastal structures of past developments are relatively far apart and were used during different periods of time, a remaining effect in the Point Thomson area from past external actions on coastal erosion would be minor.

However, reasonably foreseeable future projects closer to the Point Thomson area such as the restart of Badami operations and/or development for gas sales at Point Thomson (see Section 4.2, Cumulative Impacts Methodology for list of past, present, and future actions considered in cumulative impacts analysis), could have effects on the physical marine environment and coastal erosion if the developments include construction of additional docks or other coastal structures and increased barge/vessel traffic. These actions, combined with effects identified for each of the action alternatives, could impact coastal processes such as erosion. The effects associated with the past, present, and future oil and gas and other coastal developments include adverse cumulative impacts, such as temporary increased suspended sediments and turbidity during construction of coastal facilities and an ongoing increase in barge/vessel traffic and associated erosion, turbidity, spills, and runoff effects.

5.5.8 Alternatives Comparison and Consequences

At Point Thomson 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.

The main difference between the alternatives relative to coastal processes is that under Alternatives C and D, there would be no barge offloading facility with its associated dredging and screeding. Therefore, total impacts on coastal processes would be only slightly higher than under Alternative A. Minor impacts would be associated with the barge offloading facility under Alternatives B and E.

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5.6 HYDROLOGY

The key findings of hydrology are summarized below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

All Action Alternatives: Long-term, moderate to major impacts to hydrology would result from new gravel infrastructure and gravel mines. Ice infrastructure could alter natural drainage patterns and streamflow during spring breakup. These impacts could extend across the entire project area.

Water withdrawal from lakes and reservoirs for ice infrastructure and other project needs could lower water levels.

Alternative A: No impacts.

Differentiators:

- Alternatives C and D would use more water, potentially lowering lake levels.
- Stream 24 would be diverted to fill gravel mine reservoir for Alternative D.
- Alternative C has more gravel infrastructure that can interfere with flow and drainage patterns (gravel access road) and Alternative E has less.

5.6.1 Methodology

Hydrologic resources evaluated in this section include freshwater in groundwater, lakes, and streams. The nearshore environment is addressed in Section 5.5, Physical Oceanography and Coastal Processes.

Groundwater is divided into shallow groundwater or deep groundwater classifications. This analysis focused on impacts to shallow groundwater. Deep groundwater is addressed in Section 5.1, Geology and Geomorphology. Shallow groundwater, sometimes referred to as “inter-flow,” flows in the shallow subsurface overlying permafrost throughout the project area. Shallow groundwater also includes taliks, which may provide hydrologic connections between lakes and streams.

Lakes and reservoirs were undifferentiated for this analysis. Lakes are natural water bodies and those identified for potential water withdrawal would be assessed based on ice thickness, available under-ice water, and fish species presence as part of the TWUP program. Reservoirs are water bodies that are manmade, usually developed from previous gravel-mining operations. Gravel mine reservoirs have been used as winter water sources because they are typically much deeper than natural lakes, providing more available winter water (White et al. 2008).

Streams include smaller streams originating on the ACP and larger streams with drainage areas extending beyond the ACP, into the Arctic Foothills and the Brooks Range. Within the project study area, all streams except one unnamed river between the Staines River and the Badami development originate on the ACP. Between Badami and the Endicott Spur Road, larger streams include the following:

- Sagavanirktok River (Main Channel)
- Sagavanirktok River (East Channel)
- Kadleroshilik River
- West Shaviovik River
- Shaviovik River
- No Name River (east of Shaviovik River)

Streams in this analysis were defined as those features identified in the ADNR Information Resource Management Section *Alaska Hydrography 1:63,360* (ADNR 2007) GIS dataset. The hydrography was digitized primarily from 1:63,360 USGS quadrangles photo-revised by the BLM from aerial high altitude photography flown between 1978 and 1985. In addition, stream channels mapped in the field were included in the stream crossing inventory. This dataset was used for the purpose of estimating the number of stream crossings by project components for each alternative.

As discussed in Section 3.6, Hydrology, smaller streams were identified in three studies from 1998, 2003, and 2009 (MBJ 1998, URS 2003a, PND 2009b). These studies covered the area of infield gravel infrastructure of Alternative B, but did not include the gravel access road proposed in Alternative C and areas south of the extent of Alternative B. An ADNR hydrography dataset and an HDR field reconnaissance dataset were used for the analysis of the Alternative C gravel access road.

The proposed project has the potential to affect natural drainage patterns, stream stage (water level) and streamflow (volume), stream velocity (which influences erosion and sedimentation rates), and lake levels. These impacts are summarized in Table 5.6-1 and further described below.

Table 5.6-1: Hydrologic Impact Types

Type of Impact	Description
Changes to Natural Drainage Pattern	Natural drainage patterns may be affected by blockage or redirection of flow.
Changes in Stage and Streamflow	Stage (water level) and/or streamflow may increase or decrease because of diversion, constrictions at road and pad crossings, or other stream channel disturbance.
Changes in Stream Velocities and Increased Erosion or Sedimentation	Erosion and sedimentation may increase or decrease due to changes in streamflow velocities and/or sediment sources.
Changes in Lake Level	Lake levels may decrease seasonally or year-round following water withdrawal. This may eliminate unfrozen deep water in the winter, and any associated thaw bulbs or taliks.

Proposed project components predicted to have the greatest potential effects on hydrologic resources include stream crossings of gravel fill, fill placement for infrastructure, and water withdrawal to support the construction, drilling, and operations phases, and construction of ice roads.

5.6.1.1 Changes to Natural Drainage Pattern

Modification of the natural surface water drainage patterns would typically be caused by blockage or redirection of flow. Examples include displacement of a lake or pond by fill, or placing fill (such as for an airstrip) transversely across grade, thereby blocking the natural drainage of sheet flow runoff, shallow groundwater, stream input, or rain catchment.

5.6.1.2 Changes in Stages and Streamflow

Alternatives may impact ***stage*** and/or ***streamflow.*** Stage and flow are typically related; if flow increases or decreases then stage generally follows suit. However, stage may increase or decrease without an accompanying change in flow volume. For example, if flow is diverted from a creek, both stage and streamflow would decrease; but if fill is placed in a channel creating a constriction or impoundment, stage would increase without a corresponding increase in flow. Likewise if a stream channel is widened or lowered through erosion or dredging, stage may decrease without flow decreasing.

5.6.1.3 Changes in Stream Velocities and Increased Erosion or Sedimentation

Increased or decreased stream velocities could result in increased erosion or sedimentation. Generally, increases in velocity result in increased erosion, and decreases in velocity result in increased sedimentation. Flow constrictions such as through culverts or bridges would most likely lead to increased stream velocity, which may increase erosion. Similarly, flow blockages or other obstructions can lead to decreased velocity, potentially resulting in increased sedimentation. Diversions may also affect erosion and sedimentation. Decreasing the volume of water flowing in a stream typically decreases velocity and sediment transport capacity, while increasing streamflow typically increases velocity and erosive capacity.

5.6.1.4 Changes in Lake Level

Water withdrawal to support components of each alternative could impact the water levels of lakes used as water sources, and any connected water body, such as streams or wetlands. For this analysis it is assumed that only permitted lakes or reservoirs (under the State of Alaska TWUP program) would serve as water sources.

5.6.1.5 Impact Evaluation

Potential impacts to hydrology from project alternatives were evaluated based on the criteria in Table 5.6-2. Changes to the hydrologic regime include increase or decrease of water quantity, stage, streamflow or velocity, and modification of drainage patterns.

Table 5.6-2: Impact Criteria—Hydrology		
Impact Category*	Intensity Type*	Specific Definition for Hydrology
Magnitude	Major	Changes to the hydrologic regime require rehabilitation or cannot be rehabilitated to maintain preproject hydrologic function.
	Moderate	Changes to the hydrologic regime are measurable, yet do not require rehabilitation to maintain preproject hydrologic function. Examples per type of impact: • Drainage patterns change, yet impoundment and draining are similar to annual flooding and seasonal inundation extents. • Streamflow or stage changes, yet seasonal and annual base flow and peak events are preserved, and flood inundation limits are similar. • Stream velocity changes, but erosional and depositional characteristics are preserved and increases are not compounded. • Lakes levels change seasonally but recharge annually.
	Minor	Slight changes to the hydrologic regime that are not measurable.
Duration	Long term	Impact to hydrologic regime would exceed 4 years.
	Medium term	Impact to hydrologic regime would last beyond a season but less than 4 years.
	Temporary	Impact to hydrologic regime would be seasonal and associated with only the construction or drilling phases.
Potential to Occur	Probable	Changes to the hydrologic regime are predicted to occur.
	Possible	Changes to the hydrologic regime may or may not occur, or impacts would be avoided or mitigated.
	Unlikely	Changes to the hydrologic regime are not expected.
Geographic Extent	Extensive	Changes to hydrologic regime extend beyond the immediate water body affected, or affect a large portion of an individual water body of great size or critical value. Impacts beyond the immediate water body are due to hydrologic connections such as downstream, upstream, lakes feeding stream, stream feeding lakes, and shallow groundwater connections between lakes and other lakes or streams.
	Local	Changes to hydrologic regime are limited to areas without stream connections or water bodies of great size or critical value that are discernible from either aerial photographic interpretation or a GIS hydrography dataset.
	Limited	Changes to hydrologic regime are limited to areas without lakes or stream connections that are discernible from either aerial photographic interpretation or a GIS hydrography dataset.

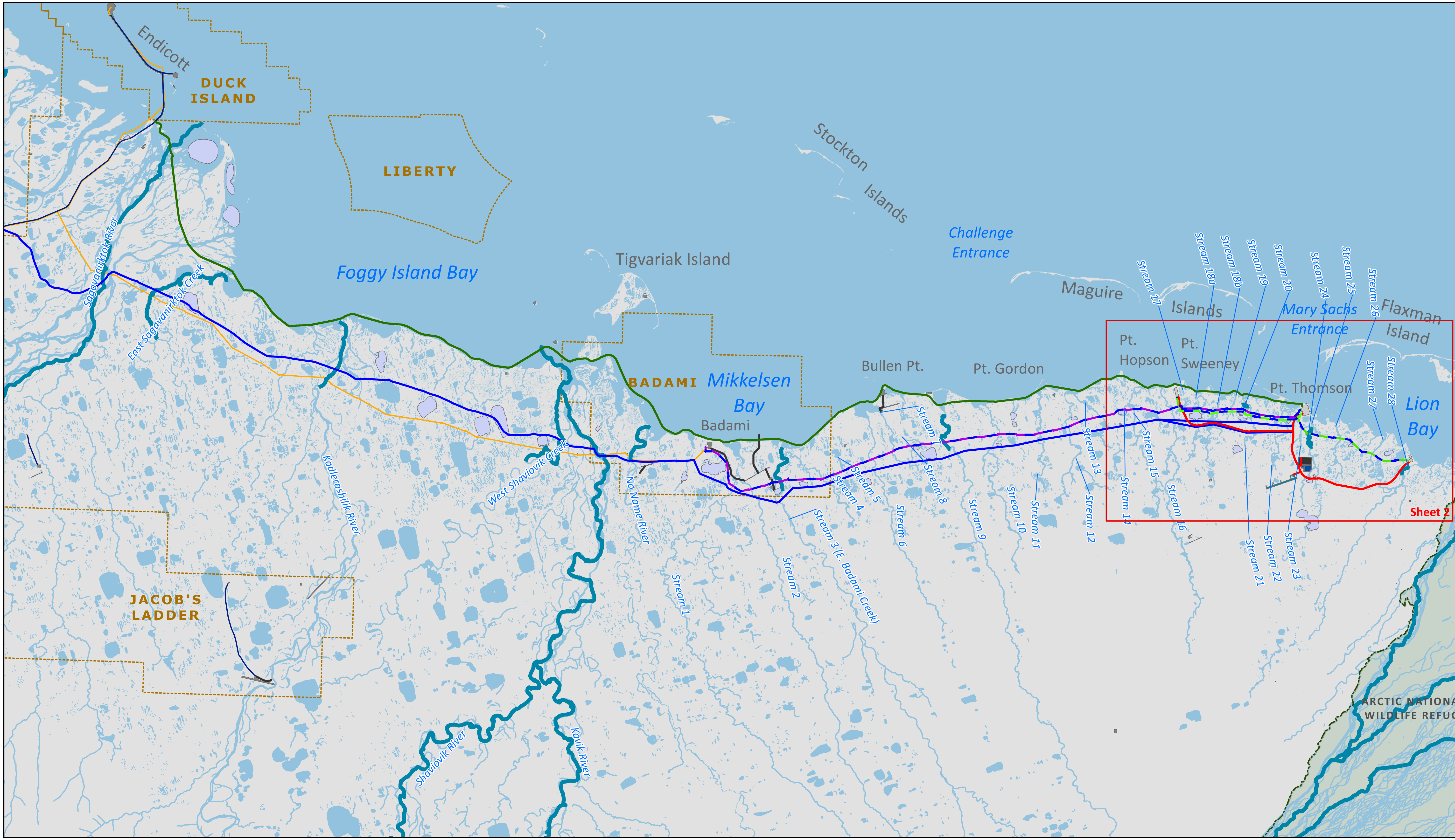
* Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology

5.6.2 Alternative A: No Action

Alternative A includes monitoring of the two existing wells at the Central Pad. No direct or indirect impacts would occur to hydrologic resources under this alternative.

5.6.3 Alternative B: Applicant's Proposed Action

Delineation and production of the Point Thomson Reservoir under Alternative B could impact the hydrologic regime through gravel fill placement, construction of ice roads and ice pads, and water withdrawal and discharge. The project has been designed to minimize the footprint of the facilities and number of stream crossings. Alternative B infrastructure in relation to streams and water bodies is shown on Figure 5.6-1 and Figure 5.6-2. Table 5.6-3 lists the number of water bodies crossed by project infrastructure for each alternative.



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Legend

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

Proposed Project Layout

- Tundra Ice Road
- Sea Ice Road
- Gathering Pipelines
- 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

N

Figure 5.6-1
Alternative B
Streams and Water
Bodies of Interest – Sheet 1 of 2

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

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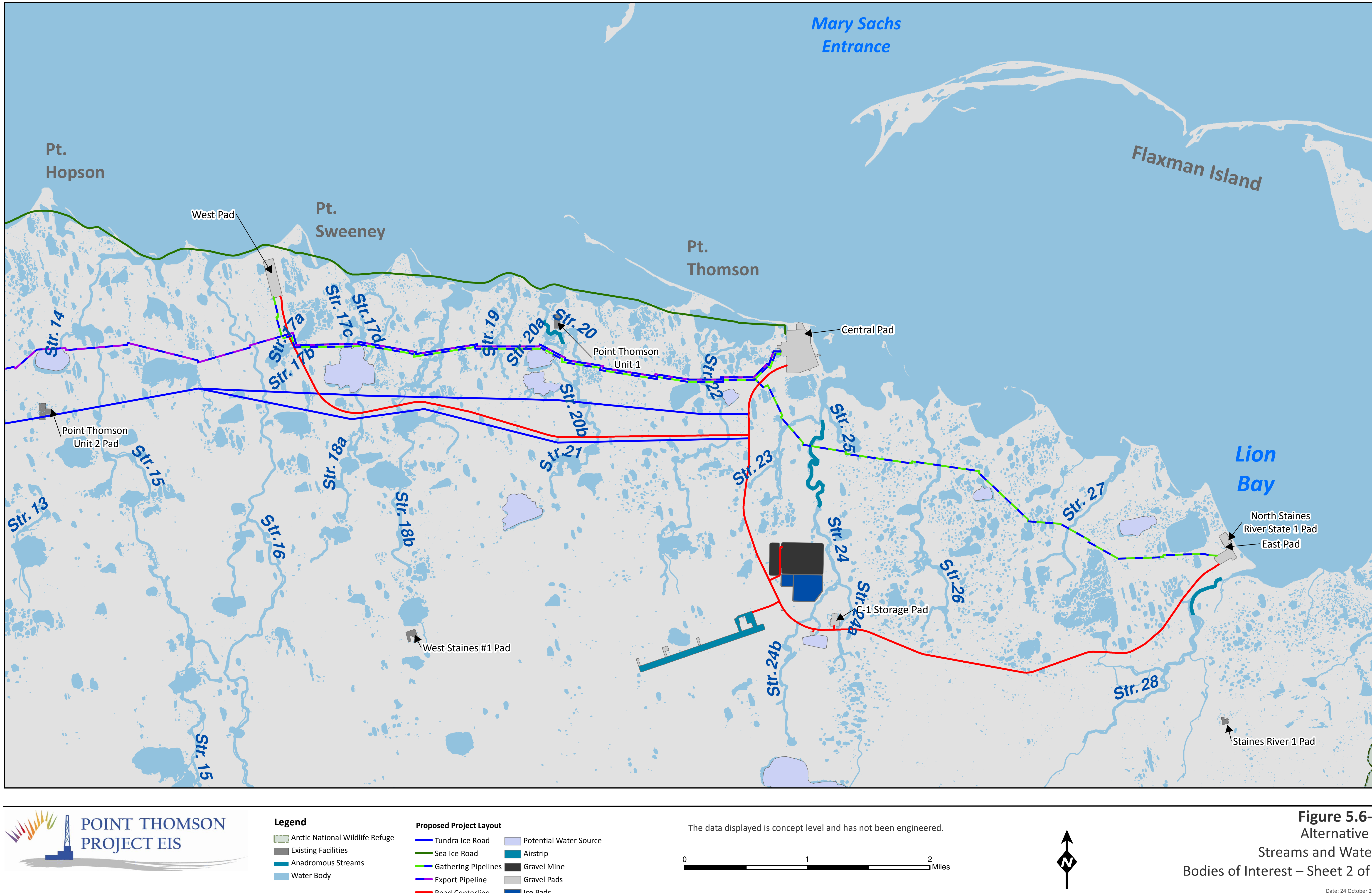

POINT THOMSON
PROJECT EIS

Figure 5.6-2
Alternative B
Streams and Water
Bodies of Interest – Sheet 2 of 2

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

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Table 5.6-3: Stream Crossings by Component for Action Alternatives				
	Number of Stream Crossings			
Project Component	Alternative B	Alternative C	Alternative D	Alternative E
Infield Construction Ice Roads	33	11	22	7
Tundra Ice Road/Module Transport Ice Road[a]	45	49	37	39
Pipeline Construction Ice Road	34	53	19	31
Optional Sea Ice Road[b]	18	18	18	18
Infield Gravel Road(s)	9	4	7	1
Infield Pipelines	18	13	16	15
Export Pipeline	32	56	24	35
Gravel Access Road	--	46	--	--
Total	171	232	125	142

[a] A tundra ice road would be built annually during operations under Alternative D.

[b] A portion of the optional sea ice road would be onshore. The sea ice road stream crossings are not included in totals.

5.6.3.1 Alternative B: Construction, Drilling, and Operations

Project activities that could impact the hydrologic regime include placement of gravel infrastructure for pads, roads, and an airstrip; construction of ice roads and ice pads; construction of pipelines; construction of a new gravel mine site; water withdrawal from area lakes and reservoirs for construction of temporary ice infrastructure, hydrostatic testing, and camp use; and disposal of wastewater to the tundra. This analysis combines all project phases (construction through operations) because the impacts to the hydrologic regime would be continuous throughout the project.

Gravel Infrastructure

Gravel Pads: Alternative B would require three primary gravel pads (Central, West, and East) and several smaller pads including the existing C-1 storage pad, a water source access pad, and a gravel storage pad. Two small gravel pads also would be constructed at Badami. These pads and their sizes are described in Chapter 2, Alternatives.

Gravel pad infrastructure would most likely impact hydrologic resources by changing natural drainage patterns and affecting stage and/or streamflow. Drainage patterns could be altered if the pads impound or redirect water upgradient of the pads. Streamflow impacts from the gravel pads would be minimized because proposed pad locations avoid streams. However, water connections between lakes by poorly defined channels and shallow groundwater would likely be intercepted by the Central and West Pads.

Infield Gravel Roads: Approximately 11.3 miles of infield gravel roads connecting the well pads, airstrip, storage pads, and water source access areas would cross nine small streams originating on the ACP. Bridges or culverts would be used for stream crossings, depending on stream size. All stream crossing structures would be designed for a 50-year flood event and analyzed for a 100-year event. The Applicant conducted a hydraulics analysis to estimate the 50-year design flow at major stream crossings under Alternative B (WorleyParsons and PND 2011). As part of this analysis, streams with a 50-year flood discharge of 500 cfs or greater were designated to be crossed with a bridge, and streams with a 50-year flood discharge less than 500 cfs were designated to be crossed with a culvert battery.

HDR performed a similar analysis on all of the action alternatives using the same criteria for stream crossing structures as WorleyParsons and PND (2011). Based on this analysis, under Alternative B four streams would be crossed with bridges, and five streams would be crossed with culverts or culvert batteries consisting of culverts at least 36 inches in diameter. Table 5.6-4 summarizes the estimated number of culverts and bridges for each alternative. Detailed results of the HDR hydrology and hydraulics study, including a detailed stream crossing table, are provided in Appendix S, and Section 5.8, Vegetation and Wetlands, provides a discussion of the analysis relative to vegetation.

Table 5.6-4: Stream Crossing Structures Summary

Alternative	Total Length of Gravel Roads (miles)	Stream Crossing Structures (Number)	
		Culverts[a]	Bridges[b]
Alternative B	11.3	5	4
Alternative C[c]	63.2	21	27
Alternative D	17.2	5	2
Alternative E	3.4	0	1

Sources: EIS Hydrology and Hydraulics Analysis, see Appendix S

[a] 50-year design flow is 500 cfs or less.

[b] 50-year design flow is greater than 500 cfs.

[c] Shaviovik Slough (two crossings) would be crossed with either culverts or bridges; therefore total would be 50.

The analysis in Appendix S is intended to provide a conservative estimate of the duration of inundation upstream of gravel fill roads during breakup. The purpose of estimating inundation time is to determine whether it could potentially be long enough to affect vegetation growth. Although preliminary engineering is available for one alternative that would affect the calculation of inundation times, it is not available for other alternatives. To provide a comparison across alternatives, the same conservative assumption that up to 4 feet of water could be impounded upstream of the gravel road was applied.

Some structures designed for a 50-year flood would impact stream stage and modify erosion and sedimentation conditions due to constriction of stream channel conveyance. Constriction of the stream channel could have upstream and downstream effects and could affect other connected water bodies.

Crossing structures are typically narrower than streams at flood flow. This is especially true on the ACP, where stream channel capacity is small and the majority of breakup flows outside of the stream channel. As an example, Stream 18a, which the Applicant proposes to cross with a 48-inch culvert in Alternative B, has an annual flooded width of about 100 feet. Stream 22b, which the Applicant proposes to cross with a 65-foot bridge in Alternative B, has an annual flooded width of about 740 feet. The effect of constricting streams includes increasing stage and decreasing velocities upstream of the crossing, and decreasing stage and increasing velocities downstream of the crossing. The Applicant would provide erosion protection on the downstream outlet of stream culverts.

The roads leading from the West and East Pads would traverse the hydraulic gradient and have potential to impound sheet flow and shallow groundwater. Culverts would be placed approximately every 500 feet along all gravel roads to allow passage for sheet flow, as discussed in Appendix G, North Slope Construction Methods. The culvert spacing was determined by the Applicant based on breakup studies conducted in 2009 and 2010 (WorleyParsons and PND 2010, 2011). Specific culvert placement locations were determined based on field reconnaissance along the road routes. Additional culverts would be added to the roads in late summer after installation if observations during spring breakup identify that the roads are not allowing sufficient water flow through the area. Conditions would be monitored during subsequent years to determine if and where additional culverts are needed and to keep culverts free of debris.

Table 5.6-5 summarizes the area of increased stage (inundation) upstream and decreased inundation downstream of the proposed gravel roads for all alternatives. The maximum time of inundation upstream for all alternatives due to the gravel roads would be 4.4 days in addition to normal sheet flow duration (see Appendix S).

Table 5.6-5: Altered Inundation Area

Alternative	Area of Increased Stage (Ponding) Upstream of Gravel Roads (acres)	Area of Decreased Stage (Drying) Downstream of Gravel Roads (acres)
Alternative B	1,140	433
Alternative C	17,481	3,000
Alternative D	1,004	640
Alternative E	208	0

Sources: EIS Hydrology and Hydraulics Analysis, see Appendix S

Impacts due to the infield gravel roads include changes to drainage patterns, stream stage, and increases in erosion or sedimentation.

Gravel Airstrip: The 5,600-foot-long by 200-foot-wide, gravel airstrip would be constructed south of the other infrastructure components and would be located to avoid placement of gravel fill into stream channels. Potential impacts from the gravel airstrip would be similar to impacts from the gravel pads, including potential changes to natural drainage patterns and changes to stream stage. The airstrip would be oriented generally east-west, perpendicular to the dominant hydraulic gradient. The gravel fill would intercept movement of sheet flow, runoff, and possibly shallow groundwater. Changing airstrip orientation to avoid these impacts would not be feasible due to the prevailing wind direction. Culvert placement beneath the runway to allow some cross-drainage would be problematic because the airstrip would be 200 feet wide. Differential settling would be likely to occur (WorleyParsons and PND 2011) which could reduce effectiveness and result in an uneven runway surface.

The Alternative B airstrip would divert drainage away from Stream 22 and toward Stream 24, effectively increasing Stream 24's drainage area by 1.8 mi^2 and decreasing Stream 22's drainage area by the same amount. This drainage area corresponds to roughly 48 cfs of runoff (48 percent of Steam 22) during the mean annual flood.

Summary of Gravel Infrastructure Impacts. Gravel infrastructure would cover 213 acres of tundra in the project area (see Chapter 2, Alternatives). The airstrip and 11.3 miles of roads would traverse the natural drainage pattern in the project area. The following impacts would be expected from construction of gravel fill in Alternative B:

- Drainage patterns would be impacted by impoundment of sheet flow and shallow groundwater. Changes in drainage patterns could include ponding of water, widespread inundation upgradient of gravel fill and drier areas downgradient, particularly if culverts are not properly placed. Interception of sheet flow and shallow groundwater would be likely to affect lakes with hydrologic connections. These impacts would be increased by gravel fill structures that traverse the natural gradient, including the airstrip and infield gravel roads.

Stream 22 would decrease in flow and Stream 24b would increase in flow because of drainage diversions by the proposed airstrip.

- Stream stage could increase upstream of culverts (or other crossing structures) that form a constriction in surface water conveyance. An increase in stream stage upstream would also be associated with decreased velocities in ponded, or backwater, areas. Decreased stream velocity creates a depositional environment, where sedimentation increases. Stream velocity would increase through culverts. Increased velocity on the downstream side results in increased erosion, often observed as downcutting or channel incision at the downstream side of a culvert. Prolonged conditions can result in perched culverts where erosion at the downstream end has incised the stream channel such that the culvert outlet is exposed, creating a waterfall effect and a condition of increasing erosion.

Gravel road impacts to stream stage, stream velocities and changes in erosion and sedimentation are expected to be moderate, long-term, and extensive.

Ice Infrastructure

Seasonal Ice Roads: Numerous seasonal tundra ice roads would support all phases of the project. These would include the following:

- A transportation ice road between the Endicott Spur and the project (47 to 51.4 miles) would be built on tundra or sea ice annually during construction, drilling, and approximately every 5 years as needed during operations. The tundra ice road would cross 45 small to large streams. If a sea ice road is built, an onshore segment of this road would have 18 stream crossings. Impacts from the sea ice road are addressed in Section 5.5, Physical Oceanography and Coastal Processes.
- An export pipeline construction ice road between Badami and the Central Pad (29.3 miles long with 32 stream crossings) would be constructed in three consecutive winter seasons.
- Infield ice roads (22.6 miles long with 33 stream crossings) would be constructed to support pad, road, gathering pipeline, airstrip, and gravel mine site construction activities.

Some infield ice roads would generally follow the water flow gradient, but most of the ice roads would traverse it. The tundra transportation ice road would generally traverse the dominant hydraulic gradient, crossing between 45 streams. Five crossings west of Badami are larger streams, such as the Sagavanirktok River, which may require crossing multiple braided channels. The ice road could alter natural drainage patterns, stream stage, and streamflow during spring breakup because the ice road would melt more slowly than the surrounding tundra and streams. Blockage of streamflow and increased stream stage could occur during spring breakup due to ice roads that are not adequately slotted or breached (Whitman 2010). The Applicant would minimize impacts at stream crossings by slotting the ice roads during breakup to facilitate drainage.

Ice Pads: A seasonal ice pad would be constructed two seasons at the gravel mine site for overburden storage. Ice pads would also be used for construction camps south of the Central Pad (one season) and along the export pipeline (two seasons), if needed. Detailed information regarding these ice pads is provided in Chapter 2, Alternatives. No ice pads would be constructed during operations. All ice infrastructure would be built annually and melt in the summer.

Ice infrastructure during construction and drilling would require approximately 295 million gallons (MG) of freshwater (ExxonMobil 2011a). Potential water sources would include currently permitted water sources and potentially additional sources pending identification and permitting. Impacts of this and other water uses for Alternative B are described below under Water Supply.

Potential ice infrastructure impacts include the following:

- Ice roads may alter natural drainage patterns because most spring meltwater flows as sheet flow with the gradient. Because the ice masses of the ice road would persist later into spring breakup, the ice road would act as a dam, impounding meltwater upgradient of the road. Such changes to the natural drainage patterns can impact shallow groundwater, lakes, and smaller streams.
- Stream meltwater impounded by the ice road would increase stream stage at crossings for both larger and smaller streams. Stream stage could be further increased during breakup as the flow of impounded sheet flow is rerouted and concentrated at stream crossings.
- Stream velocities would be impacted in two ways. Impoundment would decrease stream velocities in the upstream of the ice roads, in turn increasing sedimentation.
- At openings in the ice roads where streamflow is allowed to flow downstream, a constriction of conveyance would likely occur. Constrictions are likely to increase stream velocities, much like breaching of a dam, and erosion capacity would then increase.
- Ice pads would have similar impacts as ice roads, particularly to drainage patterns. Persisting ice masses would affect drainage patterns by redirecting flow and increasing spring runoff locally as they melt.

In summary, ice infrastructure could affect lake levels, natural drainage patterns, streamflow, and stream stage over a large area. The impacts would occur over the life of the project. During operations, the impacts would occur seasonally about every 5 years.

Pipelines (Export and Gathering)

The export pipeline (22.2 miles long and 32 major stream crossings) and gathering pipelines (9.6 miles long and 18 potential stream crossings) would be constructed on VSMs 7 feet above the tundra. Only the VSMs would have the potential to impact the hydrologic regime. VSMs would be placed to avoid streams and lakes unless necessary. Where pipelines cross rivers and streams, the bottoms of the pipelines would be designed to be above the 200-year floodwater surface elevation plus an appropriate freeboard. If it is necessary to place VSMs within a river channel or floodplain because of horizontal span-length restrictions on the pipeline, those VSMs would be designed to accommodate the maximum scour depth that is likely to occur during a 100-year flood. Properly constructed VSMs would not be expected to measurably affect the hydrologic regime.

Gravel Mine

Excavation of the new 57.2-acre gravel mine would modify the existing drainage pattern because it would create a deep reservoir where none currently exists. During construction, overburden would be stored on ice pads and returned to the gravel mine following each mining season. Two mining seasons are anticipated. Once all available gravel is extracted from the mine and the overburden replaced, the mine would be allowed to fill naturally over the course of 5 to 11 years.

Converting the mine site to a deep water reservoir would impact the hydrologic regime in the project area. The gravel mine would have minor impacts to Stream 24 because it is partially separated by topography and would have moderate impacts to Stream 23. During the winter the reservoir would likely remain unfrozen at the base, creating a thaw bulb around it. However, the reservoir would be designed to provide habitat for fish and wildlife.

Power Cable Trench

During winter, a power cable trench would be dug approximately 15 feet off the toe of the gravel road from the Central Pad to the airstrip to bury the power cable. The power cable would cross one stream (Stream 24b). At this crossing, the cable would be suspended from the road bridge I-beam rather than being buried.

Water Supply

Project water demand is summarized in Table 5.6-6 for Alternative B and the other action alternatives. Table 2.4-5 in Chapter 2, Alternatives provides details regarding water use for infrastructure construction for Alternative B. During construction and drilling, freshwater would be required for the construction and maintenance of ice roads and pads; compaction of gravel for new roads and pads; dust suppression; drilling fluids, and camp use. Freshwater would be supplied from existing, year-round sources located between Endicott and Point Thomson. Sources in the vicinity of the Central Pad include currently-permitted lakes and the existing C-1 reservoir. Sources in the vicinity of Badami include the previously permitted Shaviovik Pit, Turkey Lake, and Badami Reservoir. Previously permitted sources in the vicinity of the Endicott causeway landfall include the Duck Island Mine Site and Sag Mine Site C (Vern Lake). Other sources could be permitted as needed to support construction.

The C-1 reservoir would be the primary water source during operations with the new gravel mine reservoir serving as a future permitted backup water supply.

Table 5.6-6: Action Alternatives—Estimated Water Use

Project Phase	Alternative B (MG)	Alternative C (MG)	Alternative D (MG)	Alternative E (MG)
Construction[a]	231.5	499.4	391.1	310.8
Drilling[a]	97.6	13.5	209.1	283.9
Operations[b]	2.7	2.9	21.1	13.2

Source: ExxonMobil 2011a, Table 1B

[a] Numbers represent total water use for project under construction and drilling phases.

[b] Numbers represent annual water use for operations phase. These numbers do not include water use for ice roads that would not be constructed on an annual basis (e.g., the tundra access road conservatively estimated to be needed once every 5 years).

The volume of water withdrawn from each lake or reservoir would be stipulated in a TWUP and would depend on the amount of water available below the ice and use of the water body by fish.

The impact of water withdrawal from tundra lakes depends on the capacity of the water bodies to recharge annually from snowmelt. If lakes do not recharge sufficiently, they would not maintain preproject hydrologic function, may freeze to the bottom, and may not retain thaw bulbs or taliks. Observations and studies of lake water recharge following water withdrawal in North Slope oil fields west of the Saganavirktok River indicate that these lakes are able to recharge from spring snow melt (MBJ 2002, Hinzman et al. 2006, Sibley et al. 2008). White et al. (2008) reported that the area studied has about five times the lake surface area than the area around Point Thomson. The study also suggests the capacity of water resources to support operations that consume water differs between the regions. Therefore, lake recharge in the vicinity of the project cannot be assumed to follow the trends of the Kuparuk and Colville areas. However, recharge monitoring data in WorleyParsons and

PND (2010) indicate full recharge to the C-1 mine site reservoir and the Shaviovik pit in the project area after previous withdrawals. The quantities of withdrawal were not provided in the report.

If lakes do not fully recharge annually from snow meltwater, lakes could become shallower, freeze to the bottom, and no longer provide adequate habitat for fish. Lake recharges are required to be monitored at permitted TWUP water sources as a condition of the water use permit. If lake levels do not recharge by the following spring snow melt, freshwater withdrawal quantities would be limited to ensure complete annual recharge. Recording natural lake levels before water withdrawal and monitoring lake levels after spring recharge allows water withdrawal volumes to be adjusted to ensure lake level maintenance.

Wastewater Disposal

Treated camp wastewater would be discharged to the lake south of the Central Pad until completion of the Class I disposal well or later if the Class I disposal well were unavailable. After hydrostatic testing of the pipelines, the test water would be filtered to meet NPDES permit limits and discharged to the tundra. The total volume of test water would be 16,200 barrels.

5.6.3.2 Alternative B: Impact Summary

Impacts on hydrology from Alternative B would result primarily from construction of gravel infrastructure, which would modify drainage patterns and streamflow. Ice roads and ice pads could seasonally affect natural drainage patterns and streamflow during spring breakup. After construction, these impacts would occur about every 5 years. Water withdrawal for ice roads, drilling, and camp use has the potential to affect lake and reservoir levels. These impacts would be minimized by water use permit requirements that limit water withdrawal if recharge is not maintained.

Table 5.6-7 summarizes the impacts of Alternative B on the hydrologic regime in the study area.

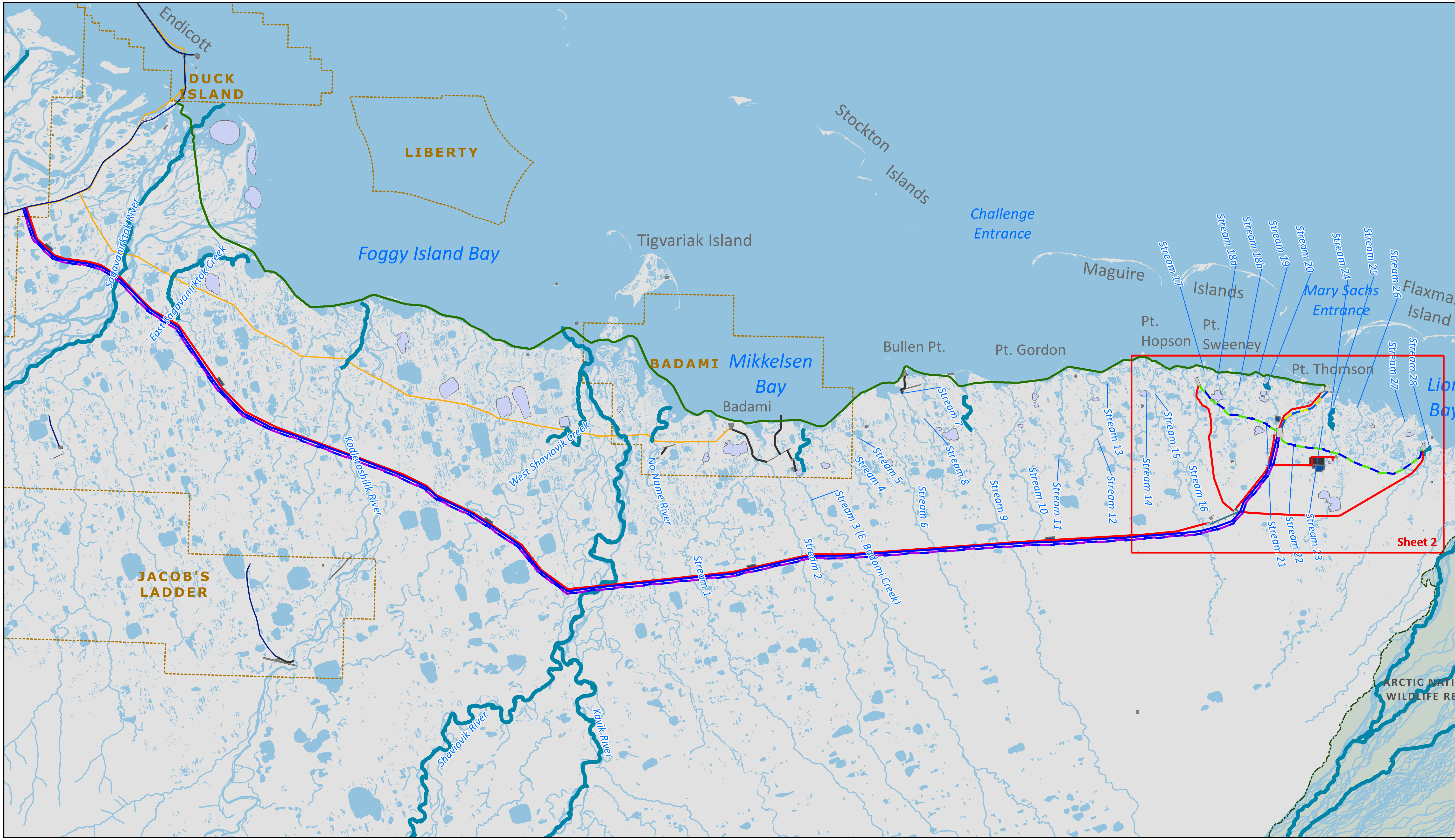
Table 5.6-7: Alternative B—Impact Evaluation for Hydrologic Regime

Project Component/Activity	Type of Impact	Magnitude	Duration	Potential to Occur	Geographic Extent
Gravel Infrastructure					
Gravel Pads	Drainage pattern	Major	Long term	Probable	Local
	Streamflow	Minor	Long term	Possible	Limited
Gravel Roads	Drainage pattern	Moderate	Long term	Probable	Extensive
	Streamflow	Moderate	Long term	Probable	Extensive
	Erosion/ sedimentation	Moderate	Long term	Probable	Extensive
Gravel Airstrip	Drainage pattern	Major	Long term	Probable	Extensive
	Streamflow	Major	Long term	Probable	Extensive
Ice Infrastructure					
Ice Roads Built Only During Construction and Drilling	Drainage pattern	Moderate	Temporary	Probable	Extensive
	Streamflow	Moderate	Temporary	Probable	Extensive
Ice Roads Built During All Project Phases	Drainage pattern	Moderate	Long term	Probable	Extensive
	Streamflow	Moderate	Long term	Probable	Extensive

Table 5.6-7: Alternative B—Impact Evaluation for Hydrologic Regime					
Project Component/Activity	Type of Impact	Magnitude	Duration	Potential to Occur	Geographic Extent
Ice Pads	Drainage pattern	Moderate	Medium term	Probable	Extensive
	Streamflow	Moderate	Medium term	Possible	Extensive
Water Supply					
Gravel Mine Site Reservoir	Lake level	Moderate	Long term	Possible	Extensive
C-1 Reservoir and Other Lakes and Reservoirs	Lake level	Moderate	Long term	Probable	Extensive
Other Components/Activities					
Pipelines	Drainage pattern	Minor	Long term	Possible	Extensive
	Streamflow	Minor	Long term	Possible	Extensive
Gravel Mine	Drainage pattern	Moderate	Long term	Probable	Extensive
Wastewater Disposal	Drainage pattern	Minor	Medium term	Possible	Limited

5.6.4 Alternative C: Inland Pads with Gravel Access Road

Delineation and production of the Point Thomson Reservoir under Alternative C could impact the hydrologic regime through gravel fill, ice infrastructure construction, and water withdrawal and discharge. Alternative C infrastructure in relation to streams and water bodies is shown on Figure 5.6-3 and Figure 5.6-4. The number of water bodies crossed by project infrastructure under Alternative C is provided in Table 5.6-4 (see Section 5.6.3 Alternative B: Applicant's Proposed Action).



POINT THOMSON PROJECT EIS

Legend

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

Proposed Project Layout

- Tundra Ice Roads
- 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 2.5 5 Miles

N

Figure 5.6-3
Alternative C
Streams and Water
Bodies of Interest – Sheet 1 of 2

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

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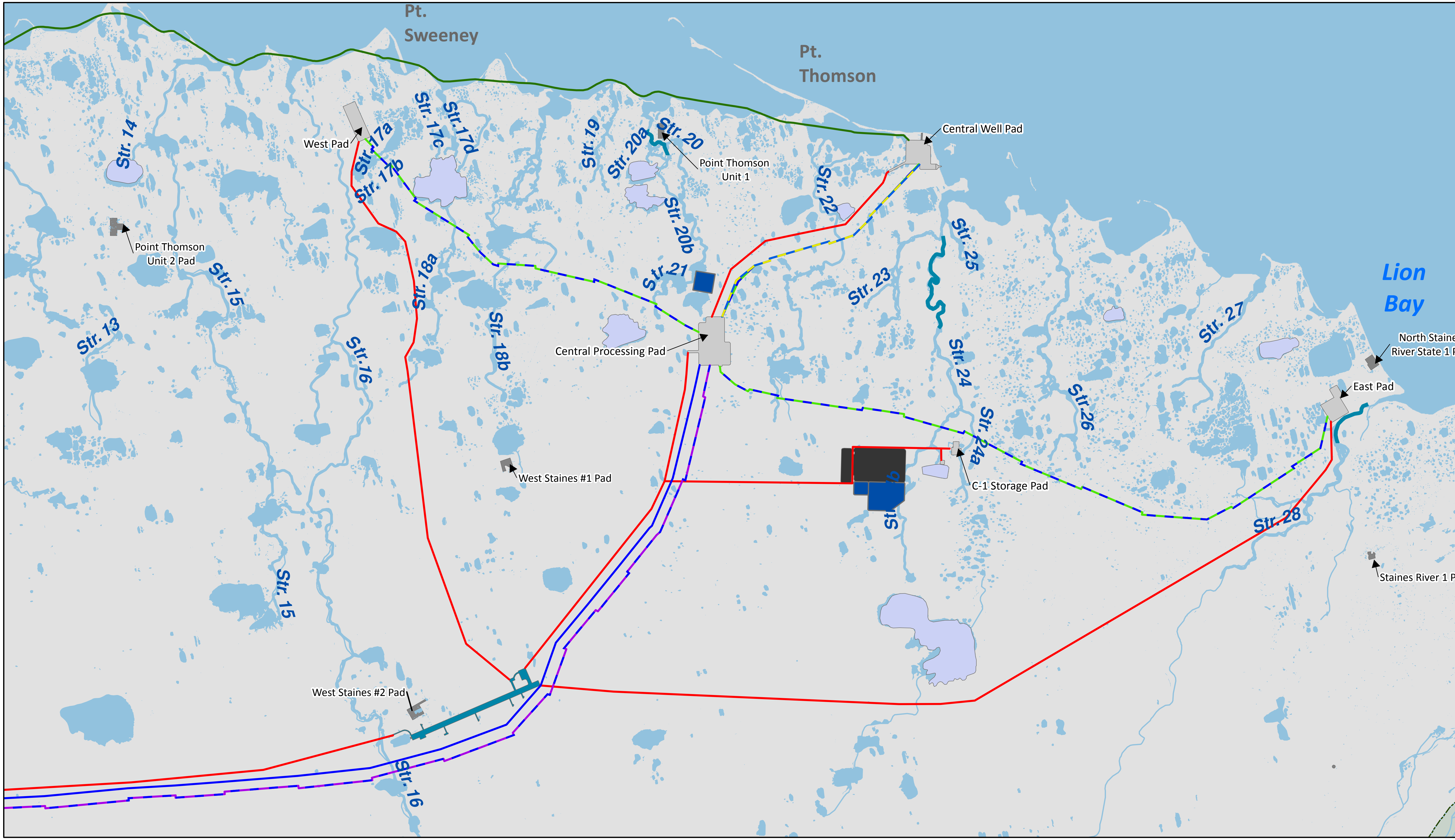

POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Existing Facilities
- Water Body
- Anadromous Streams

Proposed Project Layout

- Tundra Ice Roads
- 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 5.6-4
Alternative C
Streams and Water
Bodies of Interest – Sheet 2 of 2

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

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5.6.4.1 Alternative C: Construction, Drilling, and Operations

Construction-related activities that could impact the hydrologic regime include placement of gravel infrastructure for pads, roads, and an airstrip; construction of temporary tundra ice roads and ice pads; construction of pipelines; construction of new gravel mine sites; water withdrawal from area lakes and reservoirs for construction of temporary ice infrastructure, hydrostatic testing, and camp use; and disposal of wastewater to the tundra. Effects to the hydrologic regime due to construction, drilling, and operations would be similar and the discussions have been combined below.

Gravel Infrastructure

Pads: Four primary gravel pads would be constructed to support well production. The West Pad, East Pad, Central Well Pad, and Central Processing Pad are shown on Figure 5.6-4. In addition, gravel storage pads at each mine site and a new gravel pad at Deadhorse for module staging would be built.

The gravel pads under Alternative C would have the same types of impacts and intensity as those described for Alternative B.

Infield Roads: Potential impacts due to the infield gravel roads (19.1 miles, four stream crossings [two bridges and two culverts]) are expected to be of the same types and intensity as those described for Alternative B.

The infield roads leading from the East Pad inland to the airstrip traverses the hydraulic gradient and has greater potential to impound sheet flow and shallow groundwater than the roads leading from the Central Processing Pad and West Pad to the airstrip, which are aligned generally parallel to the existing drainage patterns and are not expected to cross streams. Minimizing the impact to the natural drainage patterns would require consideration of microtopography, unmapped channels, and hydrologic connections to lakes to determine that actual placement of the roads within the project area.

Access Road: The gravel access road (44.1 miles) would have about 46 stream crossings (including multiple crossings of the same stream), including both smaller streams originating on the ACP and larger streams with drainage areas extending into the Arctic Foothills and Brooks Range. As indicated in the EIS Hydrology and Hydraulics Analysis (see Appendix S), bridges are proposed for the following larger streams:

- Main channel of the Sagavanirktok River
- Kadleroshilik River
- Shaviovik River
- Unnamed River (east of the Shaviovik River)
- Unnamed River (east of Badami)

A summary of bridge and other crossing components is provided in Appendix S.

The other streams would be crossed with culverts or culvert batteries. All stream crossing structures would be designed for a 50-year flood. A summary of the area of increased and decreased inundation for Alternative C is found in Table 5.6-5. Impacts would be similar to those described for infield gravel roads but would extend across a larger area and larger water bodies would be crossed.

Gravel Airstrip: Potential impacts due to construction of the gravel airstrip (5,600 feet by 200 feet) are expected to be the same types of impacts as those described for Alternative B. There would be a decrease in the drainage area of Streams 18A and 18B and an increase in the drainage area of Stream 21 by 0.8 mi^2. This corresponds to a decrease of about 22 cfs in flood runoff in Streams 18a and 18b (14 percent of combined flow), and an increase of the same amount for Stream 21.

Ice Infrastructure

Seasonal Tundra Ice Roads: Seasonal ice roads that would support construction for Alternative C include the following:

- A transportation ice road between the Endicott Spur and the project (approximately 48.3 miles; 49 stream crossings) would be built on tundra. For three seasons, the ice road would be heavy-duty (1-foot thick compared to the standard thickness of 6 inches) to withstand the weight of module transport and would require more water for construction. Once the gravel access road was useable, this ice road would no longer be constructed.
- An export pipeline construction ice road between the Central Pad and Endicott (approximately 43.5 miles; 53 stream crossings) would be constructed in three consecutive winter seasons. During operations, maintenance would occur from the gravel access road and maintenance ice roads would not be constructed.
- Infield ice roads (approximately 14.5 miles; 11 stream crossings) would be constructed to support pad, road, and gathering pipeline construction activities. During operations, pipeline maintenance ice roads would be built occasionally as needed.
- An optional sea ice road may be constructed from Endicott Spur to Point Thomson to maximize the ice road season during any or all years of construction. An onshore segment of this road would have 18 stream crossings. Sea ice road impacts are addressed in Section 5.5, Physical Oceanography and Coastal Processes.

The impacts to hydrology from ice roads would be similar to those described for Alternative B, except that the heavy-duty tundra access road would take longer to melt during spring breakup due to its greater thickness. In addition, after the gravel access road is built, Alternative C would require fewer ice roads.

Ice Pads: Ice pads would be built for infield and export pipeline construction camps and for infield gravel mine overburden storage (43.4 acres total). Ice pads associated with the gravel access road include a construction camp ice pad and overburden storage pads at each gravel mine along the access road (132.7 acres total). Impacts from these ice pads would be similar in type and magnitude to ice pads discussed in Alternative B but would occur over a larger area.

Pipelines (Export and Gathering)

Potential impacts due to the export pipeline (50.2 miles, 56 stream crossings) and the gathering pipeline (10.9 miles 13 stream crossings) are expected to be the same types of impacts and intensity as those described for Alternative B. However, the impacts would occur across a larger area. The export pipeline for Alternative C also would include stream crossings of larger streams, those originating beyond the ACP.

Gravel Mines

Infield Gravel Mine: Potential impacts from development of the new infield gravel mine (65.9 acres) would be the same types of impacts and intensity as those described for Alternative B.

Additional Gravel Sources: Approximately five additional gravel sources (65 acres total) would be needed to meet the material requirements to construct the gravel access road. They would be sited approximately every 10 miles along the road corridor.

Potential impacts associated with each additional gravel source are expected to be similar to the impacts described for the infield gravel mine for Alternative B.

Water Supply

Water sources for Alternative C would be the same as described for Alternative B. Water use for Alternative C during construction, drilling, and operations is shown in Table 5.6-6. Details regarding infrastructure construction water use for Alternative C are provided in Chapter 2, Table 2.4-11. Alternative C would require more than double the water during the construction phase due to the additional ice roads. Drilling would require less water because under Alternative B an ice road from the Endicott Spur to Point Thomson would be needed through Year 6 to support drilling whereas under Alternative C the gravel access road could be used for later term drilling.

Wastewater Disposal

More water would be discharged from hydrostatic testing of the export pipeline in Alternative C due to its greater length. However, the magnitude and extent of potential impacts to hydrology from this discharge would not change appreciably.

5.6.4.2 Alternative C: Impact Summary

The potential impacts of Alternative C on the hydrologic regime are summarized in Table 5.6-8.

Table 5.6-8: Alternative C—Impact Evaluation for Hydrologic Regime

Project Component/Activity	Type of Impact	Magnitude	Duration	Potential to Occur	Geographic Extent
Gravel Infrastructure					
Gravel Pads	Drainage pattern	Major	Long term	Probable	Local
	Streamflow	Minor	Long term	Possible	Limited
Gravel Access Road	Drainage pattern	Moderate	Long term	Probable	Extensive
	Streamflow	Moderate	Long term	Probable	Extensive
	Erosion/sedimentation	Moderate	Long term	Probable	Extensive
Infield Gravel Roads	Drainage pattern	Moderate	Long term	Probable	Extensive
	Streamflow	Moderate	Long term	Probable	Extensive
	Erosion/sedimentation	Moderate	Long term	Probable	Extensive
Gravel Airstrip	Drainage pattern	Major	Long term	Probable	Extensive
	Streamflow	Moderate	Long term	Probable	Extensive
Ice Infrastructure					
Ice Roads Built During Construction and Drilling	Drainage pattern	Moderate	Temporary	Probable	Extensive
	Streamflow	Moderate	Temporary	Probable	Extensive
Ice Roads Built During Operations	Drainage pattern	Moderate	Temporary	Probable	Extensive
	Streamflow	Moderate	Temporary	Probable	Extensive
Ice Pads	Drainage pattern	Moderate	Medium term	Probable	Extensive
	Streamflow	Moderate	Medium term	Possible	Extensive
Water Supply					
Gravel Mine Site Reservoir	Lake Level	Moderate	Long term	Possible	Extensive

Table 5.6-8: Alternative C—Impact Evaluation for Hydrologic Regime					
Project Component/Activity	Type of Impact	Magnitude	Duration	Potential to Occur	Geographic Extent
C-1 Reservoir	Lake Level	Moderate	Long term	Probable	Extensive
Other Lakes and Reservoirs	Lake level	Moderate	Medium term	Probable	Extensive
Other Components/Activities					
Pipelines	Drainage pattern	Minor	Long term	Possible	Extensive
	Streamflow	Minor	Long term	Possible	Extensive
Gravel Mines	Drainage pattern	Moderate	Long term	Probable	Extensive
Wastewater Disposal	Lake level	Minor	Medium term	Possible	Limited

5.6.5 Alternative D: Inland Pads with Seasonal Ice Access Road

Delineation and production of the Point Thomson Reservoir under Alternative D could impact the hydrologic regime through gravel fill, ice infrastructure construction, and water withdrawal and discharge. Alternative D infrastructure in relation to streams and water bodies is shown on Figure 5.6-5 and Figure 5.6-6. The number of water bodies crossed by project infrastructure under Alternative D is provided in Table 5.6-3 (see Section 5.6.3, Alternative B: Applicant's Proposed Action).

5.6.5.1 Alternative D: Construction, Drilling, and Operations

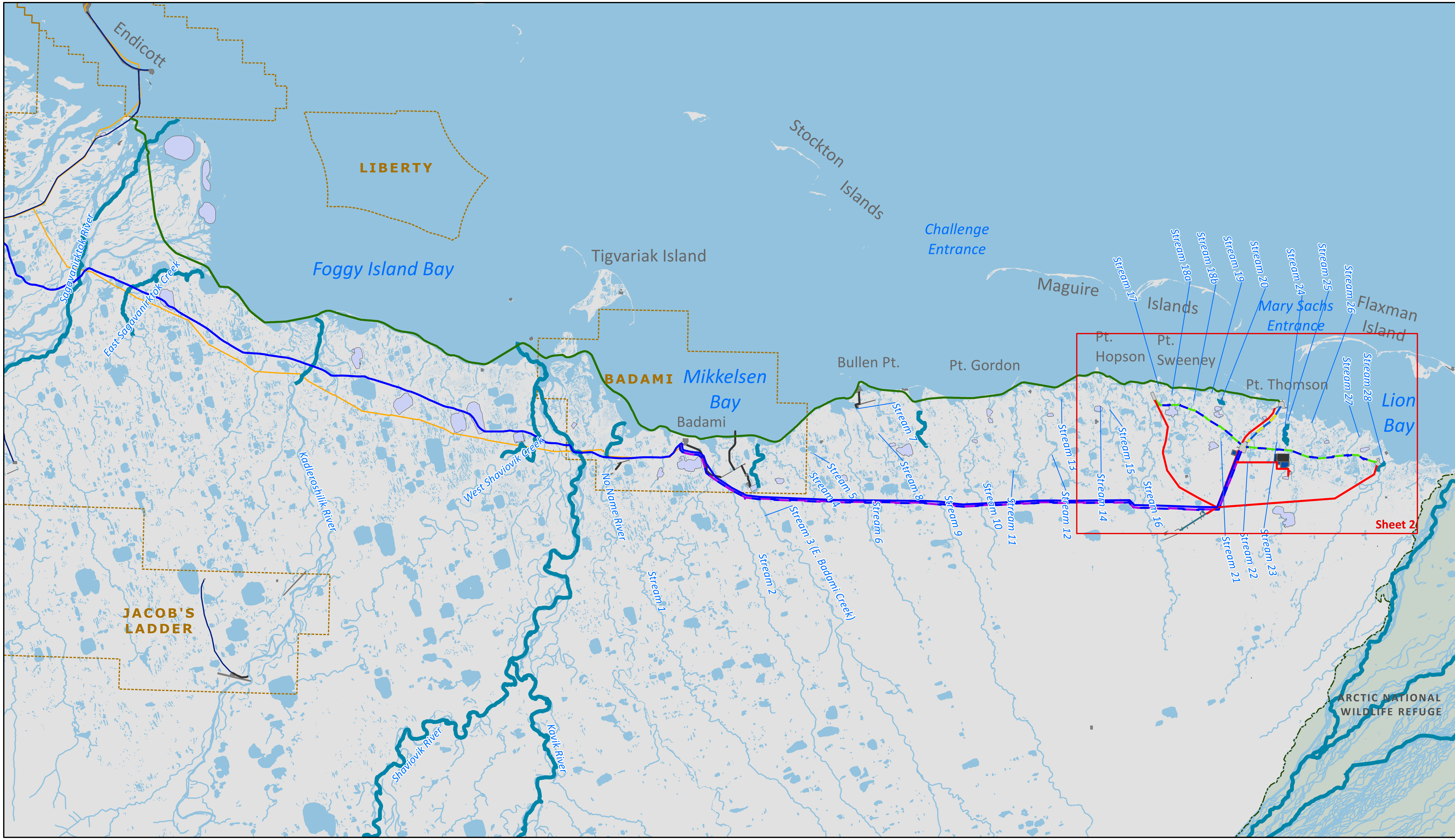
Construction-related activities that could impact the hydrologic regime include placement of gravel infrastructure for pads, roads, and an airstrip; construction of temporary tundra ice roads, ice pads, and an ice airstrip; construction of pipelines; construction of a new gravel mine site; water withdrawal from area lakes and reservoirs for construction of temporary ice infrastructure, hydrostatic testing, and camp use; and disposal of wastewater to the tundra. Effects to the hydrologic regime due to construction, drilling, and operations would be similar and the discussions have been combined below.

Gravel Infrastructure

Pads: Four primary gravel pads would be constructed to support well production the same as under Alternative C except that the Central Well Pad would be smaller (see Chapter 2, Alternatives). Potential impacts due to construction of gravel pads would be the same as Alternative B.

Infield Roads: Overall, the potential impacts from infield gravel roads (17.2 miles; seven stream crossings [five culverts and two bridges]) would be similar to Alternative B. The infield road between the East Pad and the airstrip traverses the hydraulic gradient and has greater potential to impound sheet flow and shallow groundwater than the roads leading from the Central Processing Pad and West Pad to the airstrip. These two infield roads are aligned generally parallel to the hydraulic gradient and are not expected to require stream crossings. The area of altered inundation upstream and downstream of gravel roads is provided in Table 5.6-5. Minimizing the impact to the natural drainage patterns would require consideration of microtopography, unmapped channels, and hydrologic connections to lakes to determine the actual placement of the roads within the project area.

Airstrip: Potential impacts due to construction of the gravel airstrip (5,600 feet by 200 feet) would decrease the drainage area of Stream 18B and increase the drainage area of Stream 21 by 0.5 mi^2. This corresponds to about 15 cfs of flood runoff (15 percent) diverted from Stream 18B and added to Stream 21.



POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Existing Facilities
- Water Body
- Anadromous Streams
- Existing Road
- Existing Pipeline

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 2.5 5 Miles

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Figure 5.6-5
Alternative D
Streams and Water
Bodies of Interest – Sheet 1 of 2

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

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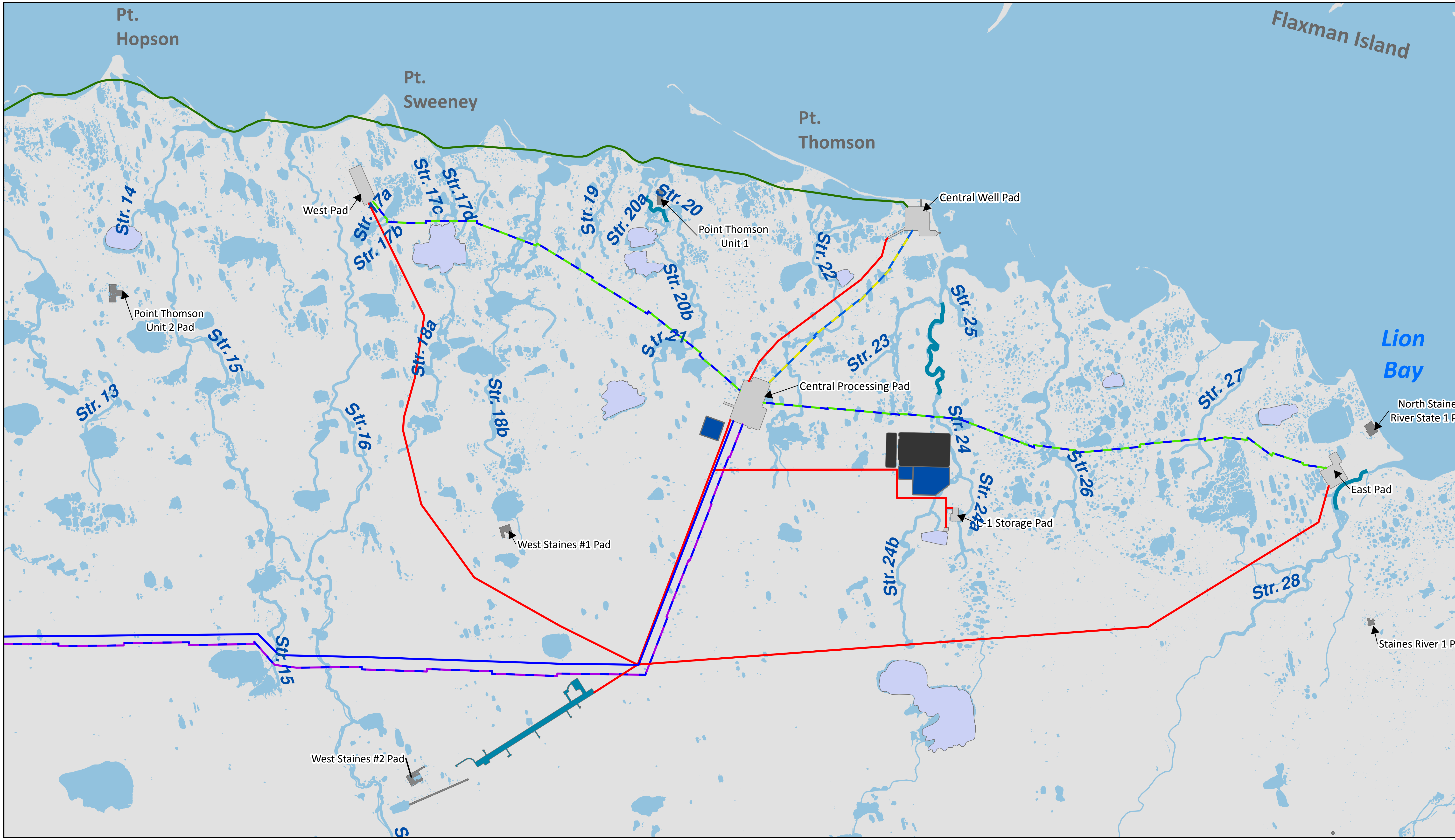

POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Existing Facilities
- Water Body
- Anadromous Streams

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 5.6-6
Alternative D
Streams and Water
Bodies of Interest – Sheet 2 of 2

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

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Ice Infrastructure

Seasonal Tundra Ice Roads: Seasonal ice roads that would support construction for Alternative D include the following:

- A transportation ice road between the Endicott Spur and the project (approximately 46.7 to 47.4 miles; 37 stream crossings) would be built on tundra. For three seasons, the ice road would be heavy-duty (1-foot thick compared to the standard thickness of 6 inches) to withstand the weight of module transport and would require more water for construction. In subsequent winters through drilling and operations, the ice road would be built annually with standard thickness, except for demobilizing the drill rig during Year 10, when it would be 1 foot thick.
- An export pipeline construction ice road between the Central Pad and Badami (approximately 21.1 miles; 24 stream crossings) would be constructed in three consecutive winter seasons. During operations, pipeline maintenance ice roads would be built occasionally as needed.
- Infield ice roads (approximately 13.9 miles; 22 stream crossing) would be constructed to support pad, road, and gathering pipeline construction activities. During operations, pipeline maintenance ice roads would be built occasionally as needed.
- An optional sea ice road may be constructed from Endicott Spur to Point Thomson to maximize the ice road season during any or all years of construction. An onshore segment of this road would have 18 stream crossings. Sea ice road impacts are addressed in Section 5.5, Physical Oceanography and Coastal Processes.

The impacts to hydrology from ice roads would be similar to those described for Alternative B.

Pads: Seasonal ice pads would be built for a construction camp and for gravel mine overburden storage (57.3 acres total). The impacts would be similar to Alternative B ice pads.

Airstrip: The ice airstrip (5,600 feet by 200 feet) would be used during the construction phase until completion of the gravel airstrip (approximately 3 years).

Pipelines

Potential impacts due to pipelines (export pipeline 22.4 miles, 24 stream crossings and gathering pipelines 9.4 miles, 16 stream crossings) would be the same as Alternative B.

Gravel Mine

Development of the new gravel mine (65.7 acres) would include the same types of impacts as those described for Alternative B. However, under Alternative D the mine site would be the primary water source for the project during operations. Once all the gravel from the new infield mine site has been excavated and the overburden has been placed back into the mine, a diversion channel would be constructed to intersect Stream 24. Information regarding Stream 24 is provided in Section 3.6, Hydrology. Water to fill the new reservoir would be captured from natural runoff and the diversion of spring/early summer stream breakup flows.

Approximately 446 MG would be required to fill the gravel mine reservoir. Most of this water would come from diversion of Stream 24 over 3 years, supplemented by an estimated 13 MG of natural recharge to the gravel mine reservoir per year (Appendix D, RFI 38). During this time period, up to 80 percent of the breakup flood volume of Stream 24 would be diverted into the new reservoir. The diversion quantities for each year would be dependent on the flood magnitude of the prior year(s). For example, if the flood volume in the first year were smaller, greater diversions may be necessary in the latter years (Appendix D, RFI 38). The diversion channel would be set at an elevation such that it would divert water only at higher stages of flow (i.e., spring breakup). Therefore, it would not divert water during the summer.

Water withdrawal from the gravel mine reservoir during operations would be approximately 2.7 MG per year for workers and equipment use. Because water demand during operations would be far less than the water required for infilling, primary recharge to the gravel mine reservoir could be provided from surface runoff, precipitation, and possibly shallow groundwater that provides an existing hydrologic surface water connection downstream. The diversion channel would remain in place to allow fish passage, and would be designed so the elevation of a “full” reservoir would not divert floodwater, but still be hydrologically connected.

During the period the gravel mine reservoir is being filled (3 years), impacts due to water diversion from Stream 24 would include changes in streamflow, increased sedimentation, and changes to reservoir level. Diversion of spring breakup flood flow from Stream 24 would prevent channel forming flows from maintaining the existing sediment transport conditions. Larger sediment that might typically be transported during higher streamflow would not be mobilized. Sediment that typically would be mobile in higher streamflow conditions would be deposited rather than transported, causing increased sedimentation. These impacts could be evident downstream from the diversion to the mouth of the stream. It is possible the depositional environment at the stream delta could be impacted due to the decrease in streamflow flowing to the coast.

Power Cable Trench

Impacts due to the power cable trench would be minimal because the trench would not cross any streams.

Water Supply

Water for ice roads between Badami and Point Thomson would be supplied from permitted water sources along the ice roads. Water for infield ice roads and other construction and drilling uses would be supplied from the existing C-1 mine site reservoir. The new mine site reservoir would provide water for operational use as described above. Water use quantities for Alternative D during construction, drilling, and operations is shown in Table 5.6-6. Details regarding infrastructure construction water use for Alternative D are provided in Chapter 2, Table 2.4-17.

Alternative D would require more water for construction than Alternative B. Less water would be used under Alternative D for ice infrastructure compared to Alternative C due to the shorter pipeline construction road and fewer ice pads required. Water use for drilling would be higher under Alternative D because of the requirement for an annual tundra ice access road for 6 years ending in Year 10. Likewise, annual water use during the operation phase would be higher than for the other alternatives because an ice access road would be built from the Endicott Spur to Point Thomson every year. As during the construction phase, the source of water for the ice access roads would be from permitted water sources along the ice road. Therefore, the amount of water that would be withdrawn from the mine site reservoir during operations under Alternative D would be the same as the amount that would be required under Alternative B.

Wastewater Disposal

Potential impacts due to wastewater disposal would be the same as those described for Alternative B.

5.6.5.2 Alternative D: Impact Summary

The potential impacts of Alternative D on the hydrologic regime are summarized in Table 5.6-9. Overall impacts to hydrology would be similar to Alternative B.

Table 5.6-9: Alternative D—Impact Evaluation for Hydrologic Regime					
Project Component/Activity	Type of Impact	Magnitude	Duration	Potential to Occur	Geographic Extent
Gravel Infrastructure					
Gravel Pads	Drainage pattern	Major	Long term	Probable	Local
	Streamflow	Minor	Long term	Possible	Limited
Gravel Roads	Drainage pattern	Moderate	Long term	Probable	Extensive
	Streamflow	Major	Long term	Probable	Extensive
	Erosion/sedimentation	Major	Long term	Probable	Extensive
Gravel Airstrip	Drainage pattern	Major	Long term	Probable	Extensive
	Streamflow	Moderate	Long term	Probable	Extensive
Ice Infrastructure					
Construction-only Roads	Drainage pattern	Moderate	Temporary	Probable	Extensive
	Streamflow	Moderate	Temporary	Probable	Extensive
Roads in All Phases	Drainage pattern	Moderate	Long term	Probable	Extensive
	Streamflow	Moderate	Long term	Probable	Extensive
Pads	Drainage pattern	Moderate	Medium term	Probable	Extensive
	Streamflow	Moderate	Medium term	Possible	Extensive
Tundra Ice Airstrip	Drainage pattern	Major	Medium term	Probable	Extensive
	Streamflow	Moderate	Medium term	Possible	Extensive
Water Supply					
Gravel Mine Site Reservoir	Streamflow	Major	Long term	Probable	Extensive
	Erosion/sedimentation	Major	Long term	Probable	Extensive
	Lake level	Moderate	Long term	Probable	Extensive
C-1 Pit Reservoir	Lake level	Moderate	Long term	Probable	Extensive
Lakes and Reservoirs	Lake level	Moderate	Long term	Probable	Extensive
Other Components/Activities					
Pipelines	Drainage pattern	Minor	Long term	Possible	Extensive
	Streamflow	Minor	Long term	Possible	Extensive
Gravel Mine	Drainage pattern	Major	Long term	Probable	Extensive
Wastewater Disposal	Drainage pattern	Minor	Medium term	Possible	Limited

5.6.6 Alternative E: Coastal Pads with Seasonal Ice Roads

Delineation and production of the Point Thomson Reservoir under Alternative E could impact the hydrologic regime through gravel fill, ice infrastructure construction, and water withdrawal and discharge. Alternative E infrastructure in relation to streams and water bodies is shown on Figure 5.6-7 and Figure 5.6-8. The number of water bodies crossed by project infrastructure under Alternative E is provided in Table 5.6-3 (see Section 5.6.3, Alternative B: Applicant's Proposed Action).

5.6.6.1 Alternative E: Construction, Drilling, and Operations

Construction-related activities that could impact the hydrologic regime include placement of gravel infrastructure for pads, roads, and an airstrip; construction of temporary tundra ice roads and pads and a sea ice airstrip; construction of pipelines; construction of a new gravel mine site; water withdrawal from area lakes and reservoirs for construction of temporary ice infrastructure, hydrostatic testing, and camp use; and disposal of wastewater to the tundra. Effects to the hydrologic regime due to construction, drilling, and operations would be similar and the discussions have been combined below.

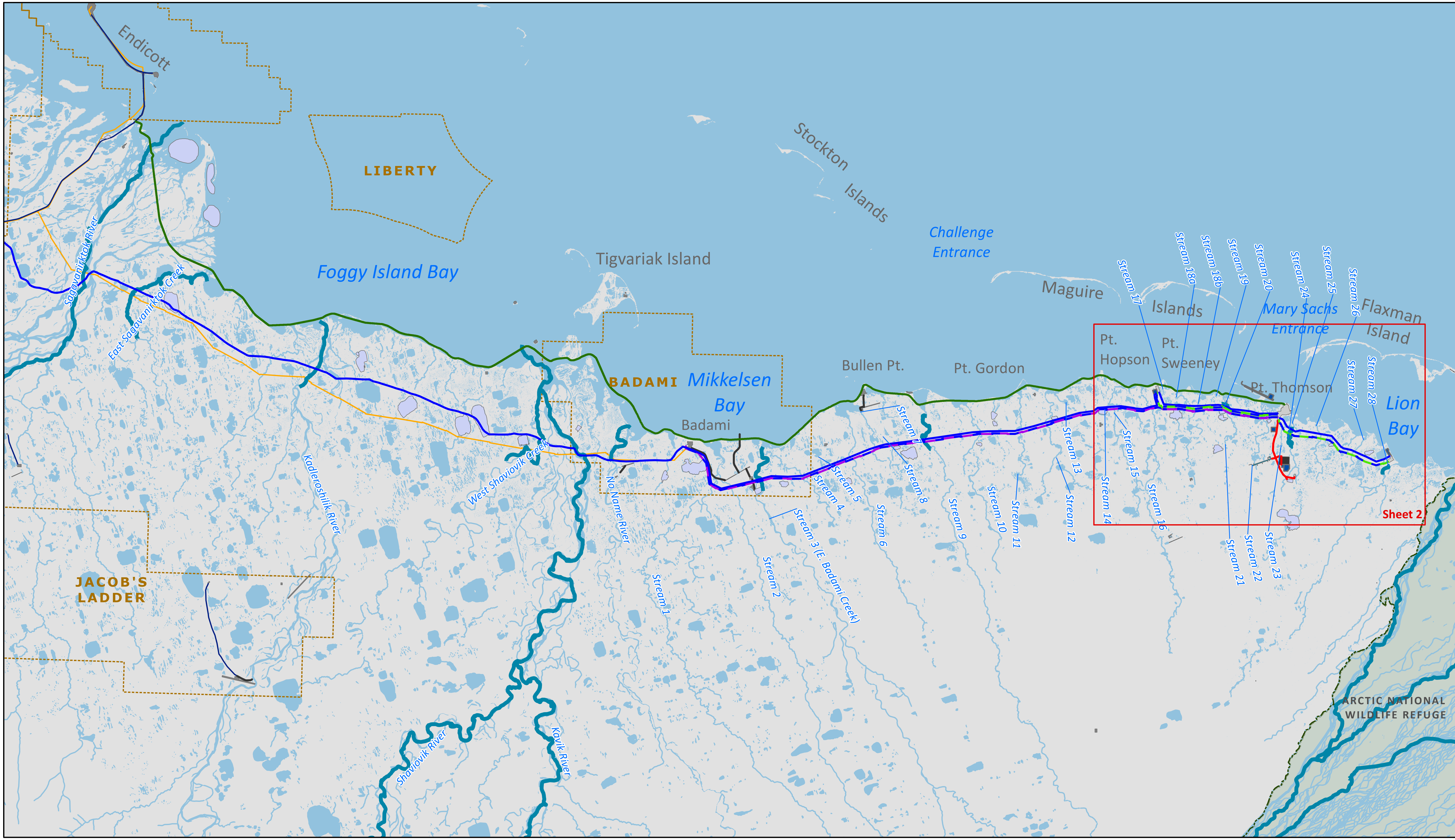
Gravel Infrastructure

Pads: Three primary gravel pads would be constructed to support well production. The Central Pad would be enlarged compared to Alternative B because other gravel infrastructure would be restricted, and the East and West Pads would be smaller, as shown on Figure 5.6-8. Additional smaller pads include a gravel storage pad, water source access pad, and the existing C-1 storage pad. Total size of the gravel pads under Alternative E would be 101.2 acres.

Potential impacts on hydrology due to gravel pads would be similar to Alternative B, except that the enlarged size of the Central Pad and its proximity to a lake may result in greater impacts to hydrology from the Central Pad.

Infield Roads: Alternative E would restrict gravel road construction to one 3.4-mile road (one bridge crossing Stream 24B) connecting the Central Pad to the airstrip, which would be generally aligned parallel to the hydraulic gradient with one stream crossing. Area of altered inundation upstream and downstream of the gravel road is provided in Table 5.6-5. Minimizing the impact to the natural drainage patterns would require consideration of microtopography, unmapped channels, and hydrologic connections to lakes to determine the actual placement of the road.

Airstrip: The gravel airstrip proposed for Alternative E would be shorter than other alternatives (3,700 feet by 200 feet), but the proposed location crosses a stream identified in the ADNR hydrography. Because a culvert could pose settling issues, the stream would be diverted around the airstrip, creating a major impact to the streamflow. The drainage area of Stream 22 would decrease and the drainage area of Stream 24 would increase by 2.1 mi^2. This corresponds to a flood runoff of 55 cfs (54 percent of Stream 22 flow) diverted from Stream 22 into Stream 24.



POINT THOMSON PROJECT EIS

Legend

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

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 2.5 5 Miles

N

Figure 5.6-7
Alternative E
Streams and Water Bodies of Interest – Sheet 1 of 2

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

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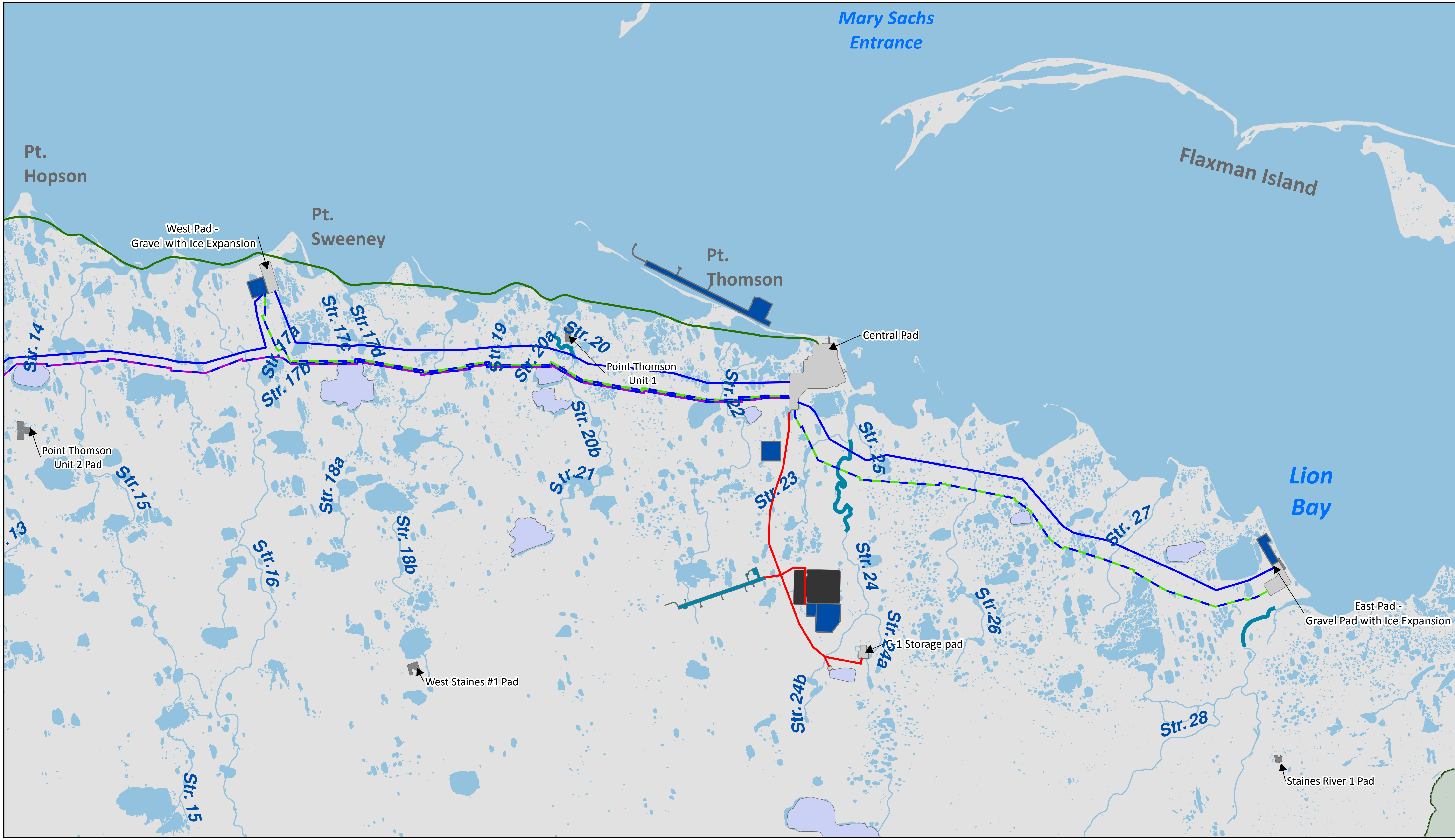

POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Existing Facilities
- Water Body
- Anadromous Streams

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

N

Figure 5.6-8
Alternative E
Streams and Water
Bodies of Interest – Sheet 2 of 2

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

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Ice Infrastructure

Seasonal Tundra Ice Roads: Seasonal ice roads that would support Alternative E include the following:

- A transportation ice road between the Endicott Spur and the project (43.9 to 46.7 miles; 39 stream crossings) would be built on tundra annually for three seasons during construction. The ice road would be constructed if needed during operations, conservatively estimated to be every 5 years.
- An export pipeline construction ice road between the Central Pad and Badami (21.3 miles; 35 stream crossings) would be constructed in two consecutive winter seasons.
- During construction, infield ice roads (14.9 miles; 15 stream crossing) would be built annually to access the gathering pipeline construction, East and West Pads, gravel mine site and reservoir, and C-1 storage pad.
- During operations. a seasonal ice road from Badami would be built as needed.
- An optional sea ice road may be constructed from Endicott Spur to Point Thomson to maximize the ice road season during any or all years of construction. An onshore segment of this road would have 18 stream crossings. Sea ice road impacts are addressed in Section 5.5, Physical Oceanography and Coastal Processes.

The impacts to hydrology from ice roads would be similar to those described for Alternative B; however, infield ice roads would not be required every year during operations for Alternative B.

Pads: Multiseason ice pads would be built for extensions to the East and West Pads during drilling activities (11 acres each). Seasonal ice pads would be used for the infield construction camp, pipeline construction camp, and gravel mine overburden storage for a total of 42.6 acres. The impacts would be similar to Alternative B ice pads.

Sea Ice Airstrip: The ice airstrip (5,600 feet by 200 feet) would be used during the construction phase until completion of the gravel airstrip (approximately 2 years).

Pipelines

The infield gathering pipelines would cross several fewer streams (15 total) and the export pipeline would cross several more streams (35 total) compared to Alternative B. As described under Alternative B, the pipelines are not expected to have measureable impacts on hydrology.

Gravel Mine

Potential impacts from development of the new gravel mine would be similar in type and intensity as those described for Alternative B, but the mine would be about 25 percent smaller in surface area.

Power Cable Trench

Impacts due to the power cable trench would be minimal because the trench would not cross any streams.

Water Supply

The same water sources would be used for Alternative E as described for Alternative B. Water use quantities for Alternative E during construction, drilling, and operations are shown in Table 5.6-6. Potential impacts from water use would be similar to Alternative B except Alternative E would require nearly four times more water for drilling due to the need for ice roads and the longer time period required for drilling. During operations Alternative E would require about five times more water annually than Alternatives B and C due to ice road construction. Therefore, Alternative E would likely require annual water withdrawal from permitted water sources in addition to the C-1 mine reservoir.

Wastewater Disposal

Potential impacts due to wastewater disposal would be the same as those described for Alternative B.

5.6.6.2 Alternative E: Impact Summary

The potential impacts of Alternative E on the hydrologic regime are summarized in Table 5.6-10. The impacts associated with gravel infrastructure would be greatly reduced from other alternatives, but the magnitude of impacts to the hydrologic regime from sustained high levels of annual water withdrawal could be high if area lakes are not able to recharge each year.

Table 5.6-10: Alternative E—Impact Evaluation for Hydrologic Regime

Project Component/Activity	Type of Impact	Magnitude	Duration	Potential to Occur	Geographic Extent
Gravel Infrastructure					
Gravel Pads	Drainage pattern	Major	Long term	Probable	Local
	Streamflow	Minor	Long term	Possible	Limited
Gravel Roads	Drainage pattern	Moderate	Long term	Probable	Local
	Streamflow	Minor	Long term	Unlikely	Limited
	Erosion/sedimentation	Minor	Long term	Possible	Limited
Gravel Airstrip	Drainage pattern	Major	Long term	Probable	Extensive
	Streamflow	Major	Long term	Probable	Extensive
Ice Infrastructure					
Ice Roads Built Only During Construction	Drainage pattern	Moderate	Temporary	Probable	Extensive
	Streamflow	Moderate	Temporary	Probable	Extensive
Ice Roads Built During All Project Phases	Drainage pattern	Moderate	Long term	Probable	Extensive
	Streamflow	Moderate	Long term	Probable	Extensive
Ice Pads	Drainage pattern	Moderate	Medium term	Probable	Extensive
	Streamflow	Moderate	Medium term	Possible	Extensive
Sea Ice Airstrip	Drainage pattern	Moderate	Medium term	Probable	Extensive
	Streamflow	Moderate	Medium term	Possible	Extensive
Water Supply					
Gravel Mine Site Reservoir	Lake Level	Moderate	Long term	Probable	Extensive
C-1 Pit Reservoir	Lake level	Moderate	Long term	Probable	Extensive
Other Lakes and Reservoirs	Lake level	Moderate	Long term	Probable	Extensive
Other Components/Activities					
Pipelines	Drainage pattern	Minor	Long term	Possible	Extensive
	Streamflow	Minor	Long term	Possible	Extensive
Gravel Mine	Drainage pattern	Moderate	Long term	Probable	Extensive
Wastewater Disposal	Drainage pattern	Minor	Medium term	Possible	Limited

5.6.7 Mitigative Measures

This section describes measures to mitigate impacts to hydrology from the Point Thomson Project. The Applicant has proposed design measures that would be included as part of the project; BMPs and permit requirements would be stipulated by federal, state, and local agencies, and the Corps has considered additional mitigation measures.

5.6.7.1 Applicant's Proposed Design Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on hydrology.

- Routing the infield gravel roads to minimize overall length and footprint, with consideration for hydrologic impacts and project needs.
- Conducting field surveys during breakup and other times to identify natural drainage patterns and to measure streamflows at proposed road crossings.
- Routing infield roads a sufficient distance inland to avoid major stream crossings.
- Balancing the avoidance of lakes, ponds, and wetter tundra areas closest to coast with avoidance of areas farther inland where unconcentrated overland flow predominates.
- Routing the export pipeline and gathering lines to avoid locating VSMs in lakes, and crossing streams at locations that minimize the need for VSMs in active channels.
- Designing bridges and culverts at stream crossings for a 50-year flood design flow to reduce impacts to natural drainage to the extent practicable.
- Amending design to lengthen the bridge at Stream 24B to accommodate intercepted sheet flow.
- Installing cross-drainage culverts at approximately 500-foot intervals along the road system to maintain overland flow.
- Inspecting all culverts periodically, removing debris as needed, and evaluating effectiveness of culvert network during spring breakup to determine whether additional cross-drainage culverts are needed to avoid water impoundment.
- Using a sheet pile design for bridge abutments to minimize the tundra footprint, road embankment erosion, and stream scour.
- Slotting ice roads at designated stream crossings to facilitate drainage during breakup.
- Reducing surface discharge of wastewaters through use of a disposal well, including zero discharge of produced water and drilling wastes.
- Managing water withdrawal to protect water bodies, fish habitat, and the surrounding environment. These measures have been developed to address requirements of ADNR and ADF&G water use permits and avoid adverse impacts to water resources:
  - Monitoring water withdrawal volumes: A log will be kept to track water volume by source. When the withdrawal volume approaches 90 percent of the permitted water volume, use of the source will be stopped as a contingency to ensure appropriate water volumes remain.
  - Tracking: A water use preplanning chart will be used to identify water withdrawal lakes and locations for use in ice road construction. This assists in confirming there is enough water in strategic locations to support construction activity. A dispersing log will be kept in the field to track water sources and use

information, including coordination with other water users, to ensure water withdrawal limitations are met.

- Monitoring water body recharge, as needed or directed, by ADNR and/or ADF&G in the future.

5.6.7.2 BMPs and Permit Requirements

Impacts to hydrology would be avoided or minimized by BMPs and permit requirements such as water use permit requirements, project-specific stipulations required by the SPCO as part of the ROW lease, and the DO&G's mitigation and lessee advisories that would be applied to the project. The ADF&G has design and installation standards for culverts, bridges, and pipeline crossings of fish streams, which also avoid or minimize hydrology impacts.

5.6.7.3 Corps-considered Mitigation

In addition to the Applicant's proposed design measures and BMPs and permit requirements, the Corps, in consultation with others, is considering the following actions to avoid or minimize impacts to hydrology:

- If the location of a VSM within a stream channel cannot be avoided, VSM construction should be completed following the guidance described in Section 4.5 of the River and Stream Crossings of the Eastern North Slope Gas Pipeline Design Basis (ADNR 2006). This guidance includes completing a hydrology report for the pipeline and analyzing hydrologic and hydraulic characteristics that are specific to the individual crossing.
- To reduce impacts during high flow events, prepare and implement a culvert maintenance plan. This plan should be reviewed and approved by the Corps, in consultation with others, and include the following:
    - Criteria for placing additional culverts after completion of road construction
    - Annual removal of packed snow and ice
    - Placement of an end-cap and removal before breakup
    - Consideration of installing steam pipes inside culverts to aid ice thaw

5.6.8 Climate Change and Cumulative Impacts

5.6.8.1 Climate Change

Potential changes to the hydrologic regime resulting from predicted climatic changes could include increases in the amount and frequency of winter precipitation, possibly resulting in changes to river streamflow and stage; changes in drainage patterns and surface water interaction with permafrost; and changes in lake distribution and quantity.

Increases in snowfall may increase discharge in streams in the spring and summer (Frey and Smith 2003), affecting streamflow and stream stage, as well as likely increasing stream velocity and the erosive capacity of streams.

Groundwater can have an important influence on the annual water budgets of arctic surface water ecosystems (ACIA 2005). As described in Section 4.3, Climate Change, MAATs are anticipated to rise over the remainder of this century, which could produce great changes in the nature and complexity of the project region's permafrost. Permafrost melting as a result of increased surface air temperatures would allow the three components of the permafrost infrastructure (supra-permafrost, intra-permafrost, and sub-permafrost) to potentially interact with surface water. This could greatly affect the nature of the freshwater ecosystem within the project area.

Permafrost thawing could change the occurrence of lakes in the ACP. Smith et al. (2005) reviewed lake loss between 1973 and 1998 in arctic Siberia. Results showed an overall decrease in lake numbers, as indicated by drained lakes that revegetated. Further analysis suggests areas of continuous permafrost would initially experience an increase in lakes, due to initial thawing of permafrost and increased drainage to the surface. This initial increase in lake area would lead to eventual drainage of lakes as permafrost continues to thaw (Smith et al. 2005).

The action alternatives would have greater impacts from climate change due to the potential of the aforementioned effects to affect infrastructure in each of the action alternatives. Predictions of changes to the hydrologic regime due to observed climatic changes could impact infield gravel roads. Earlier breakup and flooding of rivers, and increases in precipitation as snow resulting in increased discharge in streams in the spring and summer (Frey and Smith 2003), could impact streamflow and stage. These potential hydrologic regime changes could result in increased stream velocity and erosive capacity of the streams being crossed by project roadways.

Potential changes in lake quantity and distribution could affect ice road construction. Tundra ice road construction relies heavily on the availability of freshwater sources such as lakes. A reduction in the availability of freshwater sources could negatively affect the project's ability to construct seasonal ice roads. Moreover, if ice road construction becomes limited due to a shortened winter season, there may be a move toward more use of gravel roads, which have a greater hydrologic impact.

Due to the gravel access road between the Endicott Spur and Point Thomson, Alternative C would experience greater impacts from the hydrological effects of climate change than Alternative B. Both Alternatives D and E would also experience greater impacts by climate change than Alternative B, due to their reliance on ice roads for annual resupply and infield movement, respectively.

5.6.8.2 Cumulative Impacts

Past and present activities on the North Slope that have affected the hydrologic regime include gravel road and pad construction, gravel mining and conversion of mine sites to water reservoirs, seasonal ice road and ice pad construction, and water withdrawal for ice roads and domestic water use. These activities have occurred primarily in the existing oil fields, and secondarily in villages. See Table 5.2-10 (in Section 5.2, Soils and Permafrost) for quantification of existing and potential cumulative acreage of oil and gas infrastructure on the eastern North Slope. Impacts to hydrology from past and present actions include changes in drainage patterns, stream stage, streamflow, erosion and sedimentation conditions, and lake levels. In particular, the spine roads through the existing oil fields run generally perpendicular to the North Slope drainage pattern, resulting in impounded water upgradient from the roads and drier areas downgradient. RFFAs also have the potential to affect the hydrologic regime. In close proximity to Point Thomson, future actions that may have impacts on hydrology include the development of other nearby oil and gas deposits, full-field development of Point Thomson, and a Point Thomson gas export pipeline (see Section 4.2, Cumulative Impacts Methodology).

Impacts on hydrology and water resources under the action alternatives include impacts to drainage patterns, stream flow and stage, erosion and sedimentation conditions, and lake levels due to proposed development of gravel and ice infrastructure, water withdrawal, and reservoir development. Impacts on hydrology under Alternative C are similar to those described above for Alternative B. However, Alternative C also includes the construction of a gravel access road. The addition of the road poses a greater potential for cumulative impacts in conjunction with the past, present, and RFFAs because the road would traverse multiple streams across the ACP, covering about one quarter of the east-west extent of the geographic scope of the cumulative impacts analysis. In addition, water use would be higher under Alternatives C and D during the construction phase, potentially leading to greater associated cumulative impacts.

The extent of potential hydrology impacts from these future projects is not yet known. However, anticipated additional infrastructure needed to accommodate full field development includes the expansion of the Central Pad, the expansion of the existing or development of a new gravel mine, and additional impacts from VSMs needed for infield pipeline (see Section 4.2, Cumulative Impacts). Of these, the development of the gravel mine would likely have the largest impacts to hydrology; however, impacts related to full field development are likely to be less than the impacts associated with development of the Proposed Action itself. The potential effects of the Point Thomson Project could combine with the existing and possible effects from past, present and reasonably foreseeable projects in the area, to produce adverse cumulative impacts such as increases in erosion and sedimentation, a disruption of existing drainage patterns, and an overall reduction in available surface water if recharge rates are affected.

5.6.9 Alternatives Comparison and Consequences

Surface water bodies are the primary water source on the North Slope and provide habitat for species important to the North Slope ecosystem. Even small modifications to the hydrologic regime can affect vegetation and aquatic resources. The streams in the project area east of Badami are small and originate on the ACP. The western part of the project area contains portions of major watersheds drained by the Sagavanirktok, Kadleroshilik, and Shaviovik Rivers, which originate beyond the ACP.

All action alternatives would have long-term impacts to hydrology resulting from new gravel infrastructure and gravel mines. These impacts include upstream and downstream changes to streamflow and drainage patterns. Under Alternative C, the impacts from the gravel access road and associated gravel mines would extend across a larger area. The gravel access road would cross three major rivers. Gravel airstrips under Alternatives B and E would have greater impacts on streamflow than the other airstrip alternatives, both diverting about half the flow from Stream 22.

Ice infrastructure could alter natural drainage patterns, stream stage, and streamflow during spring breakup. These seasonal impacts would be the same for the action alternatives but would occur annually over the project lifetime under Alternative E. Water withdrawal from lakes and reservoirs for ice infrastructure and other project needs could lower water levels. However, water use permits would require recharge monitoring, and continued water withdrawal would not be allowed if adequate recharge does not occur in the permitted water source. Under Alternative D, only, the infield gravel mine would be used as a primary water source during operations and Stream 24 would be diverted during breakup for 3 years to fill the reservoir. Diversion of Stream 24 to fill the gravel mine could alter streamflow and cause downstream erosion and sedimentation.

Table 5.6-11 summarizes the major differences among the alternatives relative to hydrologic impacts.

Table 5.6-11: Comparison of Action Alternatives for Hydrology

Issue	Alternative B	Alternative C	Alternative D	Alternative E	Environmental Consequences
Gravel roads could alter streamflow and drainage pattern	—	Gravel access road would increase the geographic extent of these effects compared to other alternatives. More sheet flow culverts could be required for infield gravel roads due to greater proportion of sheet flow versus defined channels compared to Alternative B.	Similar to Alternative B but more sheet flow culverts could be required for infield gravel roads due to greater proportion of sheet flow versus defined channels compared to Alternative B.	Gravel infrastructure is minimized under this alternative.	Even small modifications to the hydrologic regime can affect vegetation and aquatic resources.
Stream crossing structures could constrict channel flow during flood stage	9 crossing structures	50 crossing structures, including three at major water bodies	7 crossing structures	1 crossing structure	Bridges and culverts would be designed for a 50-year flood stage, which would minimize but not completely avoid impacts. With climate change, flows greater than the 50-year flood stage are more likely to occur within the project lifetime potentially leading to further flow construction and damage to the crossing structure.
Gravel airstrip would divert flow from one stream to another	48 cfs (48 percent of Stream 22) diverted	22 cfs (14 percent from Streams 18a and 18b combined) diverted	15 cfs (15 percent of Stream 18b) diverted	55 cfs (54 percent of Stream 22) diverted	Changes in flow could impact fish and other aquatic resources downstream.
Water withdrawal could lower lake levels	231.5 MG for construction, 97.6 MG for drilling, and 2.7 MG annually for operations	More than double the water use of Alternative B during the construction phase but less water during drilling	Almost twice as much water would be used for construction and drilling combined and nearly eight times more would be used annually during operations compared to Alternative B.	Nearly four times more water would be used for drilling and five times more annually during operations than Alternative B.	Water use permits require recharge monitoring and would not allow continued withdrawal from lakes that do not fully recharge.
Gravel mines would alter drainage pattern	Infield gravel mine changes would be permanent.	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	Changes to hydrology would be permanent.
Stream 24 diversion could alter streamflow and cause downstream erosion and sedimentation	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	Impacts could affect fish and other aquatic resources downstream.

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5.7 WATER QUALITY

The key findings of effects for water quality are summarized below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

<u>Action Alternatives:</u> The biggest impacts to water quality for each action alternative would be to freshwater resources: Alternatives B and D would result in temporary, local impacts due to gravel infrastructure and pipeline construction; Alternative C would result in impacts due to gravel infrastructure over the life of the project and over a large portion of the project area; Alternative E would result in temporary, local impacts due to pipeline construction. These impacts could be avoided or minimized through mitigation measures. Marine water quality impacts would be minor and temporary.

<u>Alternative A:</u> No impacts

Differentiators:

- The gravel access road under Alternative C would result in more extensive and longer term impacts to water quality.
- The absence of the barge offloading facility under Alternatives C and D would result in less impact to marine water quality.

5.7.1 Methodology

The analysis of potential impacts to water quality was conducted by assessing the Applicant's project description (ExxonMobil 2009a), Applicant-proposed voluntary mitigation measures, data collected by the Applicant, and information provided by the Applicant through the RFI process (Appendix D). The Applicant's information was verified by independently reviewing reference sources and previous publications on water bodies within and near the project area. Surface water quality impact analysis focused on each component of the project and its impacts to the state-defined protected water uses based on activities that could and would use water or result in discharge to water bodies. The proposed project was evaluated in light of the potential to degrade water quality or violate WQS in waters surrounding the project area.

The impact evaluation criteria used for this chapter are summarized in Table 5.7-1.

Table 5.7-1: Impact Criteria—Surface Water Quality

Impact Category*	Intensity Type*	Specific Definition for Water Quality
Magnitude	Major	Changes in water quality such that protected water use classes[a] are violated to the extent that mitigation measures would not be effective and remediation measures would be necessary, or changes in water quality that result in a new environment in which new water classes are achieved.
	Moderate	Changes in water quality based on protected water use classes predicted but can be mitigated.
	Minor	Slight changes in water quality that do not violate protected water use classes.
Duration	Long term	Impact to water quality would exceed the life of the project.
	Medium term	Impact to water quality would last the life of the project.
	Temporary	Impact to water quality would last a short period during a phase of the project.
Potential to Occur	Probable	Measureable changes in water quality would likely occur.
	Possible	Potential measurable changes in water quality may occur.
	Unlikely	No measurable water quality changes anticipated.
Geographic Extent	Extensive	Water quality changes occur in the water bodies adjacent to proposed project component footprint and associated waters that are hydraulically connected to those resources across a large portion of the project area.
	Local	Water quality changes are confined to the area within and around a component footprint and the water bodies directly surrounding the water body.
	Limited	The area of water quality changes is small and could be easily contained from moving downstream or throughout a water body for mitigation purposes.

* Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology.

[a] Protected water use classes are defined for freshwater as water supply, water recreation, and growth and propagation of fish, shellfish, other aquatic life, and wildlife. Each of these categories has subclasses and all are defined in 18 AAC 70.020. Protected water use classes are defined for marine water as water supply, water recreation, growth and propagation of fish, shellfish, other aquatic life, and wildlife, and harvesting for consumption of raw mollusks or other raw aquatic life. Each of these categories has subclasses and all are also defined in 18 AAC 70.020.

5.7.2 Permits

In accordance with federal and state regulations, water quality permits are required to ensure water quality standards are protected. Water quality permits that would be required for the project include AKG–57–0000, AKG–57–1000, Class 1 UIC Well Permit, and AKG–33–0000.

General Permits AKG-57-0000 and AKG-57-1000 are issued by the ADEC and cover domestic wastewater discharges during construction and operations to surface freshwaters (including tundra) and marine waters. The permits contain effluent limitations, monitoring and recording, and general requirements such as best management practices (BMPs) to reduce water quality degradation.

The EPA Class 1 UIC Well Permit was issued by the EPA to the Applicant in January 2010. The permit specifies the types of wastes and volumes that may be disposed of to the deep well (EPA 2010a). Examples of wastes that would be injected under this permit include: drill cuttings, drilling muds, brines, camp gray water and treated sewage, stormwater, hydrostatic test water, and industrial nonhazardous waste.

NPDES General Permit AKG–33–1000 regulates activities related to the extraction of oil and gas on the North Slope of the Brooks Range. This permit expired in January 2009 but was proposed for reissuance with a draft permit in July 2011. The types of discharges covered by this permit include hydrostatic test water, stormwater, gravel pit dewatering, construction dewatering, and treated discharge from mobile spill response or secondary containment.

Additional information on wastewater permits is provided in Section 5.24.1, Hazardous Material and Waste Management.

5.7.3 Alternative A: No Action

Alternative A is described in detail in Chapter 2, Alternatives. Under the No Action Alternative, the Applicant would be denied a Corps permit and would continue monitoring the capped wells at the existing PTU-3 pad. This activity would have no impact on water quality.

5.7.4 Alternative B: Applicant's Proposed Action

Alternative B is described in detail in Chapter 2, Alternatives. This alternative would include project components that could affect water quality such as gravel infrastructure, ice infrastructure, bridges, culverts, camps, and other facilities. The potential effects of Alternative B on water quality during the construction, drilling, and operations phases are discussed below. Impacts on water quality resulting from leaks and spills of fuels and hazardous materials are addressed in Section 5.24, Spill Risk and Impact Assessment.

5.7.4.1 Alternative B: Construction

The discussion below includes impacts associated with the construction phase of Alternative B. The overall impacts to water quality from the project are summarized in Table 5.7-2.

Ice Infrastructure

Ice infrastructure would consist of seasonal ice pads, infield ice roads, and either a sea ice road or a tundra ice road from Badami to Point Thomson. Construction and operation of ice infrastructure have the potential to impact both freshwater and marine water quality.

Tundra ice roads could have a local effect on alkalinity and pH in the surrounding freshwater bodies during spring melt near the road footprint. Lakes adjacent to the coast have higher TDS concentrations than lakes inland. If water for ice roads is drawn from lakes near the coast, alkalinity could increase under and adjacent to the road during spring melt.

Gravel Infrastructure and Facilities

Gravel infrastructure includes the airstrip, pads, infield roads, and gravel ramps leading from the Central Pad to the barge offloading facility and emergency response boat launch ramp.

The construction of processing facilities, camps, and offices would include the placement of piles secured into the gravel pad. The emergency response boat launch ramp construction would require removal of the ice layer within the boat launch footprint. Gravel fill would be placed on the substrate and covered with concrete planks. During construction, sediments and dust could be disturbed and deposited on snow and ice during the winter or on tundra and open water during the summer. The sediments and dust could be introduced into the water column, causing an increase in turbidity.

Gravel mine excavation would occur during the winter for 2 years. Excavation has the potential to alter water quality through increased dust that settles on the snow and enters the water column during spring breakup. Due to the naturally increased turbidity in the water column during spring breakup, the additional increase due to gravel mine excavation would likely to be negligible.

As gravel roads (including bridges and culverts), pads, and the airstrip are constructed during the winter, sediments and dust from gravel fill would be tracked on ice and snow. This sediment would then move into the water body during spring breakup, likely causing an increase in turbidity in the immediate area. However, due to large quantities of sediment naturally being moved toward the ocean, the relative increases in turbidity would be minor. An increase in turbidity also has the potential to increase trace metals concentrations, depending on their concentrations in the sediments. Trace metals that are attached to the sediments in the gravel being used for pad construction could be washed into the freshwater or marine environment during spring breakup. The concentrations would likely be small and difficult to differentiate from trace metals introduced naturally during spring breakup.

Gravel compaction during the summer would occur because the gravel in the project area has a high percentage of fine-grained material and ice content. As the ice melts within the gravel, the potential for the fine-grained sediment to move from the gravel road into the nearest water bodies would increase and could increase the turbidity and TSS concentrations when flow is low.

An increase in turbidity also has the potential to change water temperature, which in turn would decrease the DO concentrations in the water column (Dodds 2002). If this were to occur in streams where fish are present and the DO concentration dropped enough, it could negatively impact fish. Impacts would most likely occur during spring breakup, when water would be present and sediments would be most likely to enter the water column, which could decrease DO concentrations. The impact would likely be small during this particular time of year, when sediment transport in the water column would be high.

Dust from gravel construction activities near the coast could settle out on the sea ice and remain until spring breakup. In addition, during spring breakup when ice and snow thaw occurs, runoff from the gravel pads and infield gravel roads would probably introduce sediments from the gravel infrastructure into the marine waters. However, the impact would be minor because during spring breakup, large quantities of sediment are moved from land into the marine environment and the sediments moving into Lion Bay from the gravel pads and roads would be a small percentage of the sediments entering the marine environment. In addition, the Applicant would use dust suppression measures such as watering gravel roads and pads.

Barge Offloading Facility

Construction of the service pier would require pile driving for six offshore support piles, placement of a concrete deck, and installation of four mooring dolphins. Construction of the sealift facility would require shallow dredging and screeding and pile driving for five mooring dolphins. All of these construction activities, except screeding, would occur during winter when water levels are low or frozen to substrate, thus minimizing impacts to water quality.

Summer screeding and construction activities would increase turbidity and TSS concentrations in the construction area. DO concentrations could be impacted from the suspended sediments.

Once the barge service pier and sealift facility are constructed, both would be used during the open water season to support construction activities. Barges would be grounded during offloading by filling ballast tanks with sea water and would be refloated by releasing the sea water. The following impacts are possible when barges and tugs are present:

- Grounded barges could increase TSS concentrations in the area immediately around the barge.

- pH could change and DO could decrease in the area adjacent to the barge when ballast water is released.
- The seafloor could be scoured resulting in increased TSS concentrations when barge ballast water is released.

Pipelines

Construction of the gathering and export pipelines has the potential to impact the water quality of freshwater surface water bodies.

DO concentrations in the water column could be temporarily affected when sediments from construction are introduced during spring runoff.

During construction of the VSMs for pipelines, soils and sediments would be disturbed. If this material remained on the snow, it could be introduced into the spring runoff and possibly into local water bodies. Where pipelines cross water bodies, it would be more likely that sediments would be introduced into the water body. The introduction of sediments into the water body could slightly increase TSS concentrations in the water column, but due to the large amounts of sediment that would naturally be in the water column, the increase would be negligible.

Displaced organic nutrients during construction could be introduced to snow melt and local water bodies during spring breakup. Any organic nutrients introduced would likely be quickly taken up by sediments and vegetation. However, these sediments are more likely to introduce inorganic nutrients than organic nutrients.

Discharge

During construction, water discharge would come from treated domestic wastewater and pipeline hydrostatic testing. Domestic wastewater would be treated and discharged to the lake south of the Central Pad as permitted until completion of the Class 1 UIC disposal well at the Central Pad. Hydrostatic test water would be treated according to permit requirements and discharged to the tundra. The discharged water would have to meet the effluent limit requirements of the permit. If the hydrostatic test water does not meet the effluent requirements, it would be discharged to the Class I UIC well. If the Class 1 UIC well is unavailable, any wastewater that does not meet required standards for discharge would be stored until the well becomes available or hauled to a permitted disposal facility in Prudhoe Bay.

Discharging wastewater could potentially change the temperature of the receiving water in the limited area of the discharge pipe. The difference in temperature change would likely be minimal and would be confined to the area immediately surrounding the discharge point. Permits to discharge to the tundra or freshwater environment require secondary treatment before discharge which would remove a majority of the nutrients to decrease likely impacts to nutrient limited streams and lakes. Depending on the concentrations of trace metals in the discharge, filtering could be required as part of treatment to ensure that permit and water quality standards are met, and that ADEC’s antidegradation policy is followed.

Water Withdrawal

As part of Alternative B, water withdrawn from permitted lakes and reservoirs would be used for ice road construction, domestic uses, and dust suppression. The permits that regulate water withdrawal prevent degradation to water quality within the water source during winter months. The water source would likely be altered from the withdrawal process, including an increase in TDS.

The DO concentrations in the lakes and reservoirs gradually decrease throughout the winter as organisms in the substrate metabolize the oxygen. As the water freezes it pushes the constituents into the water column. Pumping water out of the lake or reservoir and leaving the ice open and the water circulating could cause oxygen depletion to occur at a slower rate because of oxygen exchange with the atmosphere. Oxygen depletion would still occur, but the impacts would be minor.

The activity of withdrawing water could stir up sediment located at the bottom of the water source. The method used for water withdrawal can affect the amount of turbidity generated. However, regulations associated with water withdrawal activities and water use permit stipulations associated with each water source would limit turbidity from water withdrawal.

The alkalinity and pH of water sources could be affected during winter withdrawal because of the decrease in the amount of water in the lake or reservoir under the ice. The water would have increased ion concentrations and depleted oxygen levels, which could lead to changes in alkalinity and pH. However, Chambers et al. (2008) have shown that these impacts are temporary and minor in nature on the North Slope.

Organic nutrients are also likely to increase in the winter months in the water sources that have large amounts of vegetation surrounding them. Withdrawing water could increase the organic nutrient concentrations in the remaining water. However, this impact would be expected to be minor and temporary and decrease during spring breakup (Myerchin et al. 2007, Chambers et al. 2008).

5.7.4.2 Alternative B: Drilling

There would be an overlap in drilling with the construction and operations phases of the project in Alternative B. The potential impacts to water quality associated with a well blowout or other spill during the drilling process are discussed in Section 5.24, Spill Risk and Impact Assessment.

5.7.4.3 Alternative B: Operations

While construction and drilling activities could occur during the operations phases of the project, this section focuses on the potential impacts to water quality that could occur from day-to-day activities associated with the project.

Ice Infrastructure

A sea or tundra ice road could be constructed (approximately every 5 years) and used during the winter season as needed during operation of the project. Impacts to water quality would be similar to the discussion under Section 5.7.4.1, Alternative B: Construction.

Processing Facilities

The gas cycling process would take place in a fully-enclosed modular building, which would contain most leaks or spills. Emergency flaring of gas could occur if the CPF were in an upset condition or were shut down temporarily. Emergency flaring and emissions from the natural gas-fired equipment could send minute quantities of trace metals into the atmosphere and deposit them in local water bodies. Concentrations of these trace metals in water bodies would not be expected to measurably increase as a result of the project.

Fuel Tanks and Storage Areas

Fuel tanks and storage areas would be located on gravel pads. BMPs such as secondary containment units would be required for these areas to prevent leaks and spills onto the tundra or to any aquatic environment. Spills are further addressed in Section 5.24, Spill Risk and Impact Assessment.

Snow Removal and Storage

Snow removal would be unlikely to affect water quality. Contaminated snow would be collected and allowed to melt and then injected into the Class 1 disposal well. Snow mixed with gravel and sediments would be moved to gravel pad stockpile areas so that the sediments and gravel would remain on gravel pads during snow melt (BPXA and ConocoPhillips 2005).

Gravel Infrastructure

Impacts associated with maintenance of the gravel roads, pads, and airstrip would likely occur during spring breakup similar to impacts discussed in Section 5.7.4.1, Alternative B: Construction, but with smaller magnitude. Summer operations would likely have dust deposition into nearby water bodies near all gravel roads, pads, and airstrips. The deposition of the dust could potentially increase sediment and turbidity concentrations in the water bodies.

Pipelines

Pipeline maintenance could require welding and use of large equipment. The potential impacts would be similar to those described for construction, but would be more localized and of lower magnitude. If pipeline maintenance were required during summer, the use of large equipment such as tundra-safe, low-pressure vehicles to get to the pipeline would likely increase sedimentation in wetland areas and downstream water bodies.

Water Withdrawal and Discharge

The potential types of water quality impacts resulting from water withdrawal during operations would be similar to those during construction, except that less water would be required annually during operations. Therefore, the magnitude of potential water quality impacts would be less.

During operations, domestic wastewater, stormwater, and process water would be treated as necessary to meet discharge permit requirements and would be disposed of to the Class 1 UIC well at the Central Pad.

5.7.4.4 Alternative B: Impact Summary

Table 5.7-2 summarizes the impacts to water quality from Alternative B.

Table 5.7-2: Alternative B—Impact Evaluation for Surface Water Quality

Project Component	Water Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Sea Ice Road	Marine	Minor	Temporary	Unlikely	Extensive
Tundra Ice Infrastructure	Fresh	Moderate	Temporary	Unlikely	Extensive
Gravel Infrastructure and Facilities Construction	Fresh	Moderate	Temporary	Probable	Local
	Marine	Minor	Temporary	Unlikely	Limited
Barge Offloading Facility	Marine	Minor	Temporary	Probable	Limited

Table 5.7-2: Alternative B—Impact Evaluation for Surface Water Quality					
Project Component	Water Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Pipeline Construction	Fresh	Moderate	Temporary	Probable	Local
Processing Facilities Operation	Fresh	Minor	Temporary	Unlikely	Limited
	Marine	Minor	Temporary	Unlikely	Limited
Pipeline Maintenance	Fresh	Minor	Temporary	Unlikely	Limited
Snow Storage and Removal	Fresh	Minor	Temporary	Unlikely	Local
	Marine	Minor	Temporary	Unlikely	Limited
Discharge	Fresh	Moderate	Temporary	Possible	Local
Fuel Tanks and Storage Areas	Fresh	Moderate	Temporary	Possible	Local
	Marine	Minor	Temporary	Unlikely	Limited
Water Withdrawal	Fresh	Minor	Temporary	Possible	Limited

5.7.5 Alternative C: Inland Pads with Gravel Access Road

Alternative C is described in detail in Chapter 2. From the standpoint of water quality impacts, Alternative C would be different from Alternative B due to movement of the East, West, and Central Processing Pads inland from marine waters, the absence of barging facilities, and the construction of a gravel access road from the Endicott Spur Road to Point Thomson.

5.7.5.1 Alternative C: Construction

Ice Infrastructure

The impacts of constructing ice infrastructure under this alternative are similar to the impacts discussed for Alternative B. However, the magnitude of impact from ice roads would be greater under Alternative C because of the increase in the number of ice roads needed during the construction phase.

Gravel Infrastructure and Facilities

The construction of the gravel infrastructure and facilities under this alternative would have impacts to water quality similar to Alternative B. However, Alternative C has the potential to affect water quality over a larger geographic extent than Alternative B because of the gravel access road from Endicott Spur Road to Point Thomson.

Pipelines

The impacts to water quality during the construction of the gathering lines and export pipeline would be similar to the impacts discussed for Alternative B construction, only greater due to the increase in the lengths of both the gathering lines and the export pipeline.

Discharge

Domestic wastewater discharge quantities would be greater under Alternative C compared to Alternative B due to the greater number of workers required during construction. However, the water would be treated to meet discharge permit requirements and the potential impacts from discharge of wastewater would be similar to those described for construction of Alternative B.

Water Withdrawal

While the amount of water withdrawn for ice road and pad construction, construction camps, pipeline hydrostatic testing, and other activities would be much greater during construction of Alternative C than under Alternative B, the impacts to water quality from water withdrawal would be similar.

5.7.5.2 Alternative C: Drilling

The impacts to water quality from drilling activities under Alternative C (including use of gravel facilities, wastewater discharge, tank storage, and water withdrawal) would be similar to those described for Alternative B.

5.7.5.3 Alternative C: Operations

While construction and drilling activities could occur during the operations phases of the project, this section focuses on the potential impacts to water quality that could occur from day-to-day activities associated with the project.

Processing Facilities

In Alternative C the processing facilities would be located approximately 2 miles from the coast. The distance from the coast would aid in protecting marine water quality. Impacts to the freshwater environment would be similar to those for Alternative B.

Fuel Tanks and Storage Areas

Construction of the tank and storage areas under this alternative would likely have similar impacts as discussed under Alternative B. However, there would not likely be impacts to the marine environment because the tank and storage areas would be on the Central Processing Pad located 2 miles from the coast.

Snow Removal and Storage

Impacts to water quality from snow removal and storage would be similar to those discussed for Alternative B.

Gravel Infrastructure

During maintenance of the gravel roads, pads, and airstrip, there are likely to be impacts during spring breakup similar to described for Alternative B. The impacts would cover a larger geographic extent because of the gravel access road.

Pipelines

Potential impacts to water quality from pipeline operation and maintenance would be similar to those discussed for Alternative B.

Water Withdrawal and Discharge

The impacts to water quality due to water withdrawal during operation of Alternative C would be similar to the impacts discussed under Alternative B. Alternative C would require less water withdrawal during operations than Alternative B because seasonal access ice roads would not be constructed. Wastewater discharge during operations would be similar.

5.7.5.4 Alternative C: Impact Summary

Table 5.7-3 summarizes the impacts to water quality for Alternative C. Water quality in the marine environment would incur fewer impacts than Alternative B because some facilities would be moved inland and barging would not occur, but water quality in the freshwater environment may have greater impacts because of the gravel access road.

Table 5.7-3: Alternative C—Impact Evaluation for Surface Water Quality

Project Component	Water Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Sea Ice Road	Marine	Minor	Temporary	Unlikely	Extensive
Tundra Ice Roads and Airstrip	Fresh	Moderate	Temporary	Unlikely	Extensive
Gravel Infrastructure and Facilities Construction	Fresh	Moderate	Medium	Probable	Extensive
	Marine	Minor	Temporary	Unlikely	Limited
Pipeline Construction	Fresh	Moderate	Temporary	Probable	Extensive
Processing Facilities Operation	Fresh	Minor	Temporary	Unlikely	Limited
	Marine	Minor	Temporary	Unlikely	Limited
Pipeline Maintenance	Fresh	Minor	Temporary	Unlikely	Limited
Snow Removal and Storage	Fresh	Minor	Temporary	Unlikely	Local
	Marine	Minor	Temporary	Unlikely	Limited
Discharge	Fresh	Moderate	Temporary	Possible	Local
Fuel Tanks and Storage Areas	Fresh	Moderate	Temporary	Possible	Local
	Marine	Minor	Temporary	Unlikely	Limited
Water Withdrawal	Fresh	Minor	Temporary	Possible	Limited

5.7.6 Alternative D: Inland Pads with Seasonal Ice Access Road

Alternative D would be similar to Alternative C in that it would move the Central Processing Pad away from the coast. Similar to Alternative C, Alternative D would rely on seasonal ice roads for construction in lieu of barging and would have infield gravel roads connecting facilities. Similar to Alternative B, Alternative D would use seasonal ice roads for project site access during operations.

5.7.6.1 Alternative D: Construction

The construction impacts of Alternative D would be similar to those described in Alternative B. Unique impacts include:

- **Gravel Mine Site Reservoir and Stream Diversion:** As described in Chapter 2, Alternatives, the gravel mine would be used as the primary water source during operations under Alternative D. Water from Stream 24 would be diverted for 2 to 3 years during spring breakup to increase the rate the reservoir is filled. The diversion channel from Stream 24 to the gravel pit would be constructed during winter and lined with filter fabric and cement tiles. Impacts from construction of the diversion channel would be similar to construction of the other project infrastructure. Although large quantities of water would be diverted to the gravel mine site, the diversion would be unlikely to impact water quality in the surrounding water bodies.

- **Water Withdrawal and Discharge:** The impacts from water withdrawal and discharge during construction would be similar to those described in Alternative B, though the volumes would be greater.

5.7.6.2 Alternative D: Drilling

The impacts to water quality from drilling activities under Alternative D (including use of gravel facilities, barging, wastewater discharge, tank storage, and water withdrawal) would be similar to those described for Alternative B.

5.7.6.3 Alternative D: Operations

Impacts from operations would be similar to those described in Alternative B, except that because Alternative D does not include a barge offloading facility and the Central Processing Pad is located away from the coast, impacts to marine water quality would be reduced.

5.7.6.4 Alternative D: Impact Summary

Table 5.7-4 summarizes the impacts to water quality from Alternative D. Water quality impacts would generally be similar to Alternative B, though some potential impacts to marine water quality would be reduced because the Central Processing Pad would be located away from the coast.

Table 5.7-4: Alternative D—Impact Evaluation for Surface Water Quality

Project Component	Water Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Sea Ice Roads	Marine	Minor	Temporary	Unlikely	Extensive
Tundra Ice Roads	Fresh	Moderate	Temporary	Unlikely	Extensive
Gravel Infrastructure and Facilities Construction	Fresh	Moderate	Temporary	Probable	Limited
	Marine	Minor	Temporary	Unlikely	Limited
Pipeline Construction	Fresh	Minor	Temporary	Probable	Local
Processing Facilities Operation	Fresh	Minor	Temporary	Possible	Limited
	Marine	Minor	Temporary	Possible	Limited
Stream 24 Diversion	Fresh	Moderate	Temporary	Probable	Local
Pipeline Maintenance	Fresh	Minor	Temporary	Unlikely	Limited
Snow Removal and Storage	Fresh	Minor	Temporary	Unlikely	Local
	Marine	Minor	Temporary	Unlikely	Limited
Discharge	Fresh	Moderate	Temporary	Possible	Local
Fuel Tanks and Storage Areas	Fresh	Moderate	Temporary	Possible	Local
	Marine	Minor	Temporary	Unlikely	Limited
Water Withdrawal	Fresh	Minor	Temporary	Possible	Limited

5.7.7 Alternative E: Coastal Pads with Seasonal Ice Roads

Alternative E would locate pads and other infrastructure in similar locations to Alternative B, but would minimize infield gravel roads and would rely on multiseason ice pads to supplement space needs at the East and West Pads during drilling activities.

5.7.7.1 Alternative E: Construction

The impacts caused by the construction of each component are shown in Table 5.7-5. Generally, those impacts would be similar to impacts discussed for Alternative B, though the impacts from ice roads would be greater, as infield ice roads would be used for the duration of construction. Impacts from gravel infrastructure would be less.

5.7.7.2 Alternative E: Drilling

The impacts to water quality from drilling activities under Alternative E (including use of gravel facilities, barging, wastewater discharge, tank storage, and water withdrawal) would be similar to those described for Alternative B.

The use of multiseason, multiyear ice pads adjoining the East and West Pads to support drilling activities has the potential to impact water quality as the edges of the ice pads melt during the summer and water pools at the base of the pads. After drilling activities are completed and the ice pad additions were no longer needed, water quality impacts from final thaw of the ice pads would include increased TSS and turbidity from runoff in nearby water bodies, increased chance of contaminants such as hydrocarbons and trace metals entering nearby water bodies through runoff, and potential for alkalinity and pH readings to dip slightly. These impacts would be temporary, minor, and limited.

5.7.7.3 Alternative E: Operations

Operational impacts to water quality in Alternative E would be similar to those described in Alternative B, though there would be unique impacts from the following components:

- **Tundra Ice Roads:** Impacts due to Alternative E ice infrastructure would be greater than for Alternative B, because they would be more extensive and occur throughout the life of the project.
- **Gravel Infrastructure:** The impacts of maintenance to gravel infrastructure during breakup would be smaller than those in Alternative B because of the reduced gravel infrastructure.
- **Water Withdrawal:** The amount of water withdrawn from many water sources would be greater in Alternative E than in other alternatives, but the impacts to water quality from water withdrawal would still be similar to the other alternatives.

5.7.7.4 Alternative E: Impact Summary

Table 5.7-5 summarizes the impacts to water quality from Alternative E. Water quality impacts would generally be similar to the Applicant's Proposed Action.

Table 5.7-5: Alternative E—Impact Evaluation for Surface Water Quality

Project Component	Water Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Sea Ice Road	Marine	Minor	Temporary	Unlikely	Extensive
Sea Ice Airstrip	Marine	Minor	Temporary	Unlikely	Local
Tundra Ice Pads	Fresh	Moderate	Temporary	Unlikely	Local
Tundra Ice Roads	Fresh	Moderate	Long term	Unlikely	Extensive
Gravel Infrastructure and Facilities Construction	Fresh	Minor	Temporary	Probable	Local
	Marine	Minor	Temporary	Unlikely	Limited

Table 5.7-5: Alternative E—Impact Evaluation for Surface Water Quality					
Project Component	Water Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Barge Offloading Facility	Marine	Minor	Temporary	Probable	Limited
Pipeline Construction	Fresh	Moderate	Temporary	Probable	Local
Processing Facilities	Fresh	Minor	Temporary	Possible	Limited
	Marine	Minor	Temporary	Possible	Limited
Pipeline Maintenance	Fresh	Moderate	Temporary	Unlikely	Limited
Snow Storage and Removal	Fresh	Minor	Temporary	Unlikely	Local
	Marine	Minor	Temporary	Unlikely	Limited
Discharge	Fresh	Moderate	Temporary	Possible	Local
Fuel Tanks and Storage Areas	Fresh	Moderate	Temporary	Possible	Local
	Marine	Minor	Temporary	Unlikely	Limited
Water Withdrawal	Fresh	Minor	Temporary	Possible	Limited

5.7.8 Mitigation Measures

This section describes measures to mitigate impacts to water quality from the Point Thomson Project. The Applicant has proposed design measures that would be included as part of the project; BMPs and permit requirements would be stipulated by federal, state, and local agencies, and the Corps has considered additional mitigation measures.

5.7.8.1 Applicant's Proposed Design Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on water quality.

Freshwater

- Reducing surface discharge of wastewaters through use of a disposal well, including zero discharge of produced water and drilling wastes.
- Managing snow melt and runoff under site-specific Stormwater Pollution Prevention Plans (SWPPPs) to protect water quality.
- Designing storage and transfer locations for fuels and other fluids with appropriate secondary containment systems and site-specific procedures (e.g., drip pans/duck ponds and pads underneath equipment).
- Implementing various BMPs, such as the Drips and Drops Program, for road and pad maintenance (e.g., vehicle inspections).
- Slotting ice roads at designated drainage paths to reduce the potential for erosion and sedimentation during breakup.
- Implementing dust control measures for roads and construction areas to avoid impacts of dust on nearby water bodies.
- Designing bridges and culverts to maintain existing surface drainage patterns and prevent erosion.
- Implementing spill prevention and response programs, as detailed in Section 5.24, Spill Risk and Impact Assessment.

Marine Water

- Optimizing module weight to eliminate the need to dredge a channel for barge access (Alternatives B and E only).
- Constructing a permanent service pier on piles, not fill, for offloading coastal barges to reduce the number of barge trips and minimize disturbance to the ocean bottom and associated impacts to marine water quality (Alternatives B and E only).
- Installing mooring dolphins and pilings through the ice in the winter to minimize potential suspended sediment effects on water quality (Alternatives B and E only).
- Dredging the barge landing area through the ice during the winter preceding an open water sealift to minimize sedimentation effects on water quality (Alternatives B and E only).
- Limiting summer screeding (and summer dredging if it becomes necessary) to the minimum amount needed to maintain the appropriate seabed profile for barge landing (Alternatives B and E only).
- Implementing spill prevention and response programs, as detailed in Section 5.24, Spill Risk and Impact Assessment.

5.7.8.2 BMPs and Permit Requirements

The CWA includes a wide array of requirements for maintaining water quality such as water quality standards and wastewater discharge permitting requirements (see Section 3.7.3). Erosion and sedimentation control measures that would avoid or minimize turbidity impacts would be included in the project SWPPP and project-specific stipulations that are required by the SPCO as part of the ROW lease. Many of the measures designed to protect wetlands (see Section 5.8.7.2) as well as requirements related to waste management and spills (see Section 5.24.12.2) would also avoid or minimize impacts to water quality.

5.7.8.3 Corps-considered Mitigation

In addition to the Applicant's proposed design measures and BMPs and permit requirements, the Corps, in consultation with others, is considering the following action to avoid or minimize impacts to marine water quality: direct barge ballast water discharge away from the seafloor to avoid disturbance of seafloor sediments.

5.7.9 Climate Change and Cumulative Impacts

5.7.9.1 Climate Change

While the project would not directly impact the rate of climate change, the reverse is not true. The effects of climate change, including sea level rise and MAAT increases, on water quality would likely be the same for each of the alternatives, since those effects would occur independently of any action or inaction on the part of the Applicant.

Sea level rise in the Arctic, as quantified in Section 4.3, Climate Change, is anticipated to be 2 inches by 2020 and 10 inches by 2080. These anticipated values are not expected to overtop the low cliff that represents the vast majority of the land edge along the Beaufort Sea north of the project area, but this expected rise in sea level when compounded by high tide and a storm surge will be capable of inundating land areas in the proximity of the ocean. This potential inundation, combined with increased saltwater intrusion at outflow points along the coast, could greatly increase the level of TDS in this region and change the geographic distribution of plant and animal life from low order phytoplankton to high order predatory mammals within close proximity to the coast.

Additionally, the warming described in Section 4.3, Climate Change is easily amplified by the high latitude climate and environment of the Arctic. Temperature-induced permafrost melt (see Section 5.2, Soils and Permafrost) is anticipated to increase the volume of nutrients exchanged between the melting soils and the freshwater inflows to tundra lakes and nearshore waters.

The most important source of freshwater in the project area is primarily from snowfall. The rapid spring melt of the snowpack can make up the majority of the total annual flows of streams in the project region. The ACIA points out that spring meltwater can also have major impacts on the quality of water entering lakes and rivers (2005). When highly acidic, it can produce "acid shock" in receiving waters. However, because the incoming meltwater is usually warmer than the pond/lake water, it tends to pass through the lake with little mixing. The potential acidic spring pulse is therefore temporary, without any marked biological consequences, as documented by paleolimnological investigations (ACIA 2005).

There is an additional water quality impact to the oceans related to acidification that comes from the exchange of increasing levels of CO_2 in the atmosphere with ocean waters. Dissolving CO_2 in seawater increases the hydrogen ion (H+) concentration in the ocean, thus decreasing the pH. As the amount of CO_2 in the atmosphere increases, the rate of acidification also increases, and ocean acidity is anticipated to more than double in the next 40 years (ACIA 2005).

Increasing air temperatures in the project region could have an impact on water quality by changing the nature of the interaction between groundwater and surface water. Permafrost has a profound influence over the levels and distribution of groundwater in the Arctic. The thickness of the permafrost determines the availability of the sub-permafrost water to freshwater ecosystems, acting as a relatively impermeable upper barrier (ACIA 2005). If rising temperatures were to melt the permafrost, thus debilitating this barrier, sub-permafrost water would be able to directly interact with surface water systems. This would greatly influence water quality characteristics such as cation, anion, nutrient, and dissolved organic matter concentrations.

5.7.9.2 Cumulative Impacts

In addition to climate change, this analysis investigated past, present, and future activities (Section 4.2.1) that could interact with the effects of the proposed project and alternatives. Generally, past and present activities on the North Slope (including development of Badami and the use of the Bullen Point military site) that have affected water quality in the region include gravel road and pad construction, gravel mining (increased turbidity), seasonal ice road and ice pad construction and operation (spills and contamination), and domestic and industrial discharges (permitted and accidental). Reasonably foreseeable future human actions include continued exploration and development of the oil and gas resources within the area, including restart of Badami operations, development of gas sales at Point Thomson, and exploration activities such as Sivulliq.

Cumulative impacts to surface water quality for any of the action alternatives could occur with increasing development along the North Slope coastal areas that would result in increased sedimentation in streams and lakes and an increase of contaminants, including hazardous materials from leaks and spills. Cumulative impacts associated with spills are further addressed in Section 5.24, Spill Risk and Impact Assessment.

Increased sedimentation from new construction of oil and gas developments and gravel roads into the area could also increase turbidity concentrations in localized areas, but would be temporary and likely occur during spring breakup. The areas most likely to be impacted would be water bodies in the immediate vicinity of the construction, and sediments would likely settle out before being transported long distances. Once construction of new developments or roads is completed, the potential for sedimentation would be reduced substantially. As a result, no concerns related to adverse cumulative effects on water quality have been identified at this time.

The gravel access road proposed under Alternative C poses a greater potential for adverse cumulative impacts on water quality than the other action alternatives because the road would traverse multiple streams across the ACP, covering about one quarter of the east-west extent of the geographic scope of the cumulative impacts analysis.

5.7.10 Alternatives Comparison and Consequences

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 in the project area are considered protected under the CWA. The primary impacts to freshwater quality from all action alternatives would be increased turbidity associated with gravel mining, gravel infrastructure, and pipeline construction. These impacts would be more extensive under Alternative C due to the gravel access road, additional five gravel mines, and longer export pipeline. Construction and operation of the barge offloading facility (including summer screeding) would cause temporary turbidity increases in marine waters under Alternatives B and E.

The Central Processing Pad would be located inland for Alternatives C and D, thus decreasing the potential for marine water quality impacts from the gravel pad. The impacts of spills and leaks on water quality are addressed in Section 5.24, Spill Risk and Impact Assessment.

5.8 VEGETATION AND WETLANDS

The key findings of effects for vegetation and wetlands are summarized below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

Alternative C: Major impacts to vegetation and wetlands are probable and would last beyond the life of the project. Impacts would extend across the study area. Alternative C results in 724 acres of wetlands fill and excavation.

Alternative B: Moderate impacts to vegetation and wetlands are probable and would last beyond the life of the project. Alternative B would affect 5% of the dry dwarf shrub, crustose lichens vegetation type. Impacts would predominantly be localized to the eastern portion of the project area. Alternative B results in 261 acres of wetlands fill.

Alternatives D and E: Minor impacts to vegetation and wetlands are probable and would last beyond the life of the project. Impacts would be localized within the eastern portion of the project area. Alternative D results in 336 acres of wetlands fill. Alternative E results in 184 acres of wetlands fill.

Alternative A: No impacts

Differentiators:

- Alternative C has the greatest impacts to vegetation and wetlands because of the all-season gravel road, longer infield roads, and addition of a fourth pad (Central Processing Pad).
- Alternative E has the least impacts to vegetation and wetlands from the placement of gravel fill; however, multiseason ice pads and annual infield ice roads would have medium term effects and tundra travel during the summer would have long-term effects.

Project alternatives have the potential to result in the loss or alteration of vegetation and wetlands from the discharge of gravel or fill materials and other activities related to the construction and operation of hydrocarbon production infrastructure. Wetlands and waters of the U.S. are potentially subject to Corps jurisdiction under authority of Section 10 of the Rivers and Harbors Act of 1899 or under authority of Section 404 of the CWA. Section 10 of the Rivers and Harbors Act provides regulatory authority to the Corps for work in or affecting navigable waters (excavation, dredging, and deposition of material into navigable waters), and the construction of any structure in, over, or under navigable waters which would result in a hazard or obstruction to navigation. Section 404 of the CWA gives authority to the Corps to regulate the discharge of dredged or fill material to waters of the U.S., including wetlands, and is intended to minimize impacts to these aquatic resources. Section 404 also gives the EPA oversite authority. The Corps issues permits authorizing the discharge of dredged or fill materials according to the Section 404(b)(1) guidelines established by the EPA. The Corps cannot issue a Section 404 permit unless it determines that the project complies with these guidelines and the proposal is within the public's interest.

5.8.1 Methodology

This analysis is an evaluation of the potential impacts resulting in loss or alteration and cumulative impacts to vegetation and wetlands within the project area. The project area is defined as the area between the Sagavanirktok River and the Staines River. The study area for vegetation and wetlands is defined as a mapped subset of the project area. The analysis presented in this section is based on the vegetation and wetlands mapping that was produced for the project area. The locations of project components such as gravel roads and pipelines as presented in this analysis are considered preliminary and conceptual in design for all alternatives. The exact locations and alignments of the project components would be adjusted during final engineering design stages to further avoid and minimize impacts to sensitive resources as practicable. Effects on vegetation and wetland ecosystems may also affect related resources such as soils, hydrology, water quality, and wildlife habitat; effects to related resources are detailed in their respective Chapter 5 sections. This section generally describes the potential effects on vegetation and wetland ecosystems that are not covered in other sections.

Effects on vegetation and wetlands from the project components of each alternative, obtained through use of GIS, are described qualitatively in the text and quantitatively in the tables. Impacts within the footprints of project components were calculated by overlaying the project component footprints of each alternative onto the baseline vegetation and wetland mapping (Schick and Noel 1995; Noel and Funk 1998, 1999, 2001; OASIS 2009, 2010; HDR 2011i) described in Section 3.8, Vegetation and Wetlands, and calculating the areas of each vegetation and wetland type within the footprints.

Hettinger (1992) reported the effects of snow accumulation, increased moisture, increased thaw depth, and dust deposition from a gravel road in Prudhoe Bay on tundra vegetation and wetlands, and found that these effects most often occur within a 164-foot area from the perimeter of the road. For this analysis, these effects were considered as adjacent effects and were calculated by applying a 164-foot buffer to the perimeter of gravel-filled areas and calculating the areas of each vegetation and wetland type within the buffer. Discussion of potential impacts to vegetation and wetlands from hydrocarbon spills or toxic leaks is presented in Section 5.24, Spill Risk and Impact Assessment.

Gravel and ice roads constructed across the natural drainage gradient could potentially impound water during the intense spring snowmelt and runoff period because that is the period when water drains by sheet flow across extensive areas of the coastal plain. After snowmelt, surface flow is expected to be limited to drainageways, and culverts would be placed in those locations to prevent or limit impoundment. Using the Applicant's road design criteria, standard hydraulic analysis methods, and detailed topographic data, hydrologists predicted the widths and duration of changes in inundation that would result from placement of a cross-gradient gravel road. They calculated the distance upgradient of the road that would be inundated during the spring sheet flow period; the distance downgradient of the road that would be inundated if downstream of a cross-culvert or deprived of sheet flow if between culverts; and the maximum duration of road-caused inundation upgradient of the road during spring snowmelt (see Appendix S).

The above analysis found the following. In the west part of the study area, the maximum distance of upgradient inundation effects would be approximately 5,700 feet; in the east part of the study area, the maximum distance of inundation would be approximately 1,180 feet. These estimates were made using conservative assumptions of ponded depth upstream of structures. Hydrologists estimated the maximum duration of increased inundation to be 4.4 days for the greatest inundation area, and less than a half day for a typical area of less extensive inundation. Adjacent to a gravel road on its downgradient side, assuming 500-foot culvert spacing, the average width expected to be affected by increased water flow is 500 feet, and the average width expected to experience loss of sheet flow between culverts is 500 feet. So, in this 500-foot-wide zone downgradient of a gravel road, approximately half the area would experience greater surface water flow and half would experience less surface water flow during the short snowmelt period. The estimates generated by the above analysis were considered when predicting impacts of gravel roads for each alternative.

Scientists have completed a preliminary functional assessment for wetlands in the study area. The assessment method is briefly described in Section 3.8, Vegetation and Wetlands, and more thoroughly described in the Wetland Functional Assessment in Appendix K. Note that some of the functions ascribed to project-area wetlands and water bodies bear little relationship to the wet nature of those areas, and that upland areas provide many of the same functions, perhaps better than do the wetlands (e.g., bear denning habitats). Also note that, if a vegetation type could be either wetland or upland, it is assumed to be wetland for the functional analysis, as well as for the calculations of affected wetland and water body acreage.

The impact evaluation criteria used for this analysis are summarized in Table 5.8-1, and impact summary tables are provided with each alternative. In circumstances where more than one intensity type may apply to an impact category, the most severe intensity type was used for evaluating impacts.

The project alternatives' potential effects on each evaluated wetland function, and on some water body functions, are described qualitatively for each project component type in Table 5.8-2. The approximate acreage potentially affected is presented in a separate table for each action alternative. The acreages are listed even for functions that would not be affected. For example, the ice road footprint acreage within an area shown to produce and export organic matter is listed even though that function would not be affected by an ice road; and the gravel mine footprint acreage within the flood flow moderation area is listed even though the mine area would still store spring snowmelt water. For effects expected to occur outside the project footprint itself, the same 164-foot average width of adjacent effects is used as is described above. The area in which functions might be affected outside the project footprints varies among functions. Using a standard width for out-of-footprint effects allows an order-of-magnitude comparison among the project alternatives.

Table 5.8-1: Impact Criteria—Vegetation and Wetlands			
Impact Category	Intensity Type	Specific Definition for Vegetation	Specific Definition for Wetlands
Magnitude	Major	Impacting >25% of a vegetation class within the study area	Impacting > 25% by acreage of any specific wetland type within the project area, or > 25% of all wetlands performing a given function within the study area
	Moderate	Impacting 5 to 25% of a vegetation class within the study area	Impacting 5 to 25% by acreage of any specific wetland type within the project area, or 5 to 25% of all wetlands performing a given function within the study area
	Minor	Impacting < 5% of a vegetation class within the study area	Impacting < 5% by acreage of any specific wetland type within the project area, or < 5% of all wetlands performing a given function within the study area
Duration	Long term	Impact would be permanent, restoration not possible or timeframe unknown	Impact would be permanent, restoration not possible within one human lifetime, or timeframe unknown
	Medium term	Impact would last for the life of the project, restoration possible	Impact would last for life of project, restoration possible within one human lifetime
	Temporary	Impact would last through project construction or would be incidental in other project phases, restoration possible or not needed	Impact would last through project construction or would be incidental in other project phases, restoration possible or not needed.
Potential to Occur	Probable	Likely to occur, even with mitigation	Likely to occur, even with mitigation
	Possible	Potential to occur (can avoid or mitigate)	Potential to occur (can avoid or mitigate)
	Unlikely	May occur, but not likely to occur	May occur, but not likely to occur
Geographic Extent	Extensive	Within and beyond project area	Within and beyond project area
	Local	Within project area	Within project area
	Limited	Within project footprint	Within project footprint

* Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology

Table 5.8-2: Effects of Project Components on Wetland Functions

Wetland Function	Gravel Roads and Pads	Gravel Mine	Ice Roads and Pads	Winter Water Withdrawal	Barge Dock/ Boat Launch/Dredging (Alternatives B and E only)	VSM-Mounted Structures	Operations
Flood Flow Moderation and Conveyance	Gravel fill eliminates area where flood waters are stored and conveyed, redirects water flow, and eliminates the absorptive capacity of the underlying vegetation and soil, with the effect of incremental increase in the height and flashiness of stream flow peaks. Fill placement in floodplains would also change the locations and duration of flooding. The functional assessment method used for this project does not ascribe this function to areas that just absorb snowmelt and rainfall (because most of the project area does this), so the acreage shown as performing the absorption component of this function is not identified.	The borrow sites would retain water during snowmelt, thus compensating some for the loss of this snowmelt-period function in basins that are partially filled by gravel pads.	Ice roads, particularly those running cross-gradient, would alter sheet flow during spring snowmelt, in some areas impounding water upgradient, reducing flows to basins that might otherwise detain runoff, and potentially routing water more directly toward streams. Ice roads would concentrate snowmelt flows into streams at the stream crossing sites, and would dam water upstream within the floodplain, but the same floodplain area would still likely store and convey spring snowmelt, minus the volume of the still-frozen ice road.	No effect. Lakes from which water was withdrawn would have more capacity to store snowmelt.	No effect.	Minimal effect on flood moderation and conveyance provided VSM placement in floodplains is minimized.	Continuation of effects of ice and gravel roads and pads described for construction period: changes in ponding and flow patterns during snowmelt and in floodplains, loss of surface water absorption capacity within gravel pad footprints.
Shoreline and Bank Stabilization	This function would be eliminated within the gravel infrastructure footprints. Fill structures built adjacent to moving water are assumed to be protected from erosion. However, placement of an embankment in a stream or floodplain could focus erosive forces in new locations that might erode the vegetation and reduce its ability to perform the function.	A gravel mine would eliminate features performing this function within its footprint. When the mine filled with water and became a lake, shore-protecting vegetation could be established.	Concentration of meltwater flow into streams at ice road crossings, damming of streams, and concentration of flow across the ice road at few locations would enhance erosive potential. Wetland vegetation may play a role in stabilizing substrates where the energy is concentrated, but it could also be eroded if the force is too great.	If water-source lakes did not refill during snowmelt, lake-margin vegetation would not be subject to wave erosion so would not have the opportunity to perform this function. If recharge did not occur, aquatic vegetation in the lake would temporarily lose vigor and its ability to stabilize shorelines.	Natural function would be replaced by bulkhead. Fill slopes could change location and intensity of wave forces and erode adjacent areas that can withstand only natural waves.	No effect provided VSM placement in floodplains is minimized.	Continuation of effects of ice and gravel roads and pads described for construction period: potential erosion of adjacent areas due to focusing of erosive forces.
Maintenance of Natural Sediment Transport Processes	This function would be eliminated within fill footprints. Fill embankments would alter natural sediment transport and deposition patterns, causing deposition in some locations and erosion in others. No changes in sediment retention at lakes because capacity is assumed not to be limited.	This function would be eliminated within the mine footprint. Mine footprint would retain any sediment it received.	Where streams and floodplains were partially obstructed by ice roads during snowmelt, natural sediment transport would be affected. Sedimentation would tend to occur upstream of the ice road crossing, and erosion would tend to occur downstream if flows were concentrated. Provided ice roads were slotted at appropriate locations, suspended sediments would continue to move downstream. Wetland vegetation's role in causing particulates to settle out of floodwaters is expected to be minimal during snowmelt.	No effect. Lakes receiving sediment would retain it.	No effect on river processes. Coastal processes not evaluated as wetland function.	No effect.	Continuation of effects of ice and gravel roads and pads described for construction period: small changes in sediment transport at ice road crossings, and more substantial changes at gravel road crossings.
Production and Export of Organic Matter	This function would be eliminated within fill footprints. Effects of fill such as release of dust, impoundment of water, and changes in downgradient site moisture would alter production of organic matter in adjacent habitats. Changes in flow patterns would alter export to downstream ecosystems. The direction of net offsite effects (beneficial/detrimental) is uncertain.	Production of organic matter would be eliminated within the mine footprint until the pit was closed, and substantially reduced thereafter, relative to the present condition.	Ice roads and pads would slightly affect flow paths during snowmelt, but the net effect on export would be negligible. Production adjacent to ice roads would be changed by altered hydrology, but direction of change is uncertain.	Lake drawdown would adversely affect productivity of lakeshore vegetation during years that the lake did not refill completely at snowmelt. Because the flow out of the lakes would be reduced, export of organic matter would be reduced.	Area performing this function in the footprint would be eliminated.	Negligible effect.	Continuation of effects of gravel fills and ice roads described for construction period. Potential changes of vegetation types and productivity adjacent to fill footprints. Off-road vehicle use could potentially damage productive vegetation.
Maintenance of Soil Thermal Regime	This function is replaced within the footprints by adequately thick fill and is degraded adjacent to the fills. Effects of fill such as generation of dust, impoundment of runoff, and changes to surface flow patterns may destabilize the thermal regime of adjacent areas, potentially resulting in thermokarst.	This function would be eliminated within the mine footprint.	If roads were located in tussocky or HCP vegetation types or were not moved from year to year, surface vegetation could be damaged, thus decreasing its ability to maintain normal soil temperatures and potentially leading to thermokarst.	No effect.	No effect.	No effect.	Continuation of effects of gravel fills described for construction period. Off-road vehicle use could potentially damage insulative vegetation mats and lead to thermokarst formation.

Table 5.8-2: Effects of Project Components on Wetland Functions

Wetland Function	Gravel Roads and Pads	Gravel Mine	Ice Roads and Pads	Winter Water Withdrawal	Barge Dock/ Boat Launch/Dredging (Alternatives B and E only)	VSM-Mounted Structures	Operations
Waterbird Support	This function would be eliminated within fill footprints. Adjacent habitats would be altered by changes in drainage, changes in snow accumulation, deposition of dust and gravel, and resulting changes in plant types and phenology.	The habitats present before gravel mining would be eliminated and open water habitat created in its place, which would represent a conversion of habitat and potential devaluation, not absolute loss. Flooded habitats adjacent to the gravel mine site would likely be converted to drier habitat types because they would be drained into the mine basin, at least until the mine reservoir filled with water.	Ice roads would delay availability, change the moisture regime, and alter plant phenology in habitats within and adjacent to the footprint, thus altering nesting and feeding site selection. The habitats ascribed this function are wetter ones that are less likely to be adversely affected by ice roads.	Lake drawdown would reduce open-water habitat and suitability of shoreline and island habitats in the years it did not completely recharge during breakup.	Function would be eliminated in footprint. Adjacent habitats would potentially be slightly degraded by changed water flow, snow accumulation, dust release, and resulting changes in vegetation.	Minimal loss and change of habitat resulting from presence of pipelines. Potential minor changes of waterbird behavior, and of predators.	Degradation of habitats adjacent to activity areas from changes of drainage patterns, pollutant and dust generation, phenologic and vegetation type changes. Changes in bird behavior resulting from human activity and presence of structures.
Terrestrial Mammal Support	This habitat would be eliminated within gravel infrastructure footprints and potentially be slightly degraded adjacent to gravel infrastructure because altered snow accumulation and site moisture and deposition of dust and gravel would change vegetation types.	This function would be eliminated within the mine footprint.	Ice roads and pads tend to thaw out later and vegetation may not sprout as soon as the surrounding tundra; these habitats likely would not be available for caribou grazing early in the summer. No effect on brown bear denning assuming FLIR surveys for polar bear dens resulted in relocation of ice road if necessary. Possible disturbance of individuals by ice road activity.	No effect on the evaluated habitats.	Slight loss of insect relief area.	Negligible loss of habitat and behavior changes resulting from presence of pipelines.	Continuation of effects begun during construction. Changes in individual mammal behavior resulting from human activity.
Resident and Diadromous Fish Support	Fish habitat and travel routes would be eliminated within gravel infrastructure footprints. Adjacent habitat would potentially be degraded by deposition of dust and gravel, changes in drainage patterns and flooding regime, and changes of vegetation and invertebrate communities.	This function would be eliminated within the mine footprint.	At stream crossings and along the coast, ice roads that have not yet thawed in spring could affect fish movements (Whitman 2010), spawning, and access to habitat. The sea ice road is unlikely to affect fish use of nearshore marine habitats because these areas are naturally frozen to the bottom during winter (see Section 5.12, Fish, Essential Fish Habitat, and Invertebrates). Slotting the road at stream crossings would minimize effects on fish movements.	Seven of 33 currently permitted water withdrawal sources provide fish habitat (see Section 5.12, Fish, Essential Fish Habitat, and Invertebrates). No effect, assuming water withdrawal from lakes with overwintering fish was restricted to ensure maintenance of fish habitat.	Loss and change of coastal fish habitat at dredge site and dredged material disposal site. Altered fish movements along shore due to barge facility.	Negligible effect.	Continuation of effects begun during construction. Additional potential habitat degradation from release of pollutants.
Threatened or Endangered Species Support • Spectacled Eider • Polar Bear	For spectacled eider, effects would be the same as for waterbird support. For polar bear, loss of potential denning habitat and disturbance of individual bears by human activity.	For spectacled eider, effects would be the same as for waterbird support. No polar bear denning habitat predicted (in wetland functional assessment) within gravel mine footprints.	Ice roads melting more slowly than adjacent areas would cause temporary loss and moisture regime change of spectacled eider habitat during snowmelt. No effect on polar bear habitat assuming ice road would be sited after FLIR survey. Possible disturbance of individual bears by activity on ice roads between emergence from den and cessation of ice road use.	Lake drawdown would reduce open-water habitat and suitability of shoreline and island habitats in the years it did not completely recharge during breakup. No effect on polar bear habitat.	Loss of potential spectacled eider habitat and obstruction in polar bear travel corridor.	Negligible loss of habitat and behavior changes resulting from presence of pipelines.	For spectacled eider, effects would be the same as for waterbird support. On-going disturbance of individual bears by human activity.
Scarce and Valued Habitats	These habitat types would be eliminated within gravel infrastructure footprints and potentially degraded where adjacent to gravel fills because of changed hydrology and deposition of dust and gravel.	This function would be eliminated within the mine footprint.	These highly valued habitat types are not among those most vulnerable to damage by ice roads, and the *Arctophila* marshes are among the least likely to be damaged by ice roads.	In lakes that support *Arctophila* that did not fully recharge during snowmelt, this habitat type would be temporarily degraded.	These habitats present within the footprint would be eliminated and the adjacent ones would be slightly degraded by factors listed under waterbird support.	Negligible effect.	Slight degradation of habitats adjacent to activity areas from changes of drainage patterns, pollutant and dust generation, phenologic changes.

5.8.2 Alternative A: No Action

Alternative A consists of monitoring the two wells at the existing PTU-3 pad. Alternative A does not include any construction or ground disturbing activities and would not result in impacts to vegetation or wetlands.

5.8.3 Alternative B: Applicant's Proposed Action

Alternative B is described in detail in Chapter 2. Figure 5.8-1 through Figure 5.8-4 show the project component footprints overlain on the mapped vegetation types (Figure 5.8-1 shows an overview of the alternative and Figure 5.8-2 through Figure 5.8-4 show additional detail of project features). Table 5.8-3 identifies the acreage of potentially-affected wetland and vegetation types associated with the direct and indirect impacts from Alternative B. They also show acreages of water body effects, using the same footprint widths and adjacent affected widths as for vegetated areas. Descriptions of water body effects are presented in Sections 5.6, Hydrology; 5.7, Water Quality; and 5.12, Fish, Essential Fish Habitat, and Invertebrates. The acreage performing each function within each project component footprint is listed in Table 5.8-4, as well as the acreage within a zone adjacent to fills and the gravel mine that might be affected by altered hydrology, dust, and gravel spray.

5.8.3.1 Alternative B: Construction

The primary construction impacts to wetlands and vegetation would be gravel mining and placement, water withdrawal for and construction of ice roads, construction and dredging for the barge offloading facility and emergency boat launch, and wastewater disposal. While VSM placement for pipelines and trenching for the installation of buried power cables would impact wetlands and vegetation, the total impacted area for both infield and export pipelines and the buried power cables would be less than 1 acre, and is therefore considered negligible.

Gravel Mine

Surface vegetation and overburden would be removed during excavation of a gravel mine site, which would be excavated over the course of two winter seasons. Overburden from the mine would be stockpiled on a temporary ice pad adjacent to the mine. This ice pad would be built annually and melt each summer for 2 years. Gravel mined from the site would be stored on a gravel pad constructed adjacent to the mine. The impacts from the ice and gravel pads are described in greater detail below. Excavation of the mine would result in loss of the existing vegetation and wetlands within the mine footprint. The gravel mine would fill slightly with water over the course of the summer and would require 1 to 2.5 weeks to dewater in the fall. Water discharged to the tundra surface or into a natural drainage for this duration during the late growing season would temporarily alter the hydrologic regime and would likely not have an effect on vegetation or wetlands. However, if discharge rates were not controlled or the flows not appropriately dissipated, vegetation could be destroyed and surface soil erosion could occur.

After completion of mining activity, the gravel mine site would be closed and rehabilitated. Rehabilitation would include replacement of overburden, contouring, and creating stable side walls. Over the course of 5 to 11 years, natural sheet flow would fill the mine site with water and create open-water habitat. The mine site could be used as a permitted backup water supply in future years (ExxonMobil 2011b).

Fill Placement

Alternative B includes gravel fill for new pads, improvements to and expansion of existing pads, infield roads, an airstrip and associated facilities, and barge offloading facilities described in Chapter 2. Gravel placed on the tundra surface for the construction of roads and pads would be between 6 and 7.5 feet thick to maintain the integrity of the underlying permafrost. Side slopes would be 2:1.

Gravel fill directly covers and kills tundra vegetation and adjacent effects can extend beyond the limits of fill (NRC 2003a). Revegetation in the arctic is a gradual process and approaches to restoring wetland plant communities vary depending on site specific conditions such as substrate and soil moisture regime. Restoration of wetland plant communities after gravel removal may be possible in wet tundra types within a timeframe of about 10 to 30 years from initial restoration efforts; but it is unlikely that moist or dry tundra habitats could be restored to conditions similar to natural communities without a greater effort, if at all (Jorgenson and Joyce 1994).

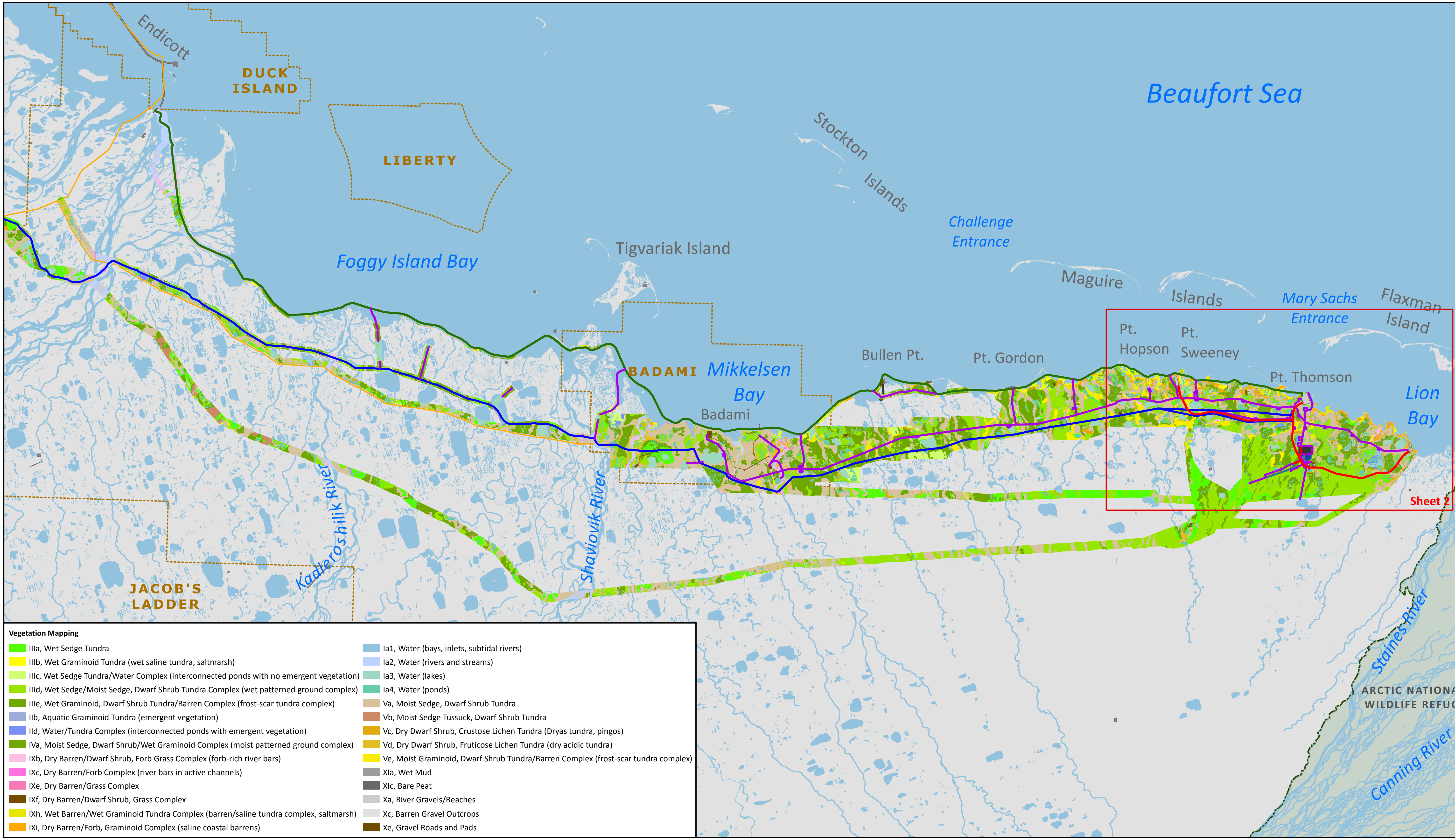
Equipment used to haul and place gravel fill could harbor nonnative plant seeds, and the placement of fill would create barren areas that pose the greatest risks for establishment of invasive nonnative species, which could spread to adjacent undisturbed areas. Due to the close proximity to the Arctic Refuge, the establishment of nonnative plant species within the study area would pose an increased risk of their establishment in the Arctic Refuge.

Impacts to vegetation and wetlands adjacent to gravel fill could result from dust deposition and gravel spray, altered snow distribution, hydrologic impoundments, and thermokarst, the effects of which would most likely occur within 164 feet from the source (Hettinger 1992). The adjacent effects from the discharge of gravel fill to the tundra surface are described below.

Dust

Dust and gravel spray are likely to be generated during gravel placement, gravel compaction activities, and vehicular traffic and equipment operation on gravel roads and pads. The most heavy dust deposition would be anticipated to occur within 35 feet of the road (Walker and Everett 1987); however, disturbances from dust have been documented out to 330 feet from the most heavily-traveled roads in Prudhoe Bay (Walker et al. 1987aa). For this analysis, the effects of dust are included within the 164-foot buffer area for the adjacent effects of gravel fill. The surface area affected by the heaviest dust fall out alone is quantified in Section 5.2, Soils and Permafrost. The effects of dust deposited on adjacent tundra may include:

- Burial or elimination of vegetation in the most heavily-impacted zones (Everett 1980)
- Reduction in vegetation biomass (Auerbach 1997)
- Early snowmelt in roadside areas due to lower albedo (Klinger et al. 1983; Auerbach 1997)
- Early green-up of plants (Walker and Everett 1987)
- Increases in graminoid composition (Auerbach 1997),
- Decreases in sphagnum and other mosses and lichens (Walker et al. 1987aa)
- Decreases in nutrient levels in soils (Auerbach 1997)
- Decreases in soil moisture
- Increases in thaw depth
- Shallower organic horizon
- Contribution to thermokarst (Walker et al. 1987a)



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

- Pipeline Construction Ice Road
- Tundra Ice Road
- Sea Ice Road
- Road Centerline
- Airstrip
- Gravel Mine
- Gravel Pads
- Ice Pads

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

0 2.5 5 Miles

N

Figure 5.8-1

Vegetation Mapping
Alternative B - Sheet 1 of 4

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

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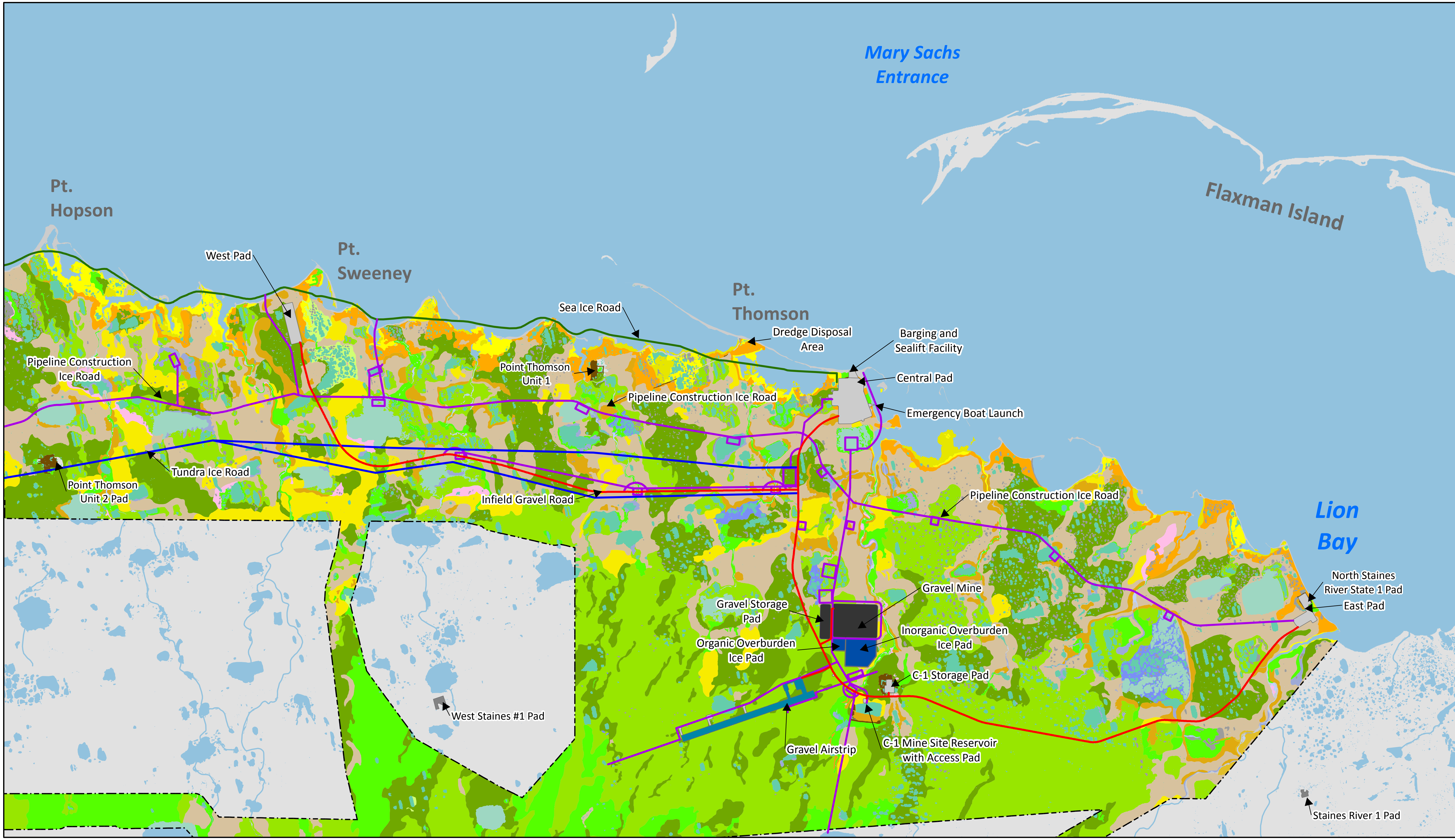

POINT THOMSON PROJECT EIS

Proposed Project Layout

- Pipeline Construction Ice Road
- Tundra Ice Road
- Sea Ice Road
- Road Centerline
- Airstrip
- Gravel Mine
- Gravel Pads
- Ice Pads
- Vegetation Mapping Extent

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

N

0 1 2 Miles

Figure 5.8-2

Vegetation Mapping
Alternative B - Sheet 2 of 4

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

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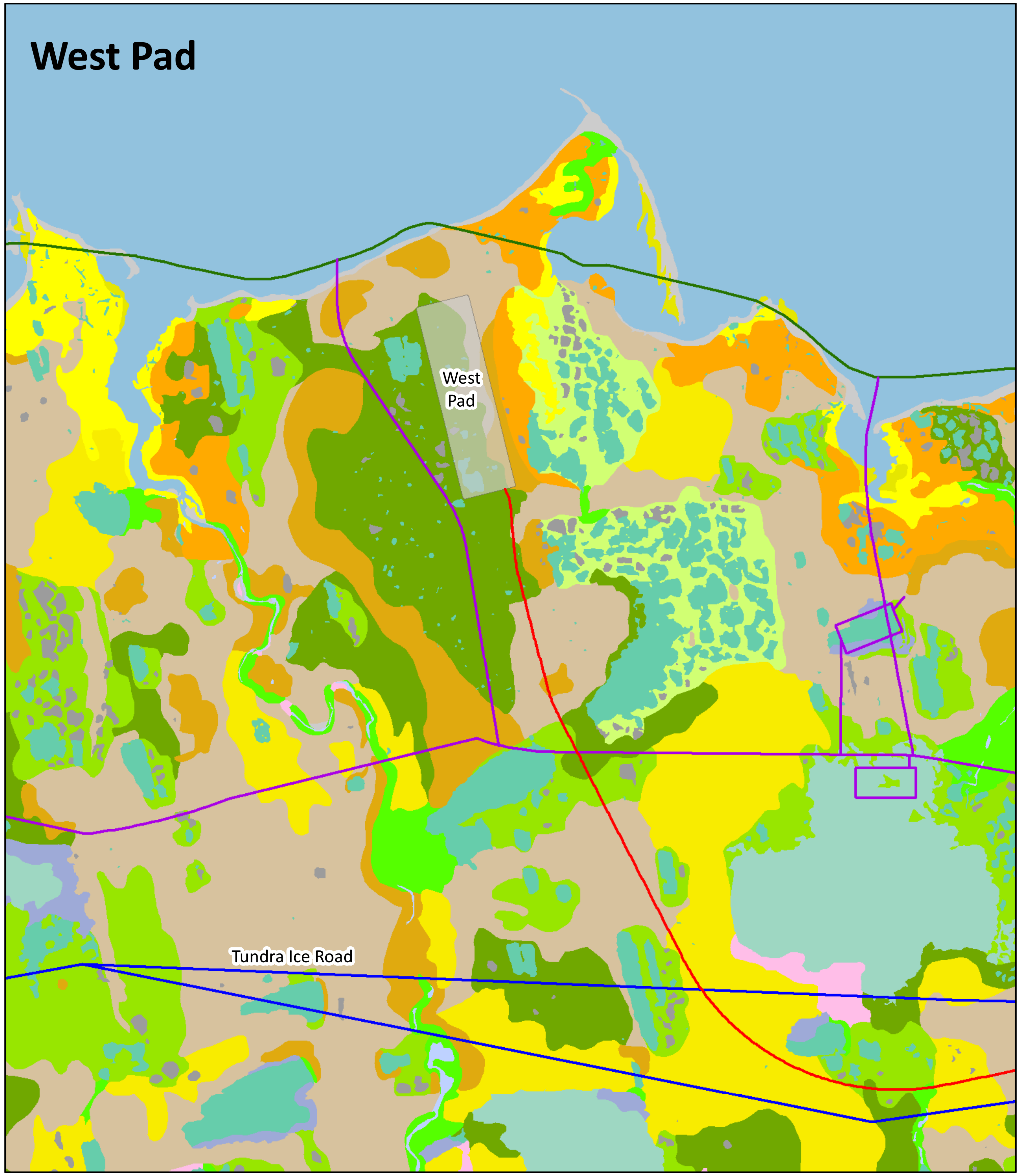
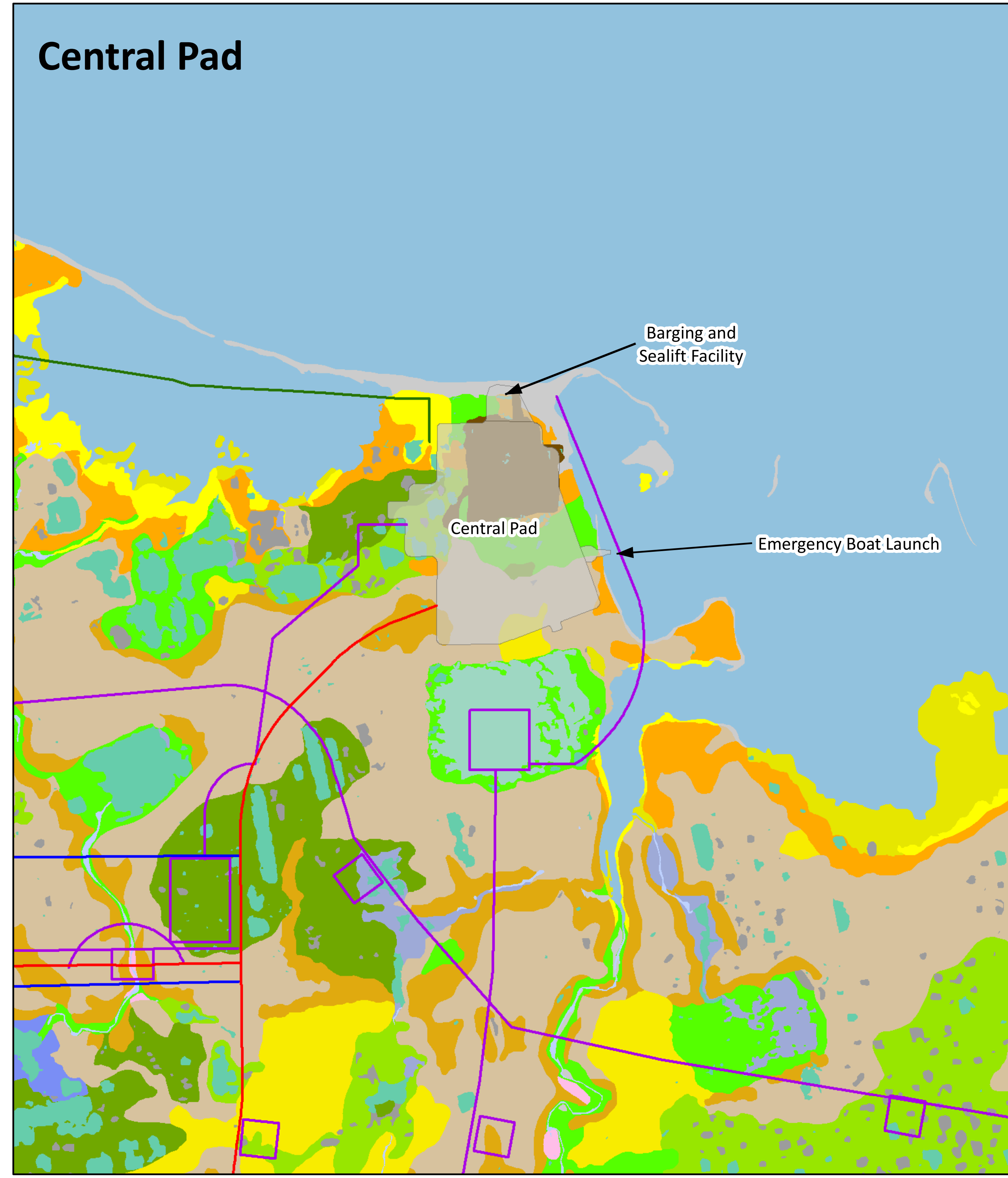


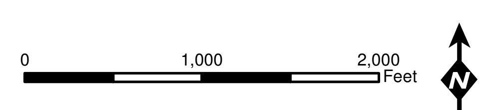


POINT THOMSON
PROJECT EIS

Proposed Project Layout

- Pipeline Construction Ice Road
- Tundra Ice Road
- Sea Ice Road
- Road Centerline
- Airstrip
- Gravel Pads
- Gravel Mine
- Ice Pads

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



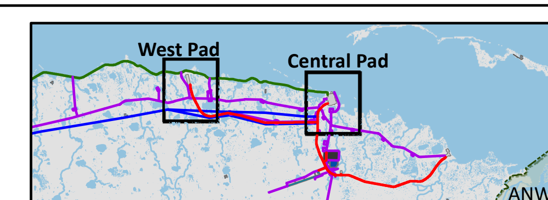


Figure 5.8-3
Vegetation Mapping
Alternative B - Sheet 3 of 4

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

Proposed Project Layout

- Pipeline Construction Ice Road
- Tundra Ice Road
- Sea Ice Road
- Road Centerline
- Airstrip
- Gravel Pads
- Gravel Mine
- Ice Pads
- Vegetation Mapping Extent

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

0 1,000 2,000 Feet

N

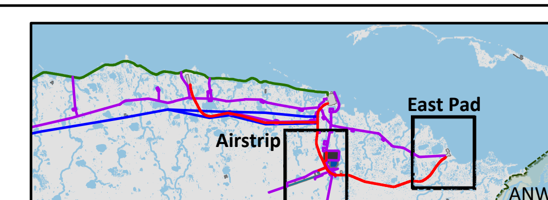

Figure 5.8-4
Vegetation Mapping
Alternative B - Sheet 4 of 4

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

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In general, the effects of dust on soil pH are more pronounced in areas of acidic tundra than in other areas, resulting in increased pH and an alteration in vegetation community composition. The soils underlying the study area are generally alkaline to circumneutral. Therefore, the effects of dust deposition on soil pH and vegetation community composition are expected to be less pronounced than in areas of acidic tundra (Auerbach 1997). Maintenance of gravel roads would include periodic watering to aid in dust suppression.

Altered Snow Distribution

Increased snow drift accumulation may occur on the downwind side of roads and pads and from plowing. Early melting of the accumulated snow may occur near the roads and pads due to dust-induced changes in albedo (Klinger et al. 1983, Auerbach 1997). The early melting of additional accumulated snow could increase local soil moisture levels (Brown et al. 1984), cause early thaw, and change plant phenology resulting in early green-up (Walker and Everett 1987). Early green-up of vegetation adjacent to roads and pads could attract geese, swans, and ptarmigan to these areas (Murphy and Anderson 1993) as described in Section 5.9, Birds.

Impoundments

Gravel fill could create impoundments by interrupting the natural drainage patterns of surface sheet flow and water flowing through the active layer. Impoundments can have variable effects that range from delayed plant growth due to temporary impoundments to conversion of tundra into deep, open lakes from permanent impoundments (Jorgenson and Joyce 1994). Increased surface water depth and duration on the upgradient sides of roads and pads could transform the vegetation community composition to wetter tundra types, with an increase in graminoid cover and a decrease in shrub cover. Prolonged inundation by deep water could also lead to plant mortality (Walker et al. 1987a). Moist tundra types present on microtopography such as strangmoor and polygon rims are important for nesting birds and could be lost due to flooding, though some waterbirds are attracted to impoundments created by altered wetland hydrology (Kertell 1994, 2000; Noel et al. 1996). While impoundment of water upgradient from a road during spring snowmelt could extend well over 1,000 feet upgradient of a road, such impoundment is estimated to last less than four days so any effects are expected to be negligible; effects of impoundment would be encompassed by the average width being used to calculate the indirectly affected areas.

The interruption of natural drainage patterns could result in a decreased moisture regime and a transformation in vegetation community composition to drier tundra types on the downgradient sides of gravel infrastructure, potentially increasing shrub cover and decreasing graminoid cover. It would also cause wetter soils in areas downgradient of the culverts. Culverts would be placed in low spots, spaced at approximately 500-foot intervals along roads, or more frequently if needed, to minimize surface water impoundments. During spring snowmelt, after construction, the need for additional culverts to minimize impoundments would be evaluated. At a 500-foot spacing, the altered moisture regimes would extend an estimated average of 500 feet on the downgradient side of a gravel road. Culverts can become clogged with snow and ice during the snow melt period, increasing flooding potential (Klinger et al. 1983). Infield gravel roads would also cross creeks and small tundra streams, with culverts planned for small tundra streams and bridges to cross the four larger drainages along the infield access road system.

Culverts could not be placed through the gravel airstrip because the airstrip would be approximately 200 feet wide and differential settling could result in an uneven runway surface. The airstrip for Alternative B, and all other action Alternatives, would be oriented in an east-west alignment, perpendicular to the dominant hydraulic gradient. The gravel fill would intercept movement of sheet flow, runoff, and possibly water moving through the active layer. Since culverts could not be placed through the airstrip, the effects on vegetation and wetlands from interrupting natural drainage patterns could be magnified in the vicinity of the airstrip. The Alternative B airstrip would divert drainage away from Stream 22 and toward Stream 24, effectively increasing Stream 24's drainage area by 1.8 mi^2 and decreasing Stream 22's drainage area by the same amount. The airstrip for each action Alternative would also alter drainage areas of streams in their vicinity (see Appendix S). For comparison between alternatives, a larger change in drainage area would be considered an increased probability of interrupting natural drainage patterns leading to subsequent effects on vegetation. The approximate change in drainage area from the airstrip for each action Alternative and potential effects on streams are discussed in Section 5.6, Hydrology. Potential effects on fish are discussed in Section 5.12, Fish, Essential Fish Habitat, and Invertebrates.

Thermokarst

As described in Section 5.2, Soils and Permafrost, thermokarst can cause drainage of surface and subsurface water from adjacent areas into the troughs, increasing thermo-erosion (Jorgenson et al. 2006). Thermokarst can be caused or accelerated by factors that increase thaw depth such as impoundments, loss of vegetative cover due to dust deposition or mechanical removal, or early snow melt due to changes in albedo. At Prudhoe Bay, thermokarst features generally occur within about 80 feet of roads, but have been observed at distances of 330 feet from roads (Walker et al. 1987a). The effects of thermokarst on vegetation and wetlands would be similar to those of increased moisture regimes caused by impoundments, leading to a transition of the affected vegetation and wetlands to wet or aquatic types, or possible mortality in areas subject to severe subsidence or prolonged inundation by deep water.

Ice Roads and Pads

Construction activities would require seasonal ice roads and seasonal ice pads which would be built during two to three consecutive years. When compared to gravel roads and pads, seasonal ice infrastructure has less of an impact to tundra vegetation communities; however seasonal ice infrastructure may still cause disturbance such as delayed plant development (phenology), plant stress, freezing of plant tissues, and physical damage resulting in "traces" or "brown trails" on the tundra surface.

Studies conducted by the BLM in the NPR-A found physical and thermal damage to grasses, shrubs, forbs, and bryophytes, with the most severe damage occurring to cotton-grass tussock communities and drier shrub communities (Guyer and Keating 2005). Communities dominated by shrubs and other woody species are the most susceptible to physical damage and stress caused by construction. Shrubs may exhibit delayed phenology or broken and abraded terminal stems. Some cotton-grass species grow in distinct tussocks which form natural micro-relief features on the tundra surface. Tussocks are easily susceptible to flattening or may become abraded or ripped during ice road construction and plowing (Walker et al. 1987a, Yokel et al. 2007). Mosses and lichens that occupy the microlows between tussocks are susceptible to compression when frozen and may become altered or destroyed (Walker et al. 1987a).

Vegetation mapping for the project identifies cotton-grass tussock and drier shrub communities as vegetation types Vb (moist tussock sedge, dwarf shrub tundra), Va (moist sedge, dwarf shrub), Vc (dry dwarf shrub, crustose lichens), Vd (dry dwarf shrub, fruticose lichen), IXb (dry barren/dwarf shrub, forb-grass complex), and IXf (dry barren/dwarf shrub, grass complex). Multiple studies have indicated that less impact from winter travel occurs in wetter vegetation types than in drier vegetation types (Felix and Raynolds 1989, Yokel et al. 2007). Flooded and wet tundra types generally exhibit little or no impact from ice road construction (Felix and Raynolds, 1989, Guyer and Keating 2005, Yokel et al. 2007). Vegetation damaged by a single-season ice road has been reported to recover within a 24-year period (Guyer and Keating, 2005). The impacts to wetlands and vegetation from seasonal ice pads would be similar to those of ice roads (Guyer and Keating 2005). Effects to soil and permafrost, which are integral to wetlands, are described in Section 5.2, Soils and Permafrost. In general, little change in the thermal regime or compaction of soil has been found to result from ice road construction (Walker et al. 1987a, BLM 2002aa, Yokel et al. 2007).

Contradictory reports exist about the effects of seasonal ice roads that are constructed within the same footprint each year. Guyer and Keating (2005) reported delayed phenology to a level of potential long-term vegetation modification where ice roads overlapped. Conversely, Yokel et al. (2007) found only minimal evidence of additive impacts from ice road overlap from two consecutive seasons, but suggested that no rigorous test has been conducted on the effects from ice road overlap for more than two years. Yokel suggested that ice roads be located in the wettest vegetation types as practicable without substantially increasing their length (Yokel et al. 2007).

Standard ice road construction practices have improved over time and include preconstruction routing surveys and road designs to avoid tussock tundra areas, steep stream banks, and deep water holes. As-built data from previous year's ice roads are considered in design and construction crews deviate alignments in the field if unexpected environmental conditions are encountered (Appendix G).

Impoundment of snowmelt runoff upgradient of ice roads is expected to be of such short duration each year that its effects would be negligible.

Water Removal

Water removal from freshwater sources would occur throughout the life of the project for use in building ice infrastructure. Water removal from freshwater sources is a permitted activity and would be regulated by permit stipulations intended to ensure recharge during spring snow melt. Because water removal would be regulated by permit stipulations, it is likely that sufficient recharge would occur in consecutive seasons. If complete recharge did not occur, the decreased water levels of ponds and lakes could result in exposure of bare substrate and potential decreased vigor of associated aquatic and shoreline vegetation until the pond refilled the following season. The potential alteration of lakeshore soils from water withdrawal is discussed in Section 5.2, Soils and Permafrost.

Barge Offloading Facilities, Emergency Response Boat Launch, and Dredging

A barge facility and an emergency response boat launch would be constructed at the Central Pad, and dredging and screeding would occur to facilitate barge shipment. Barge support infrastructure would include a bulkhead, a service pier, and mooring dolphins. The bulkhead would be located above the MHW line on the beach, with an associated gravel ramp connected to the Central Pad. The emergency response boat launch would extend approximately 165 feet into the inlet down to approximately 3.5 feet below the MLLW level, and would include a gangway and a gravel ramp. For area of impact calculation, the footprints of the bulkhead and the emergency response boat launch have been incorporated into the gravel fill footprint of the Central Pad.

Dredging and screeding and installation of pilings and mooring dolphins would occur in unvegetated waters. The area of unvegetated water impacted by the pilings and mooring dolphins has not been quantified, but is estimated to be less than 0.1 acre. The seafloor would require dredging (up to 1,500 cubic yards) and screeding to safely ground the sealift and coastal barges (ExxonMobil 2011b). Physical effects of the barge facility and barging activities are discussed in Section 5.5, Physical Oceanography and Coastal Processes.

The exact footprint of the dredged material disposal has not been quantified, however the dredged material would be placed on unvegetated gravel beaches and would not be placed in vegetated coastal wetlands, as shown on Figure 2.2-4. The location of the dredge disposal area would be adjacent to salt killed tundra and salt marsh. Deposition of the dredged material at this location could cause increased sedimentation in adjacent vegetation from runoff from the dredged material, windblown dried sediments being transported, and movement of the material by ice forced on shore or storm driven waves. Potential effects on vegetation could include decreased plant vitality from dust deposition on the leaves of individual plants or plant mortality from physical burial. If the dredged material is different in chemical composition, such as pH or salinity, from existing soil or water conditions then the species composition or density of the affected vegetation communities could be altered.

Wastewater Disposal

The discharge of hydrostatic test water to the tundra surface could result in impoundments or increased surface water retention on the tundra surface. If thermokarst were initiated by a thawing of the active layer, the impacts from discharging hydrostatic test water to the tundra surface could become permanent; these are discussed in Section 5.2, Soils and Permafrost. Because hydrostatic test water disposal would be temporary, impacts to tundra vegetation would likely be minimal.

Trenching

The power cables for the facilities along the pipeline route would be suspended above the tundra surface on cable trays attached to the pipeline VSMs. Power cables going to the facilities not along the pipeline route would be buried in a trench excavated into the tundra surface adjacent to the infield gravel access roads approximately 15 feet from the toe of the road. Junction boxes would be supported on 8-inch diameter support pipes located approximately every 1,000 feet along the buried cable. Trenching would occur over approximately 2.9 linear miles of tundra surface. Assuming an average width of 1.5 feet, approximately 0.5 acre of tundra would be disturbed by trench excavation. The trench would be excavated in the winter when the ground is frozen to minimize impacts to the tundra adjacent to the trench and to allow for trenching through water bodies. Standard North Slope restoration techniques include hand raking the sidecast material back into the trench and mounding it over the excavation during the first summer following thaw to ensure the trench is filled to ground level following subsidence and to prevent smothering of vegetation underneath the sidecast material. Additional material may need to be placed in the trench after initial subsidence. In general, natural revegetation from the surrounding tundra should progress during the first 3 years following placement of backfill and plant coverage should be approximately 50 percent cover after 5 years (BP 2005). To prevent water from flowing in the trench, additional subsidence, and expansion of the trench, several best management practices must be followed. If best management practices are not implemented, subsidence could result in thermo-erosion and ponding of water with effects on vegetation similar to that of thermokarst described above. If severe subsidence were to result, the extent of these effects would be exacerbated. Additional description of best management practices associated with trenching are described in Section 5.2, Soils and Permafrost.

5.8.3.2 Drilling

Drilling activities would not have specific impacts to wetlands and vegetation different than those discussed for construction. Discussion of potential impacts to wetlands and vegetation from hydrocarbon spills or toxic leaks that could occur during drilling is presented in Section 5.24, Spill Risk and Impact Assessment.

5.8.3.3 Operations

Many of the impacts begun during construction would continue during operations, including impacts from fill placement and ice roads. Additionally, operations may require off-road tundra travel for regular and emergency maintenance along pipelines.

Fill Placement

Pad and infield infrastructure maintenance would be ongoing during field life. Summer maintenance activities would include grading and compaction of gravel roads and pads to maintain gravel integrity. These activities, and routine travel on the gravel roads, would produce dust and gravel spray that would settle on roadside vegetation or accumulated snow.

Winter maintenance activities would include snow removal from roads and pads. Snow would be plowed with a grader or removed with a snow blower and could result in altered snow distribution and deposition of gravel spray in the vicinity of roads and pads. Impoundments and thermokarst initiated during construction would also continue through operations, if not addressed. The impacts of dust, gravel spray, altered snow distribution, impoundments, and thermokarst generated during operations are anticipated to occur within the same area identified in construction and would have similar effects.

Ice Roads

An ice access road between Point Thomson and Endicott would be constructed as needed during operations, conservatively every 5 years. Additional single-season ice roads may be constructed as needed for maintenance activities. The impacts of ice roads would be similar to those discussed above under construction.

Off Road Tundra Travel

Off-road tundra travel using tundra-safe vehicles may occur for regular and emergency maintenance of pipelines and other infrastructure. The frequency of tundra travel cannot be estimated at this time, but could occur under a variety of circumstances, such as to investigate or clean up a pipeline leak or if there was need to access an existing pad or other site with no gravel or ice road access. Potential impacts to soils and permafrost are described in Section 5.2, Soils and Permafrost. Impacts to vegetation may range from light impacts such as compression to more severe impacts such as displacement or removal. The degree of impacts generally depends on the vegetation type and the number of passes. Studies at Prudhoe Bay generally show that a single pass had light impacts to dry tundra types with little microrelief, and more severe impacts to wet tundra types with pronounced microrelief (Walker et al. 1977). Single-pass tracks through wet tundra have been reported as very visible initially, but untraceable after 7 years. Vegetation recovery rates may vary, and single pass trails from overloaded low ground-pressure vehicles have persisted after 10 years (Walker et al. 1987a). More severe impacts may result where multiple passes occur (Walker et al. 1977). Track depressions and increased thaw depth have been observed from multiple passes over wet tundra. Tracks were still depressed after 7 years and were greener than the surrounding tundra (Walker et al. 1987a). Other studies have shown that in deeply-rutted tracks in wet tundra, thermal balances, and vegetation composition were not restored until after 20 to 30 years (Abele et al. 1972, Everett 1983, Ebersole 1985). In general, if the soil organic mat remains unbroken, tundra vegetation may recover to its near original state within 10 years (Abele et al. 1984).

Winter off-road tundra travel generally results in lower amounts of damage to tundra vegetation than summer travel. A study in the northeastern NPR-A (Roth et al. 2004) rated damage to tundra vegetation caused by low-pressure vehicles using a scale of low level disturbance to very high-level disturbance. Low-level disturbance was described as causing green trails by compressing the standing dead vegetation, and high-level disturbance was described as churned or displaced vegetation, and surface soils and track depressions leading to thermokarst and ponding. In general, disturbance levels were low in moist and wet tundra types, moderate in tussock tundra, and high in dry dwarf shrub tundra types. Recovery would be expected within 3 to 5 years for low to moderate levels of disturbance, although recovery may take between 10 and 15 years for moderate levels of disturbance in tussock tundra and dwarf shrub tundra. Recovery may take between 10 and 20 years for high to very high levels of disturbance in shrub-dominated tundra (Roth et al. 2004).

On lands owned by the State, permits must be acquired from the ADNR, Division of Mining, Land, and Water for any vehicle traveling on tundra during any season. Additional permits would be required from the NSB. Adequate snow cover must be present for winter travel and tundra travel after April 15 is subject to termination based on snow cover to protect surface vegetation. Several stipulations apply to summer off-road tundra travel to minimize the effects to vegetation and wetlands (ADEC 2010d, NSB Municipal Codes), including:

- Operations are restricted to drier areas
- Avoid crossing deep water or vegetation with more than 2-3 inches of water
- Ponds, lakes, and wetlands bordering ponds and lakes cannot be crossed
- Avoid minimum radius turns with sharp articulations
- Keep multiple passes over the same area to a minimum
- All operators must be familiar with tundra vegetation types to ensure compliance with these stipulations
- Incidents of damage to the vegetation mat and follow-up corrective actions that have occurred shall be reported to the Division of Mining, Land, and Water within 72 hours of occurrence
- Vehicles are tested to determine their ability to operate on the tundra without causing extensive damage
- The state reserves the right to limit, restrict, or require retesting of vehicles at any time
- Vehicles cannot carry more payload than was carried during the certification test
- Movement of equipment through willow stands shall be avoided where possible
- Incorporate the best available technologies to prevent disturbance to permafrost that would result in habitat damage. Where disturbance to the organic mat is unavoidable, the disrupted area shall be stabilized to avoid disturbance to the permafrost layer.
- Include measures to monitor effects of tundra travel and to avoid damage to permafrost soils including using vehicles that will not result in damage to the tundra

Barge Offloading Facilities, Emergency Response Boat Launch, and Dredging

During operations, it is possible that periodic screeding and dredging would be required for the area in front of the service pier and would move up to 800 cubic yards of seafloor material. Potential effects from dredge material disposal would be similar to those described in construction.

Table 5.8-3: Alternative B—Summary of Affected Water Body, Wetland, and Vegetation Types

Cover Class	Level C Photo Interpreted Map Unit Types	Wetland Type (NWI Codes)	Gravel Roads, Pads, and Mine (acres): Gravel Roads and Pads	Gravel Mine	Dust, Snow Accumulation, Impoundments, Thermokarst	Total Acres	% of Mapped Type Affected	Ice Roads and Pads: Total Footprint (Acres)	% of Mapped Type Affected
Water Bodies	Bays, lagoons, inlets, subtidal rivers (Ia1)	E1UBL = Estuarine, subtidal, unconsolidated bottom, subtidal	0.1	0.0	4.5	4.6	<0.1	327.6	3.0
	Rivers and streams (Ia2)	R1UBV = Riverine, tidal, unconsolidated bottom, permanent tidal influence R2UBH = Riverine, lower perennial, unconsolidated bottom, permanently flooded R3UBH = Riverine, upper perennial, unconsolidated bottom, permanently flooded	0.1	0.0	0.7	0.8	0.1	31.5	2.5
	Lakes (Ia3)	L1UBH = Lacustrine, limnetic, unconsolidated bottom, permanently flooded L2UBH = Lacustrine, littoral, unconsolidated bottom, permanently flooded	0.0	0.0	0.7	0.7	<0.1	24.7	1.3
	Ponds (Ia4)	PUBH = Palustrine, unconsolidated bottom, permanently flooded	6.8	4.1	22.8	33.7	1.1	33.0	1.1
Water-associated Barrens	River gravels/beaches (Xa)	R3USC = Riverine, upper perennial, unconsolidated shore, seasonally flooded R2USC = Riverine, lower perennial, unconsolidated shore, seasonally flooded E2US1P = Estuarine, intertidal, unconsolidated shore, cobble-gravel, irregularly flooded	0.7	0.0	3.6	4.3	0.4	39.2	4.0
	Wet mud (XIa)	L2USD = Lacustrine, littoral, unconsolidated shore, seasonally flooded/well drained PUSD = Palustrine, unconsolidated shore, seasonally flooded/well drained	1.0	0.4	5.5	6.9	2.1	2.9	0.9
	Bare peat (XIc)	L2USD = Lacustrine, littoral, unconsolidated shore, seasonally flooded/well drained PUSD = Palustrine, unconsolidated shore, seasonally flooded/well drained E2US4P = Estuarine, intertidal, unconsolidated shore, organic, irregularly flooded	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Very Wet Tundra	Aquatic graminoid tundra (IIb)	L2EM2H = Lacustrine, littoral, emergent, nonpersistent, permanently flooded PEM1H = Palustrine, emergent, persistent, permanently flooded	0.0	0.0	0.4	0.4	0.1	5.6	1.5
	Water/tundra complex (IId)	L2UB/EM2H = Lacustrine, littoral, unconsolidated bottom/emergent, nonpersistent, permanently flooded PUB/EM2H = Palustrine, unconsolidated bottom/emergent, nonpersistent, permanently flooded PUB/EM1H = Palustrine, unconsolidated bottom/emergent, persistent, permanently flooded	0.0	0.0	0.2	0.2	0.1	3.1	1.3
Wet Tundra	Wet sedge tundra (IIIa)	PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	9.7	0.0	9.3	19.0	0.5	18.3	0.5
	Wet graminoid tundra (IIIb)	E2EM1N = Estuarine, intertidal, emergent, persistent, regularly exposed E2EM1P = Estuarine, intertidal, emergent, persistent, irregularly flooded	0.7	0.0	1.8	2.5	0.5	6.5	1.2
	Wet sedge tundra/water complex (IIIc)	L2EM2/UBH) = Lacustrine, littoral, emergent, nonpersistent/unconsolidated bottom, permanently flooded PEM1/UBH = Palustrine, emergent, persistent/unconsolidated bottom, permanently flooded	0.0	0.0	0.0	0.0	0.0	5.9	0.8
	Wet sedge/moist sedge, dwarf shrub tundra complex (IIId)	PSS1/EM1B = Palustrine, scrub shrub, deciduous/emergent, persistent, saturated PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	64.3	31.2	191.5	287.0	2.3	122.4	1.0
	Wet graminoid, dwarf shrub tundra/barren complex (IIIe) (frost-scar tundra complex)	PSS1/EM1B = Palustrine, scrub shrub, deciduous/emergent, persistent, saturated PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	2.6	0.0	5.4	8.0	2.4	3.6	1.1
	Wet barren/wet graminoid tundra complex (IXh)	E2USN = Estuarine, intertidal, unconsolidated shore, regularly exposed E2USP = Estuarine, intertidal, unconsolidated shore, irregularly flooded E2EM1P = Estuarine, intertidal, emergent, persistent, irregularly flooded	0.0	0.0	0.3	0.3	0.1	5.4	2.1

Table 5.8-3: Alternative B—Summary of Affected Water Body, Wetland, and Vegetation Types									
			Gravel Roads, Pads, and Mine (acres)					Ice Roads and Pads	
Cover Class	Level C Photo Interpreted Map Unit Types	Wetland Type (NWI Codes)	Gravel Roads and Pads	Gravel Mine	Dust, Snow Accumulation, Impoundments, Thermokarst	Total Acres	% of Mapped Type Affected	Total Footprint (Acres)	% of Mapped Type Affected
Moist Tundra	Moist sedge, dwarf shrub tundra (Va)	PSS1/EM1B = Palustrine, scrub shrub deciduous/emergent, persistent, saturated	56.0	17.4	167.3	240.8	1.9	153.9	1.2
	Moist tussock sedge, dwarf shrub tundra (Vb)	PEM1/SS1B = Palustrine, emergent, persistent/scrub shrub, deciduous, saturated	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Moist graminoid, dwarf shrub tundra/barren complex (Ve)	PSS1/EM1B = Palustrine, scrub shrub deciduous/emergent, persistent, saturated	8.0	3.8	33.1	44.8	3.2	25.8	1.8
Moist/wet Tundra Complex	Moist sedge, dwarf shrub/wet graminoid tundra complex (IVa)	PSS1/EM1B = Palustrine, scrub shrub, deciduous/emergent, persistent, saturated PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	43.5	0.3	113.2	157.0	1.5	138.8	1.3
Dry Tundra	Dry dwarf shrub, crustose lichens (Vc)	Upland PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	8.0	0.0	29.4	37.3	5.0	10.6	1.4
	Dry dwarf shrub, fruticose lichens (Vd)	Upland PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	0.0	0.0	0.0	0.0	0.0	8.6	1.5
	Dry barren/dwarf shrub, forb-grass complex (IXb)	Upland PSS1/EM1A = Palustrine, scrub shrub, deciduous/emergent, persistent, temporarily flooded	0.1	0.0	0.5	0.6	0.2	7.1	2.0
	Dry barren/ forb complex (IXc)	R2USC = Riverine, lower perennial, unconsolidated shore, seasonally flooded	0.0	0.0	0.0	0.0	0.0	1.2	2.4
	Dry barren/grass complex (IXe)	Upland	0.0	0.0	0.0	0.0	0.0	0.1	0.8
	Dry barren/dwarf shrub, grass complex (IXf)	Upland	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dry barren/forb-graminoid complex (IXi)	PSS5/EM1J = Palustrine, scrub shrub, dead/emergent, persistent, intermittently flooded	2.4	0.0	8.7	11.1	1.9	4.6	0.8
Disturbed Barrens	Barren gravel outcrops (Xc)	Disturbed wetland/unknown	0.0	0.0	0.0	0.0	0.0	0.1	2.2
	Gravel roads and pads (Xe)*	Upland/unknown	22.7	0.0	10.3	33.0	17.1	4.4	2.3
		Total area affected	226.7	57.2	609.2	893.1	1.4	984.9	1.5
		Total area of water bodies affected	8.7	4.5	37.8	51.0	0.3	459.0	2.5
		Total area of wetlands affected	195.3	52.7	561.1	809.1	1.8	521.6	1.1
		Total area of upland affected	22.7	0.0	10.3	33.0	16.1	4.5	2.2

[a] Impacts to Xe indicate previously permitted fill areas.
Impacts from dredge disposal area are not shown in the table due to unspecified location.
Barge facility and emergency response boat launch footprints are included in gravel roads and pads footprint.
Impacts from mooring dolphins have not been quantified and are not included in the table, but are anticipated to be less than 0.1 acre and would occur in map unit type 1a1.
Exact locations and alignments of project components would be adjusted during final engineering design stages to further avoid and minimize impacts to sensitive resources as practicable.

Table 5.8-4: Approximate Acreages of Functions Affected by Alternative B Project Components

Wetland Function	Total Acreage of Function in Study Area	Ground Disturbance				Potential Disturbance			Total Area Affected (acres)	Total % of Mapped Function Affected
		Gravel Road and Pad Footprints (acres)	Gravel Mine Site Footprint (acres)	Total Area Affected by Excavation or Fill (acres)	% of Mapped Function	Dust, Snow Accumulation, Impoundments, Thermokarst Effects (acres)[a]	Ice Road and Pad Footprints (acres)	% of Mapped Function		
Flood Flow Moderation and Conveyance	18,187	4	0	4	<0.1	37	225	1.4	266	1.5
Shoreline and Bank Stabilization	4,672	1	0	1	<0.1	10	93	2.2	103	2.2
Maintenance of Natural Sediment Transport Processes	14,171	4	0	4	<0.1	33	185	1.5	222	1.6
Production and Export of Organic Matter	18,558	53	29	82	0.4	204	206	2.2	491	2.7
Maintenance of Thermal Regimes	39,641	174	49	223	0.6	481	433	2.3	1,137	2.9
Waterbird Support	36,103	59	35	95	0.3	240	599	2.3	934	2.6
Terrestrial Mammal Support	4,398	0.1	0	0	<0.1	4	81	1.9	85	1.9
Resident and Diadromous Fish Support	24,607	4	0	4	<0.1	51	525	2.3	580	2.4
Threatened or Endangered Species Support: Spectacled Eider	33,158	55	31	86	0.3	228	534	2.3	849	2.6
Threatened or Endangered Species Support: Polar Bear	21,942	12	0	12	0.1	122	497	2.8	630	2.9
Scarce and Valued Habitats	1,999	0	0	0	0.0	11	25	1.8	37	1.8

[a] Adjacent effects of gravel from dust, snow accumulation, impoundments, and thermokarst were calculated using 164 ft perimeter around gravel fill.

5.8.3.4 Alternative B: Summary of Impacts

Alternative B would result in long-term effects to wetlands and vegetation through the placement of gravel fill for roads and pads and from excavation of a gravel mine and from the associated dust shadow, snow accumulation, impoundments, and thermokarst. When combined, these long-term impacts would affect between 0 and 5.0 percent of the total mapped area for each wetland and vegetation type. This meets the moderate magnitude threshold of equal to or greater than 5 percent impact to a specific wetland or vegetation type within the study area (Table 5.8-2). Approximately 5.9 percent of the total area identified as upland or potentially containing a mosaic of wetlands and uplands would be impacted; 46.5 percent of this upland impact area would be classified as existing gravel fill areas. Impacts to wetlands and vegetation could also result from the construction of ice roads. These impacts would be minor and temporary to medium term. Tussock tundra would not be impacted by ice roads and the percentage of drier shrub-dominated communities affected would be between 0.0 and 2.0 percent of the total mapped area for each type.

The effects of water removal, dredge material disposal, hydrostatic test water discharge, and off-road tundra travel have not been quantified but are estimated to be minor. The total acreage of wetland and vegetation affected by trenching and VSM and other support member installation is estimated to total less than one acre for each activity and would also be considered minor. The effects on vegetation and wetlands from altered drainage patterns associated with the gravel airstrip have not been quantified; however the change in drainage area would be 1.8 mi^2.

Through placement of gravel fill and excavation, Alternative B would alter, for the long term, wetland and water body areas that perform diverse ecological functions. Less than 1 percent of the area mapped as performing each function would be affected by ground disturbance. Several functions (the ones largely occurring in floodplains and polar bear habitat) would be affected at <0.1 percent, and areas rated as performing the scarce and valued habitat function would not be affected at all by ground disturbance, according to the evaluation method. Wetland functions would be affected in additional areas by construction of ice infrastructure, and by altered hydrology and deposition of dust and gravel and their subsequent effects. The acreages of these effects, within areas that perform functions, are listed for each function even if an effect is expected to be subtle. Alternative B ice infrastructure and hydrologic and dust-related changes adjacent to fill areas would affect up to 2.8 percent of the functional area of any individual function within the mapped area. The highest percentage of total functional area affected by ground disturbance, adjacent effects, and ice infrastructure is 2.9 percent–the affected percentage of estimated polar bear habitat or area performing the maintenance of thermal regime function.

Table 5.8-5 summarizes the intensity of impacts expected from Alternative B.

Table 5.8-5: Alternative B—Impact Evaluation for Vegetation and Wetlands

Component	Magnitude	Duration	Potential	Extent
Fill Placement (footprint and adjacent) and Gravel Mine[a]	Moderate	Long term	Probable	Local
Ice Infrastructure	Minor	Temporary	Possible	Local
Water Removal	Minor	Medium term	Possible	Limited
Dredge Disposal	Minor	Long term	Probable	Limited
VSMs	Minor	Long term	Probable	Limited
Wastewater Disposal	Minor	Unknown	Possible	Local
Trenching	Minor	Temporary	Probable	Local
Off-road Tundra Travel	Minor	Long term	Possible	Local

[a] Adjacent impacts of fill placement begun in construction would continue through operations

5.8.4 Alternative C: Inland Pads with Gravel Access Road

As it relates to wetlands and vegetation, Alternative C would include multiple project components and activities which have the potential to impact vegetation and wetlands. Detailed descriptions of the project components and sequencing for Alternative C are described in Chapter 2. The project component footprints are overlain on the mapped vegetation types in Figure 5.8-5 through Figure 5.8-8 (Figure 5.8-5 shows an overview of the alternative and Figure 5.8-6 through Figure 5.8-8 show additional detail of project features). Table 5.8-6 identifies the acreage of potentially-affected wetland and vegetation types associated with the footprint and adjacent impacts from Alternative C. Table 5.8-7 identifies the acreage of potentially-affected wetland and water body functions associated with Alternative C, as well as the acreage within a zone adjacent to fills and the gravel mine that might be affected by altered hydrology, dust, and gravel spray.

5.8.4.1 Alternative C: Construction, Drilling, and Operations

The types of impacts associated with construction and operations would be similar under Alternative C to those described for Alternative B, and the discussion for project phases are discussed together under this alternative.

Impacts under Alternative C would occur over a greater spatial extent than Alternative B because the project would extend farther to the south and west. The major difference from Alternative B that affects vegetation and wetlands is that Alternative C would include a 44-mile long gravel road from Point Thomson to the Endicott Spur Road. Gravel mines and associated gravel storage pads would be located approximately every 10 miles along the Endicott-Point Thomson Road. Bridges would be constructed to cross major rivers. The exact design or locations of bridge supports have not been determined or engineered, and the bridged areas were not included as affected acreage in Table 5.8-6.

Barging would not be a component of Alternative C, and dredge material would not be generated or disposed of. Power would be distributed to the pads via cables installed on the pipeline supports and distributed to the airstrip and water supply via cables buried in the infield roads, eliminating the need for trenching into the tundra surface. The export pipeline, collocated with the gravel access road, would be more than twice as long as the pipeline for Alternative B. During construction, two tundra ice roads would be constructed along the pipeline route; a construction ice road for VSM and export pipeline construction and an ice access road for transporting materials, supplies, and modules to and from Point Thomson. The ice access road would have bypass ties to the pipeline construction ice road spaced every mile between the two roads. The needs for ice roads or off-road vehicle travel to maintain the pipeline would be less because the gravel road could be used. Similarly, an ice road connecting Point Thomson and Endicott would not be needed after construction except for after the drilling program to demobilize the drill rig.

Many of the project components would be located farther from the coast than they would be under Alternative B, which would result in some increase in permanent fill acreage to connect more widely dispersed project components. The project components consolidated at the Central Pad under Alternative B would be separated into two pads with a greater total area under Alternative C.

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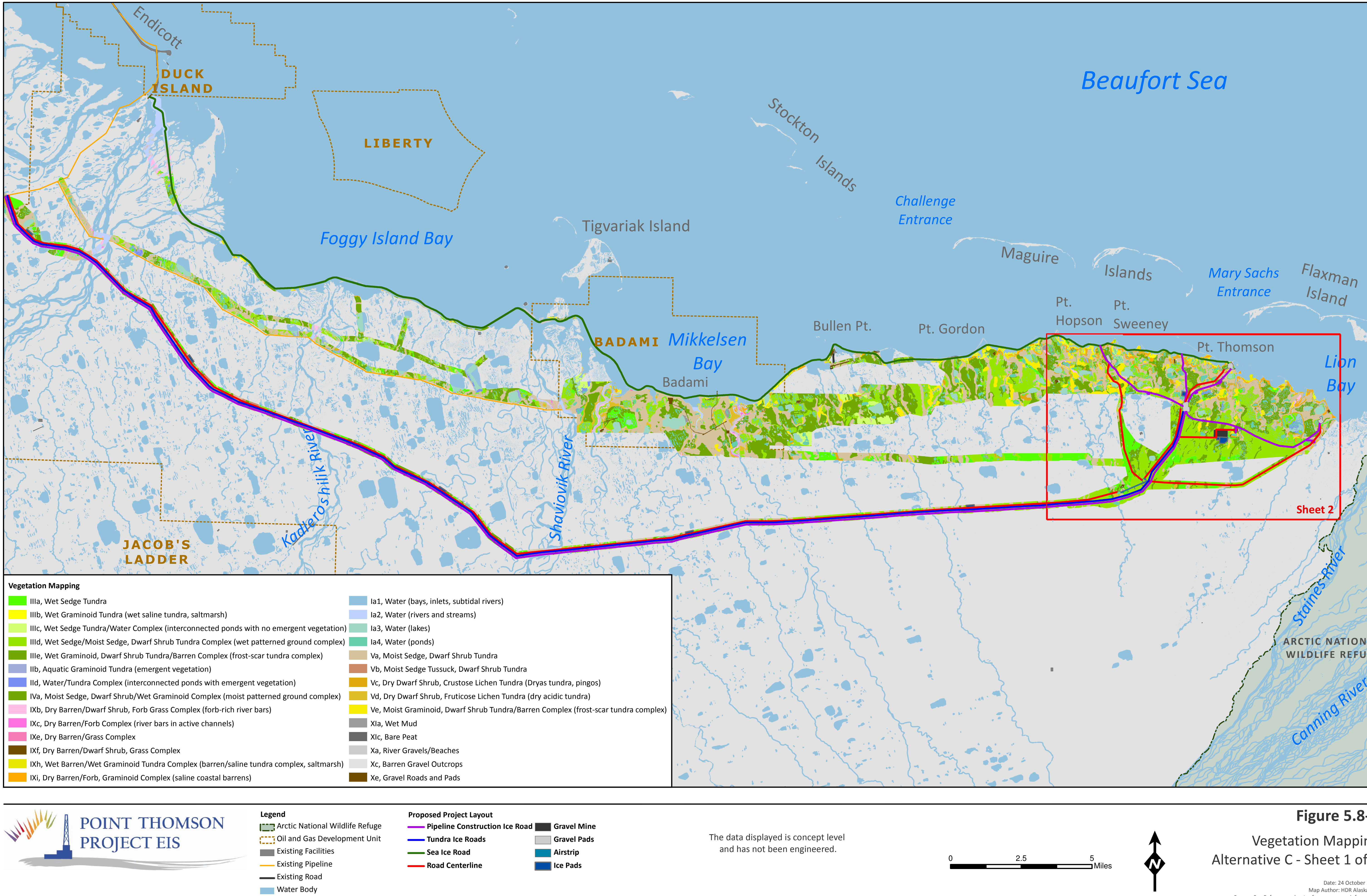

POINT THOMSON PROJECT EIS

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

Figure 5.8-5

Vegetation Mapping
Alternative C - Sheet 1 of 4

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

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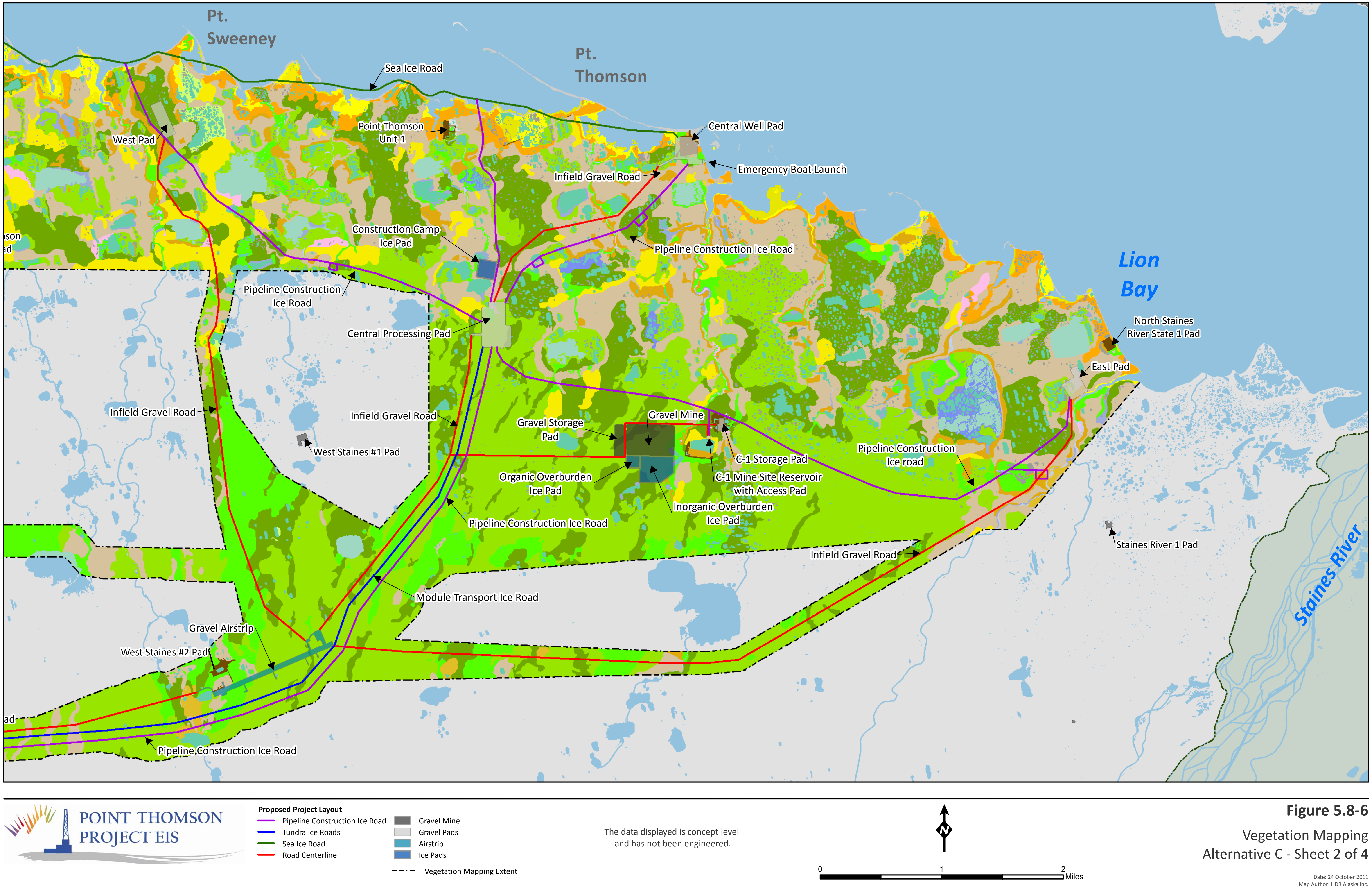

Figure 5.8-6
Vegetation Mapping
Alternative C - Sheet 2 of 4

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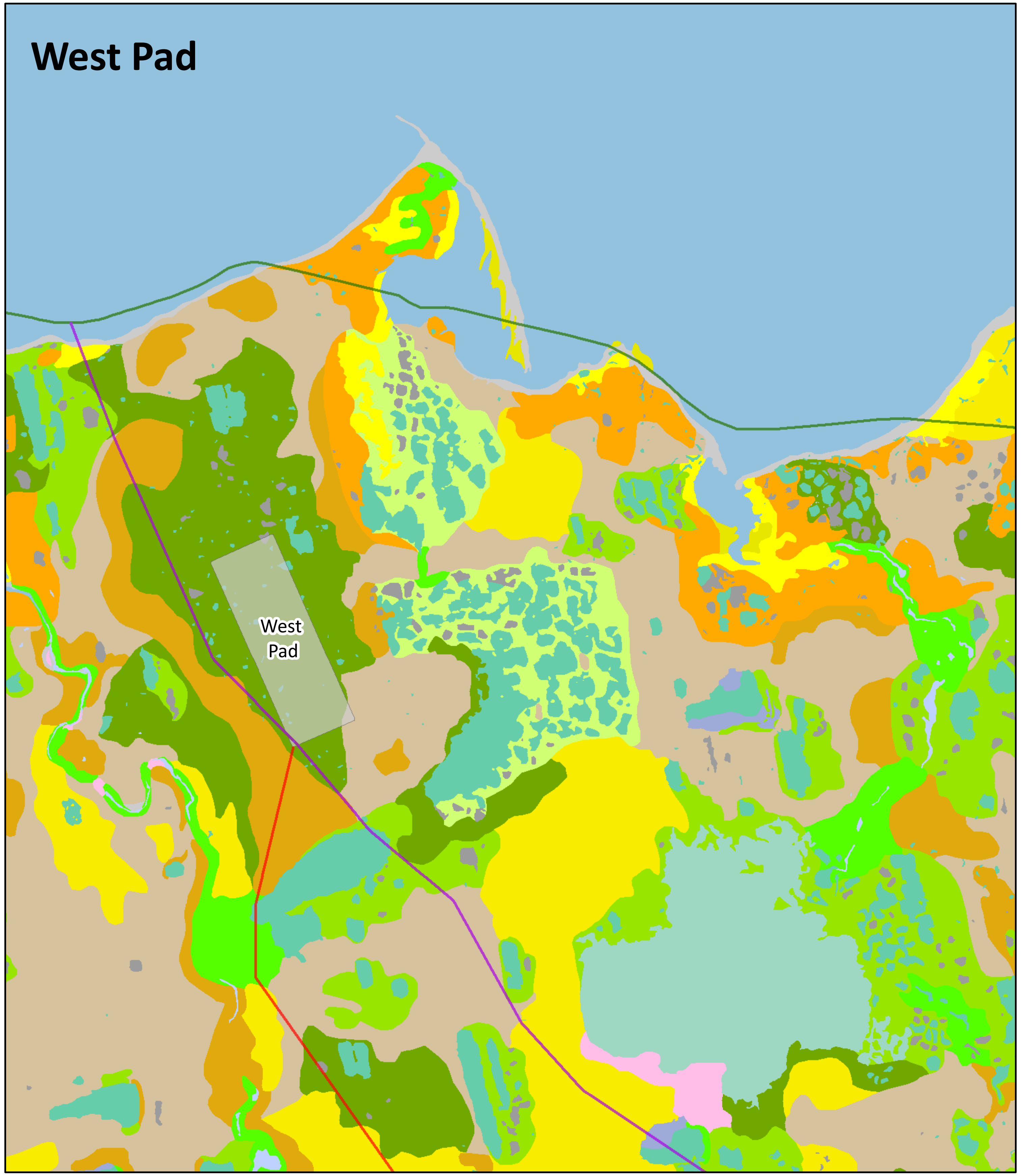

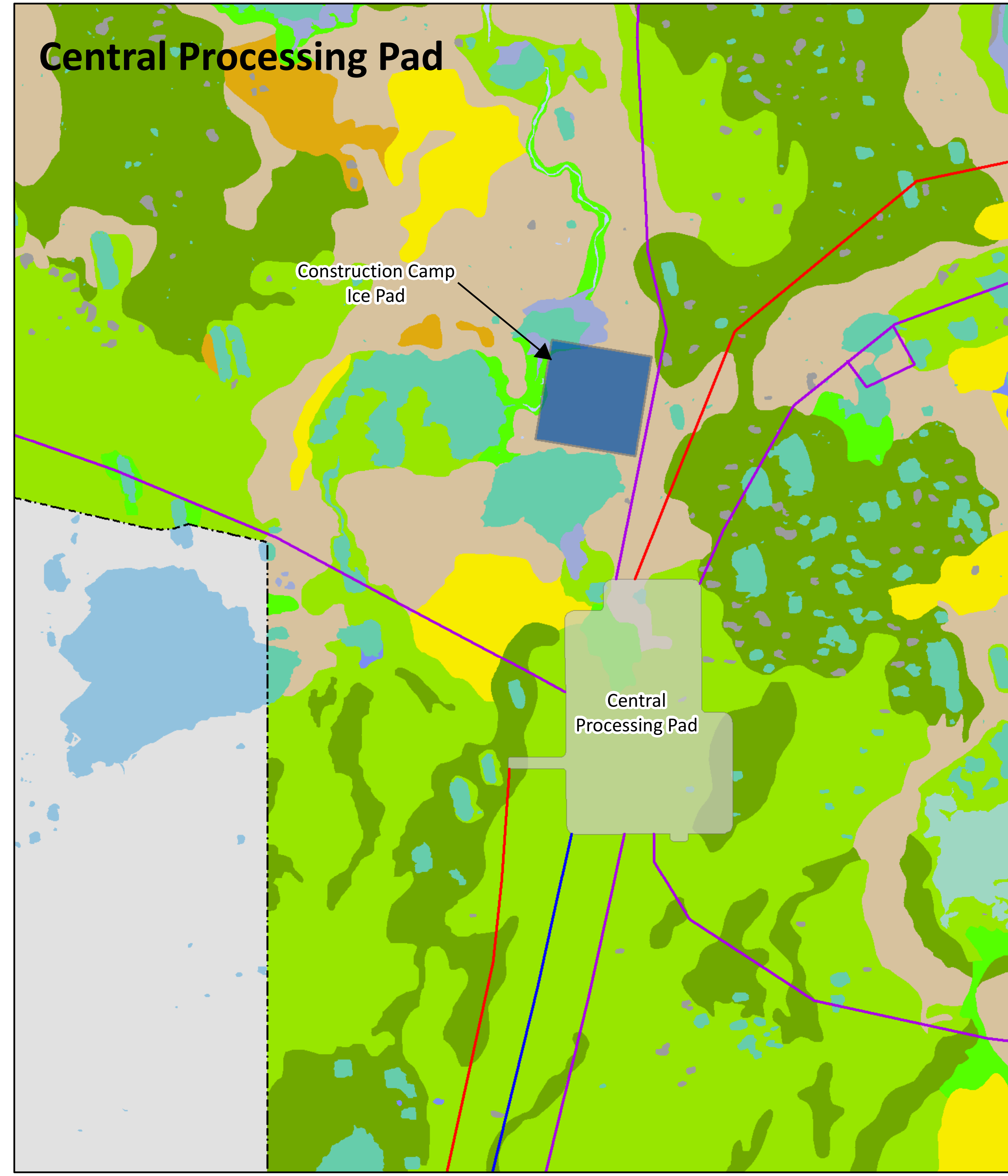

POINT THOMSON PROJECT EIS

Proposed Project Layout

- Pipeline Construction Ice Road
- Tundra Ice Roads
- Sea Ice Road
- Road Centerline
- Vegetation Mapping Extent
- Gravel Mine
- Gravel Pads
- Airstrip
- Ice Pads

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

0 1,000 2,000 Feet

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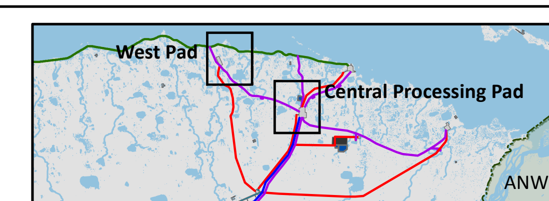

Figure 5.8-7

Vegetation Mapping
Alternative C - Sheet 3 of 4

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Sources: See References chapter for map source information

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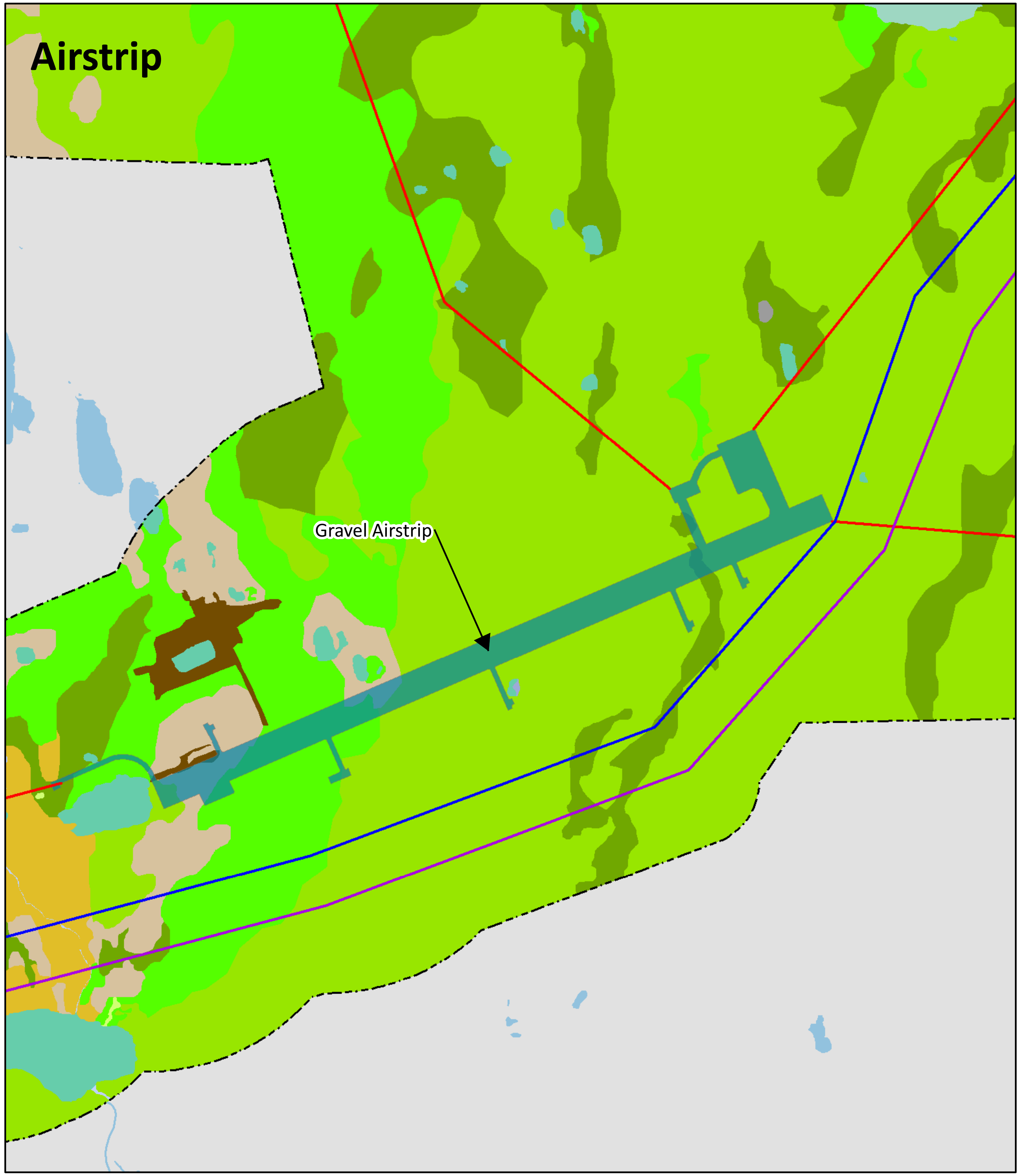

POINT THOMSON PROJECT EIS

Proposed Project Layout

- Pipeline Construction Ice Road
- Tundra Ice Roads
- Sea Ice Road
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- Gravel Mine
- Gravel Pads
- Airstrip
- Ice Pads

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

0 1,000 2,000 Feet

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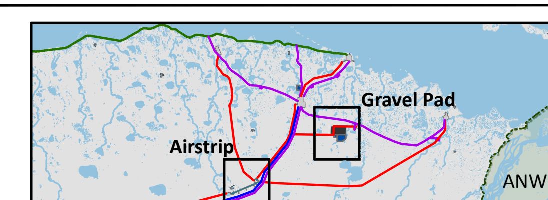

Figure 5.8-8

Vegetation Mapping
Alternative C - Sheet 4 of 4

Date: 24 October 2011
Map Author: HDR Alaska Inc.
Sources: See References chapter for map source information

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Table 5.8-6: Alternative C—Summary of Affected Water Body, Wetland, and Vegetation Types									
			Gravel Roads, Pads, and Mine					Ice Roads and Pads	
Cover Class	Level C Photo Interpreted Map Unit Types	Wetland Type (NWI Codes)	Gravel Roads and Pads (Acres)	Gravel Mine (Acres)	Dust, Snow Accumulation, Impoundments, Thermokarst (Acres)	Total Acres	Percent of Mapped Type Affected	Total Footprint (Acres)	Percent of Mapped Type Affected
Water Bodies	Bays, lagoons, inlets, subtidal rivers (Ia1)	E1UBL = Estuarine, subtidal, unconsolidated bottom, subtidal	0.1	0.0	3.5	3.6	<0.1	314.6	2.9
	Rivers and streams (Ia2)	R1UBV = Riverine, tidal, unconsolidated bottom, permanent tidal influence R2UBH = Riverine, lower perennial, unconsolidated bottom, permanently flooded R3UBH = Riverine, upper perennial, unconsolidated bottom, permanently flooded	8.7	0.6	49.3	58.6	4.6	39.5	3.1
	Lakes (Ia3)	L1UBH = Lacustrine, limnetic, unconsolidated bottom, permanently flooded L2UBH = Lacustrine, littoral, unconsolidated bottom, permanently flooded	3.0	0.0	21.5	24.5	1.3	12.0	0.6
	Ponds (Ia4)	PUBH = Palustrine, unconsolidated bottom, permanently flooded	15.6	4.2	86.7	106.5	3.6	20.6	0.7
Water associated Barrens	River gravels/beaches (Xa)	R3USC = Riverine, upper perennial, unconsolidated shore, seasonally flooded R2USC = Riverine, lower perennial, unconsolidated shore, seasonally flooded E2US1P = Estuarine, intertidal, unconsolidated shore, cobble-gravel, irregularly flooded	5.7	0.0	35.7	41.4	4.2	42.4	4.3
	Wet mud (XIa)	L2USD = Lacustrine, littoral, unconsolidated shore, seasonally flooded/well drained PUSD = Palustrine, unconsolidated shore, seasonally flooded/well drained	1.9	0.0	4.1	6.0	1.8	1.1	0.3
	Bare peat (XIc)	L2USD = Lacustrine, littoral, unconsolidated shore, seasonally flooded/well drained PUSD = Palustrine, unconsolidated shore, seasonally flooded/well drained E2US4P = Estuarine, intertidal, unconsolidated shore, organic, irregularly flooded	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Very Wet Tundra	Aquatic graminoid tundra (IIb)	L2EM2H = Lacustrine, littoral, emergent, nonpersistent, permanently flooded PEM1H = Palustrine, emergent, persistent, permanently flooded	2.9	1.1	16.9	20.9	5.7	3.5	1.0
	Water/tundra complex (IId)	L2UB/EM2H = Lacustrine, littoral, unconsolidated bottom/emergent, nonpersistent, permanently flooded PUB/EM2H = Palustrine, unconsolidated bottom/emergent, nonpersistent, permanently flooded PUB/EM1H = Palustrine, unconsolidated bottom/emergent, persistent, permanently flooded	0.5	0.0	4.8	5.3	2.3	1.4	0.6
Wet Tundra	Wet sedge tundra (IIIa)	PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	78.1	4.4	363.3	445.8	11.6	72.5	1.9
	Wet graminoid tundra (IIIb)	E2EM1N = Estuarine, intertidal, emergent, persistent, regularly exposed E2EM1P = Estuarine, intertidal, emergent, persistent, irregularly flooded	0.5	0.0	2.0	2.5	0.5	5.7	1.0
	Wet sedge tundra/water complex (IIIc)	L2EM2/UBH) = Lacustrine, littoral, emergent, nonpersistent/unconsolidated bottom, permanently flooded PEM1/UBH = Palustrine, emergent, persistent/unconsolidated bottom, permanently flooded	1.2	0.0	7.5	8.7	1.3	5.2	0.8

Table 5.8-6: Alternative C—Summary of Affected Water Body, Wetland, and Vegetation Types

Cover Class	Level C Photo Interpreted Map Unit Types	Wetland Type (NWI Codes)	Gravel Roads, Pads, and Mine: Gravel Roads and Pads (Acres)	Gravel Roads, Pads, and Mine: Gravel Mine (Acres)	Gravel Roads, Pads, and Mine: Dust, Snow Accumulation, Impoundments, Thermokarst (Acres)	Gravel Roads, Pads, and Mine: Total Acres	Gravel Roads, Pads, and Mine: Percent of Mapped Type Affected	Ice Roads and Pads: Total Footprint (Acres)	Ice Roads and Pads: Percent of Mapped Type Affected
Wet tundra (cont.)	Wet sedge/moist Sedge, dwarf shrub tundra complex (IIId)	PSS1/EM1B = Palustrine, scrub shrub, deciduous/emergent, persistent, saturated PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	213.1	56.9	832.4	1,102.4	8.9	247.7	2.0
	Wet graminoid, dwarf shrub tundra/barren complex (IIIe) (frost-scar tundra complex)	PSS1/EM1B = Palustrine, scrub shrub, deciduous/emergent, persistent, saturated PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	1.5	0.1	7.5	9.1	2.7	1.5	0.4
	Wet barren/wet graminoid tundra complex (IXh)	E2USN = Estuarine, intertidal, unconsolidated shore, regularly exposed E2USP = Estuarine, intertidal, unconsolidated shore, irregularly flooded E2EM1P = Estuarine, intertidal, emergent, persistent, irregularly flooded	0.0	0.0	0.0	0.0	0.0	5.0	1.9
Moist Tundra	Moist sedge, dwarf shrub tundra (Va)	PSS1/EM1B = Palustrine, scrub shrub deciduous/emergent, persistent, saturated	131.3	34.2	675.1	840.6	6.7	191.1	1.5
	Moist tussock sedge, dwarf shrub tundra (Vb)	PEM1/SS1B = Palustrine, emergent, persistent/scrub shrub, deciduous, saturated	10.0	2.0	56.4	68.4	26.3	18.3	7.0
	Moist graminoid, dwarf shrub tundra/barren complex (Ve)	PSS1/EM1B = Palustrine, scrub shrub deciduous/emergent, persistent, saturated	7.7	0.0	36.6	44.3	3.2	5.2	0.4
Moist/Wet Tundra Complex	Moist sedge, dwarf shrub/wet graminoid Tundra Complex (IVa)	PSS1/EM1B = Palustrine, scrub shrub, deciduous/emergent, persistent, saturated PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	98.6	24.0	417.4	540.0	5.0	117.2	1.1
Dry Tundra	Dry dwarf shrub, crustose lichens (Vc)	Upland PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	10.9	0.0	35.6	46.5	6.3	7.7	1.0
	Dry dwarf shrub, fruticose Lichens (Vd)	Upland PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	2.4	0.0	14.2	16.6	2.9	4.1	0.7

Table 5.8-6: Alternative C—Summary of Affected Water Body, Wetland, and Vegetation Types									
			Gravel Roads, Pads, and Mine					Ice Roads and Pads	
Cover Class	Level C Photo Interpreted Map Unit Types	Wetland Type (NWI Codes)	Gravel Roads and Pads (Acres)	Gravel Mine (Acres)	Dust, Snow Accumulation, Impoundments, Thermokarst (Acres)	Total Acres	Percent of Mapped Type Affected	Total Footprint (Acres)	Percent of Mapped Type Affected
Dry Tundra (cont'd)	Dry barren/dwarf shrub, forb-grass complex (IXb)	Upland PSS1/EM1A = Palustrine, scrub shrub, deciduous/emergent, persistent, temporarily flooded	0.6	0.0	3.4	4.0	1.1	4.7	1.3
	Dry barren/ forb complex (IXc)	R2USC = Riverine, lower perennial, unconsolidated shore, seasonally flooded	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dry barren/grass complex (IXe)	Upland	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Dry barren/dwarf shrub, grass complex (IXf)	Upland	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dry barren/forb-graminoid complex (IXi)	PSS5/EM1J = Palustrine, scrub shrub, dead/emergent, persistent, intermittently flooded	1.5	0.0	2.6	4.1	0.7	4.0	0.7
Disturbed Barrens	Barren gravel outcrops (Xc)	Disturbed wetland/unknown	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gravel roads and pads (Xe)[a]	Upland/unknown	18.4	0.0	7.3	25.7	13.3	0.9	0.5
		Total area affected	614.2	127.5	2,683.8	3,425.5	5.3	1,125.9	1.7
		Total area of water bodies affected	35.0	4.8	200.8	240.6	1.3	430.3	2.3
		Total area of wetlands affected	560.8	122.7	2,475.7	3,159.2	6.9	694.7	1.5
		Total area of upland affected	18.4	0.0	7.3	25.7	12.5	0.9	0.4

[a] Impacts to Xe indicates previously permitted fill areas.

Notes:

Emergency response boat launch footprint included in gravel roads and pads footprint.

Exact locations and alignments of project components would be adjusted during final engineering design stages to further avoid and minimize impacts to sensitive resources as practicable.

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Table 5.8-7: Approximate Acreages of Functions Affected by Alternative C Project Components

Wetland Function	Total Acreage of Function in Study Area	Ground Disturbance				Potential Disturbance			Total Area Affected (acres)	Total % of Mapped Function Affected
		Gravel Road and Pad Footprints (acres)	Gravel Mine Site Footprint (acres)	Total Area Affected by Excavation or Fill (acres)	% of Mapped Function	Dust, Snow Accumulation, Impoundments, Thermokarst Effects (acres)a	Ice Road and Pad Footprints (acres)	% of Mapped Function		
Flood Flow Moderation and Conveyance	18,187	141	5	146	0.8	790	283	5.9	1,219	6.7
Shoreline and Bank Stabilization	4,672	26	1	27	0.6	149	92	5.2	268	5.7
Maintenance of Natural Sediment Transport Processes	14,171	107	5	112	0.8	603	221	5.8	936	6.6
Production and Export of Organic Matter	18,558	207	51	258	1.4	977	314	7.0	1,549	8.4
Maintenance of Thermal Regimes	39,641	588	65	653	1.7	2,374	651	7.6	3,678	9.3
Waterbird Support	36,103	272	51	323	0.9	1,376	743	5.9	2,441	6.8
Terrestrial Mammal Support	4,398	53	0	53	1.2	295	123	9.5	471	10.7
Resident and Diadromous Fish Support	24,607	95	5	100	0.4	544	544	4.4	1,188	4.8
Threatened or Endangered Species Support: Spectacled Eider	33,158	263	51	314	1.0	1,319	684	6.0	2,317	7.0
Threatened or Endangered Species Support: Polar Bear	21,942	12	0	12	0.1	115	378	2.3	505	2.3
Scarce and Valued Habitats	1,999	4	1	5	0.3	27	20	2.3	52	2.6

[a] Adjacent effects of gravel from dust, snow accumulation, impoundments, and thermokarst were calculated using 164 ft perimeter around gravel fill.

5.8.4.2 Alternative C: Summary of Impacts

The acreage affected by gravel fill under Alternative C would be approximately 2.7 times greater than the acreage affected under Alternative B. Similarly, the acreage that would be affected by changes in drainage, dust production, thermokarst, and snow accumulation resulting from gravel fills would be approximately 4.4 times greater than the acreage affected under Alternative B. The greater area of gravel fill would necessitate a greater area of gravel mine, which would be approximately 2.2 times as great. When combined, these probable long-term impacts would affect between 0 and 26 percent of the total mapped area for each wetland and vegetation type. This exceeds the major magnitude threshold of greater than 25 percent impact to a specific wetland or vegetation type within the study area (Table 5.8-1). The potential for these impacts to occur would be probable. Approximately 7.7 percent of the total area identified as upland or potentially containing a mosaic of wetlands and uplands would be impacted; 27.7 percent of this upland impact area would be classified as existing gravel fill areas.

The all-season gravel road traverses the predominant hydraulic gradient and wind direction for a greater extent than the gravel infrastructure associated with any other alternative. The road would have greater potential to impound sheet flow and water moving through the active layer, and would pose an increased risk of dust and gravel migration onto tundra vegetation. The adjacent effects from the gravel road could be considered extensive, due to the exacerbated potential for surface water impoundments and potential initiation of thermokarst on the up-gradient side of the road. Because a permanent gravel road would connect Point Thomson to Alaska's road system, the risk of nonnative plant species establishment within the project area and the Arctic Refuge would be greater, and it would continue to be high for the life of the road. The potential long-term effects from the placement of gravel fill, the adjacent effects associated with fill placement, together with the greater area of gravel mine and the increased risk of nonnative plant species establishment, would result in the greatest impact to vegetation and wetlands among all alternatives (Table 5.8-1).

Impacts to wetlands and vegetation could also result from the construction of ice roads. These impacts would be local in extent and temporary in duration (Table 5.8-1 and Table 5.8-8). Approximately 7 percent of the tussock tundra mapped within the study area could be affected by ice roads. The percentage of drier shrub-dominated communities affected would be between 0 and 1.5 percent of the total mapped area for each type.

The effects of water withdrawal, hydrostatic test water discharge, and off-road tundra travel have not been quantified but are estimated to be minor. The total acreage of wetland and vegetation affected by VSM and other support member installation is estimated to total less than one acre and would also be considered minor (Table 5.8-1 and Table 5.8-8). The effects on vegetation and wetlands from altered drainage patterns associated with the gravel airstrip have not been quantified; however the change in drainage area would be approximately two times greater than the area altered under Alternative B.

Through placement of gravel fill and excavation, Alternative C would alter, for the long term, wetland and water body areas that perform diverse ecological functions. Less than 1.7 percent of the area mapped as performing each function would be affected by ground disturbance. Wetland functions would be affected in additional areas by construction of ice infrastructure, and by altered hydrology and deposition of dust and gravel and their subsequent effects. The acreages of these effects, within areas that perform functions, are listed for each function even if an effect is expected to be subtle. Alternative C ice infrastructure and hydrologic and dust-related changes adjacent to fill areas would affect up to 9.5 percent of the functional area of any individual function. The highest percentage of total functional area affected by ground disturbance, adjacent effects, and ice infrastructure is 10.7 percent–the affected percentage of the area estimated to provide terrestrial mammal support (specific brown bear, caribou, and muskoxen habitats). These estimated areas of wetland and water body functional changes are great enough to have moderate magnitude effects, some of which would be long-term, probable, and extensive.

Table 5.8-8 summarizes the intensity of impacts expected from Alternative C.

Table 5.8-8: Alternative C—Impact Evaluation for Wetlands and Vegetation

Component	Magnitude	Duration	Potential	Extent
Fill Placement (footprint and adjacent) and Gravel Mines[a]	Major	Long term	Probable	Extensive
Ice Infrastructure	Moderate	Temporary	Possible	Local
Water Removal	Minor	Medium term	Possible	Limited
VSMs	Minor	Long term	Probable	Limited
Wastewater Disposal	Minor	Unknown	Possible	Local
Off-road Tundra Travel	Minor	Long term	Possible	Local

[a] Adjacent impacts of fill placement begun in construction would continue through operations

5.8.5 Alternative D: Inland Pads with Seasonal Ice Access Road

Alternative D includes multiple project components and activities that have the potential to impact wetlands and vegetation. Detailed descriptions of the project components and sequencing for Alternative D are described in Chapter 2. Figure 5.8-9 through Figure 5.8-12 show the project component footprints overlain on the mapped vegetation types (Figure 5.8-9 shows an overview of the alternative and Figure 5.8-10 through Figure 5.8-12 show additional detail of project features). Table 5.8-9 identifies the acreage of the potentially-affected wetland and vegetation types associated with the direct and indirect impacts from Alternative D. Table 5.8-7 identifies the acreage of potentially-affected wetland and water body functions associated with Alternative D, as well as the acreage within a zone adjacent to fills and the gravel mine that might be affected by altered hydrology, dust, and gravel spray.

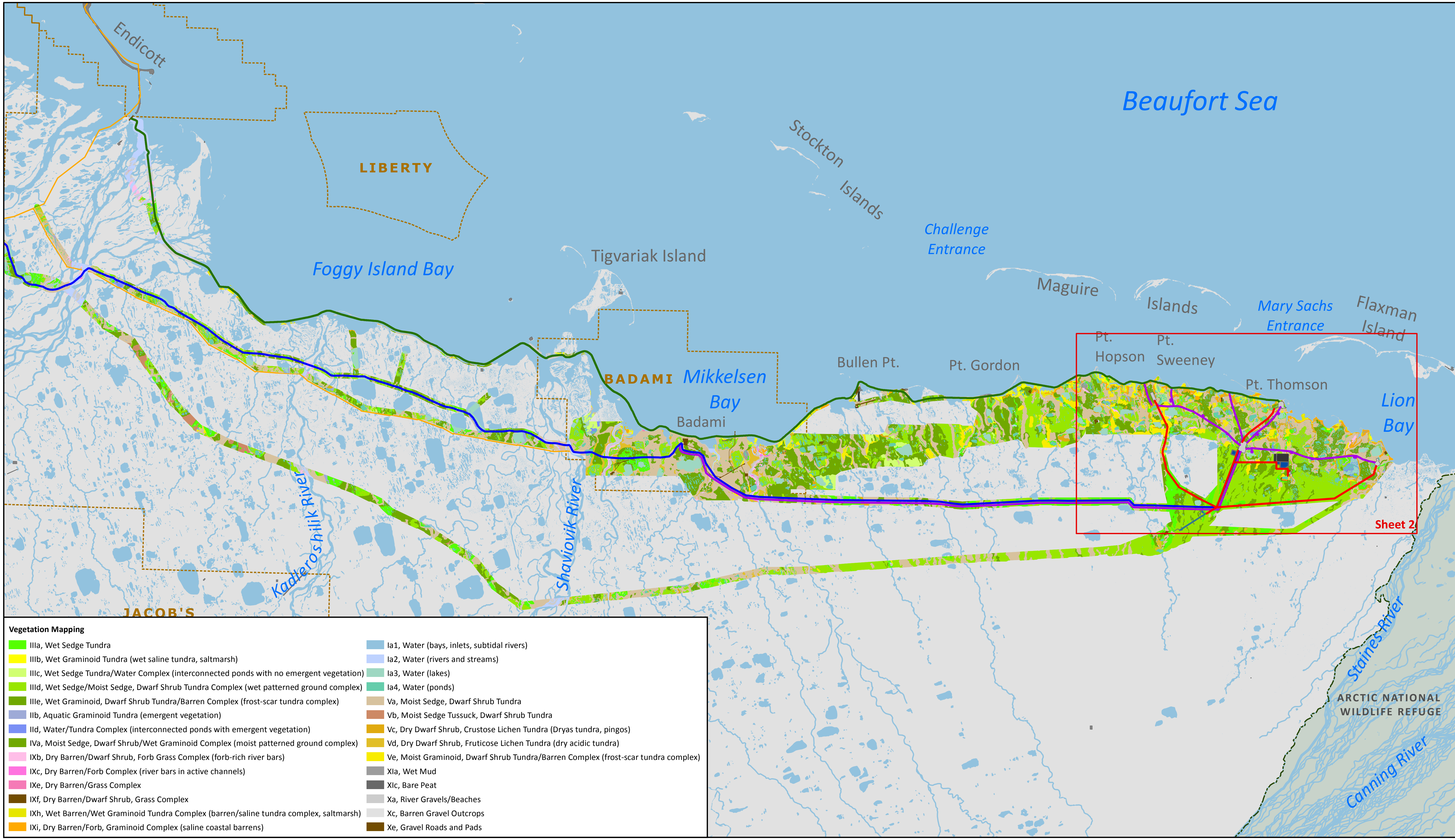
5.8.5.1 Alternative D: Construction, Drilling, and Operations

The types of impacts associated with construction and operations would be similar under Alternative D to those described for Alternative B, and the discussion for project phases are discussed together under this alternative.

Impacts under Alternative D would occur over a greater area than Alternative B because the project would extend farther to the south. Some of the project components at Point Thomson would be shifted inland relative to Alternative B, with the result that longer roads would be needed to connect the components and a larger gravel mine area. The activities consolidated at the Central Pad under Alternative B would be split into two pads, with a larger total area under Alternative D. Alternative D would not include barge facilities, but would include an ice road to connect Endicott and Point Thomson for more years during operations. As a result, Alternative D would have greater effects associated with gravel fill, gravel mining, operation, maintenance of roads and pads, and ice roads than would Alternative B.

Under Alternative D, the gravel mine would be the primary water source for the project during operations. To fill the mine site with water, a diversion channel would be constructed to intersect and capture spring/early summer breakup flows from Stream 24 for approximately 3 years. During this period, up to 80 percent of the breakup flood volume of Stream 24 would be diverted into the new reservoir. The diversion channel would be set at an elevation such that it would divert water only at higher stages of flow (i.e., spring breakup). Therefore, it would not divert water during the summer. Diversion of flows during breakup for this time period would be expected to have a negligible effect on downstream vegetation and wetland communities and on wetland functions, except for the maintenance of natural sediment transport processes function. This is because during breakup the active layer has not yet thawed and vegetation still remains dormant. Downstream wetlands would most likely be recharged by surface water from snow melt perched above permafrost, rather than from overflow from the stream. However, diversion of spring breakup flood flow from Stream 24 could prevent channel forming flows from maintaining the existing sediment transport processes during the period the mine is being filled (3 years).

Alternative D would not require the coastal dredging and dredged material disposal needed under Alternative B. The majority of the power cables would be installed on the pipeline supports and distributed to the airstrip and water supply via cables buried in the tundra and trenched approximately 180 feet to the airstrip. The impacts from trenching into the tundra surface would be approximately two orders of magnitude less than Alternative B.



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

- Pipeline Construction Ice Road
- Tundra Ice Roads
- Sea Ice Road
- Road Centerline
- Airstrip
- Gravel Pads
- Ice Pads
- Mine

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

0 2.5 5 Miles

N

Figure 5.8-9

Vegetation Mapping
Alternative D - Sheet 1 of 4

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

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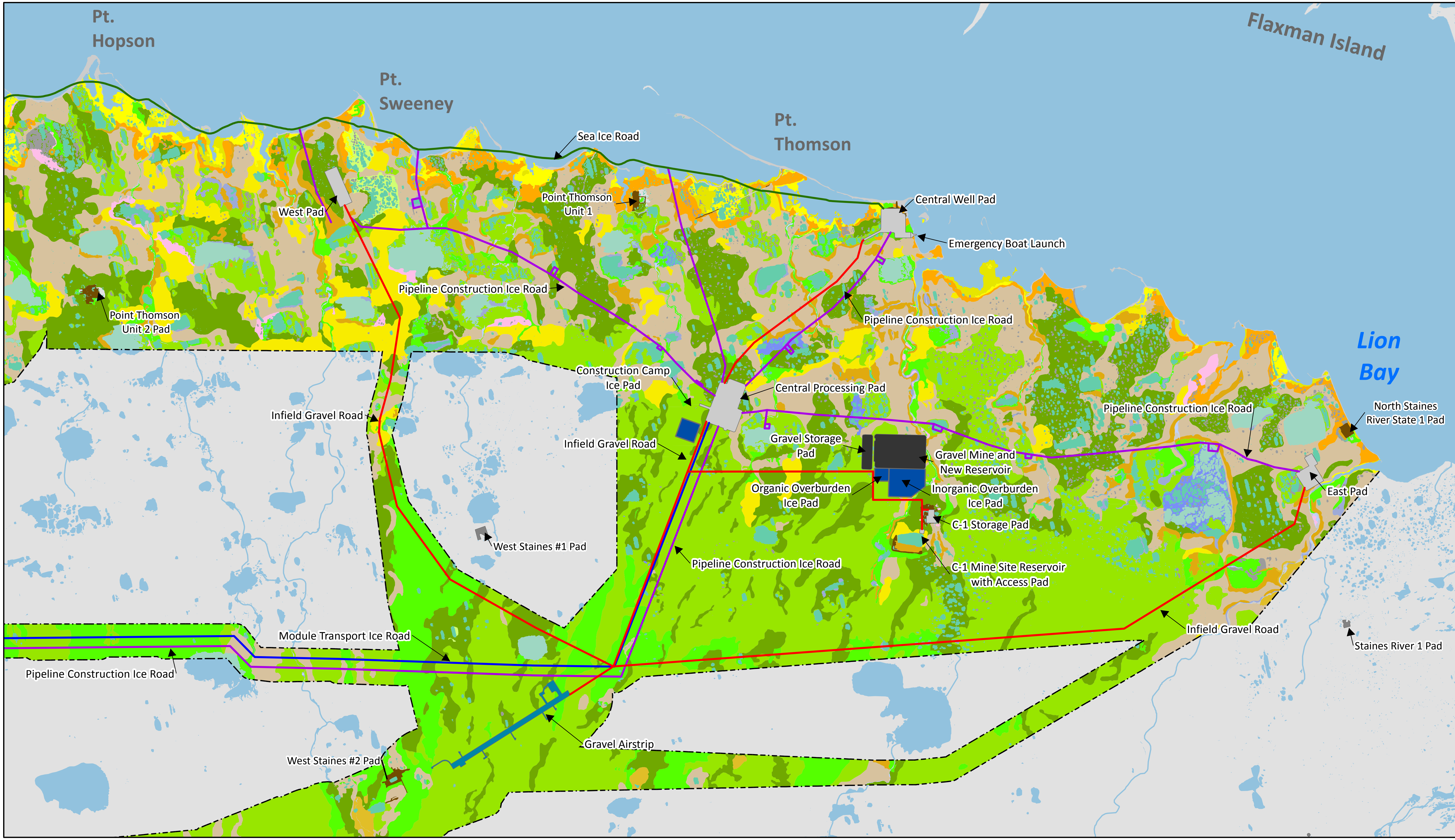

POINT THOMSON PROJECT EIS

Proposed Project Layout

- Pipeline Construction Ice Road
- Tundra Ice Roads
- Sea Ice Road
- Road Centerline
- Airstrip
- Gravel Pads
- Ice Pads
- Mine
- Vegetation Mapping Extent

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

Figure 5.8-10

Vegetation Mapping
Alternative D - Sheet 2 of 4

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

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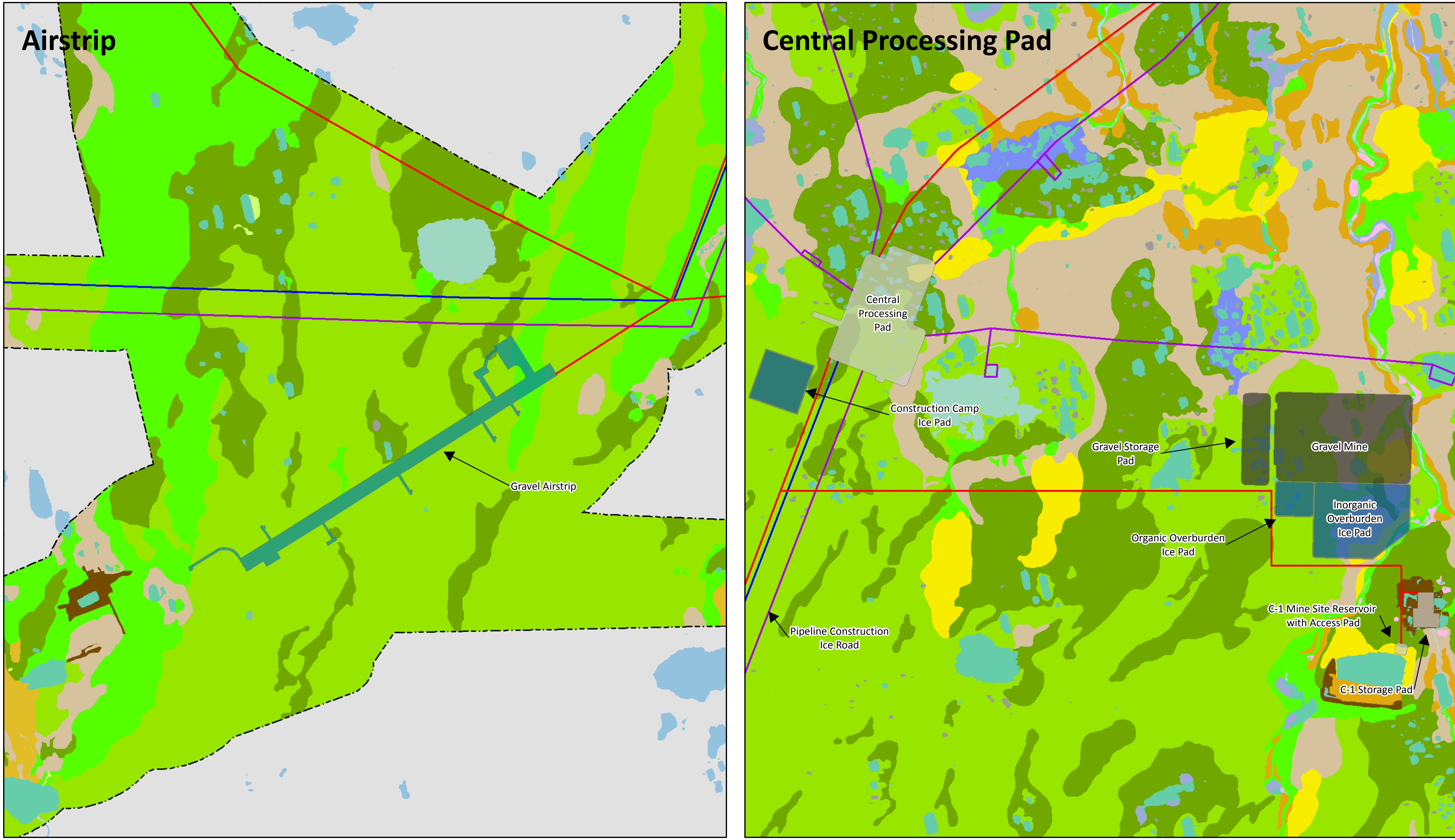

POINT THOMSON
PROJECT EIS

Proposed Project Layout

- Pipeline Construction Ice Road
- Tundra Ice Roads
- Sea Ice Road
- Road Centerline
- Vegetation Mapping Extent
- Airstrip
- Gravel Pads
- Ice Pads
- Mine

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

0 1,500 3,000
Feet

N

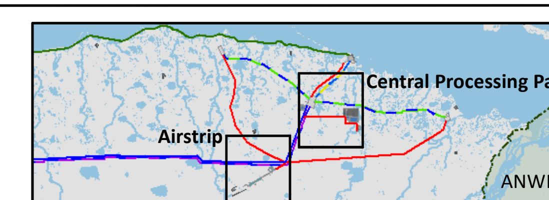

Figure 5.8-11

Vegetation Mapping
Alternative D - Sheet 3 of 4

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

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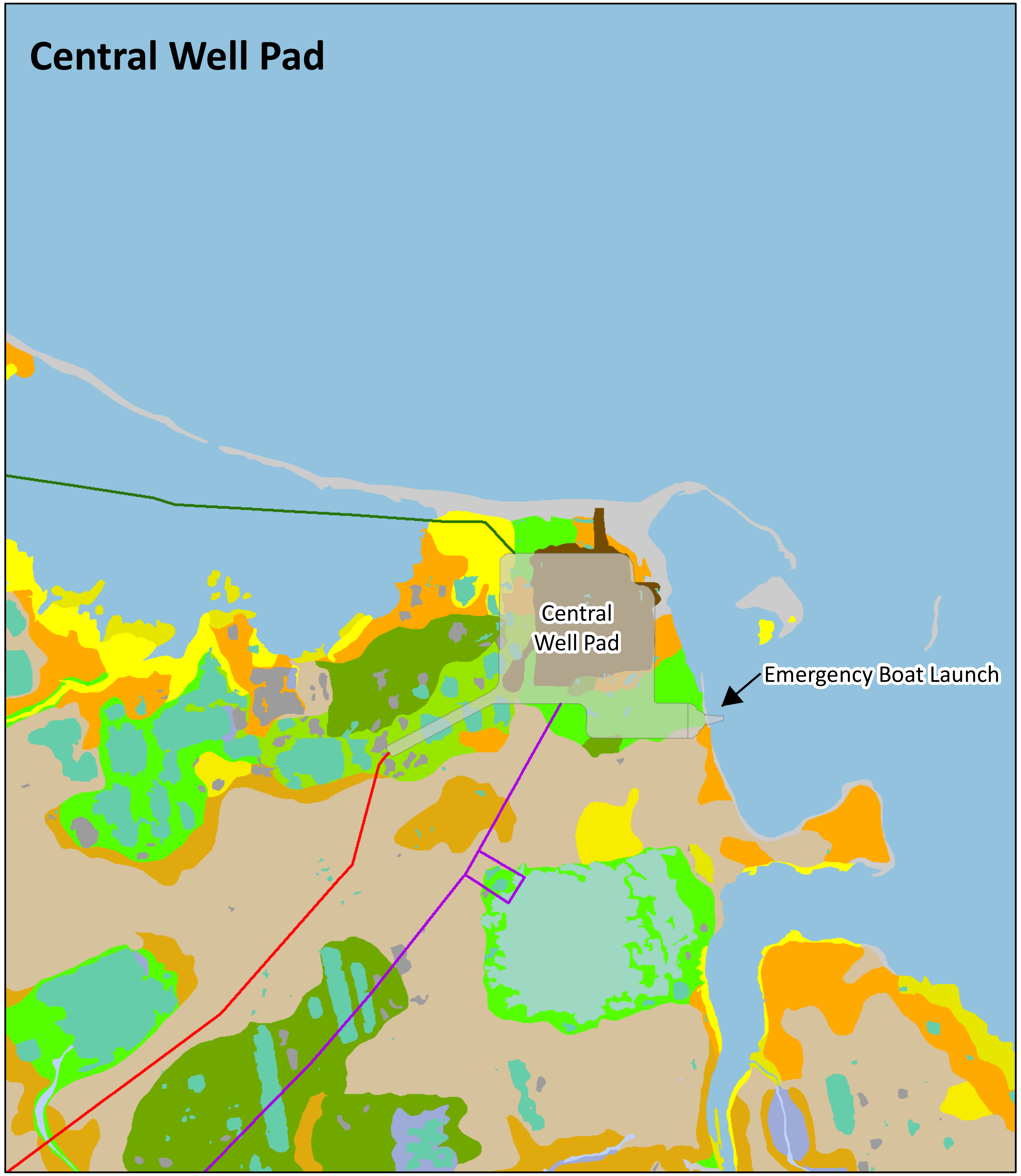

POINT THOMSON
PROJECT EIS

Proposed Project Layout

- Pipeline Construction Ice Road
- Tundra Ice Roads
- Sea Ice Road
- Road Centerline
- Vegetation Mapping Extent
- Airstrip
- Gravel Pads
- Ice Pads
- Mine

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

0 1,000 2,000
Feet

N

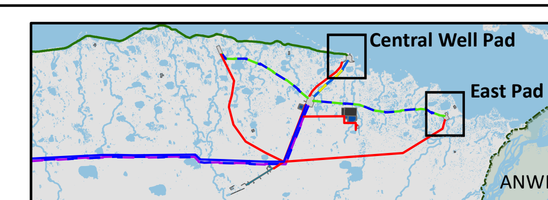

Figure 5.8-12
Vegetation Mapping
Alternative D - Sheet 4 of 4

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

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Table 5.8-9: Alternative D—Summary of Affected Water Body, Wetland, and Vegetation Types

Cover Class	Level C Photo Interpreted Map Unit Types	Wetland Type (NWI Codes)	Gravel Roads, Pads, and Mine: Gravel Roads and Pads (Acres)	Gravel Roads, Pads, and Mine: Gravel Mine (Acres)	Gravel Roads, Pads, and Mine: Dust, Snow Accumulation, Impoundments, Thermokarst (Acres)	Gravel Roads, Pads, and Mine: Total Acres	Gravel Roads, Pads, and Mine: Percent of Mapped Type Affected	Ice Roads and Pads: Total Footprint (Acres)	Ice Roads and Pads: Percent of Mapped Type Affected
Water Bodies	Bays, lagoons, inlets, subtidal rivers (Ia1)	E1UBL = Estuarine, subtidal, unconsolidated bottom, subtidal	0.1	0.0	3.5	3.6	<0.1	315.3	2.9
	Rivers and streams (Ia2)	R1UBV = Riverine, tidal, unconsolidated bottom, permanent tidal influence R2UBH = Riverine, lower perennial, unconsolidated bottom, permanently flooded R3UBH = Riverine, upper perennial, unconsolidated bottom, permanently flooded	0.0	0.2	0.5	0.7	<0.1	31.6	2.5
	Lakes (Ia3)	L1UBH = Lacustrine, limnetic, unconsolidated bottom, permanently flooded L2UBH = Lacustrine, littoral, unconsolidated bottom, permanently flooded	0.0	0.0	0.0	0.0	0.0	9.7	0.5
	Ponds (Ia4)	PUBH = Palustrine, unconsolidated bottom, permanently flooded	11.3	4.1	27.5	42.9	1.5	21.3	0.7
Water - associated Barrens	River gravels/beaches (Xa)	R3USC = Riverine, upper perennial, unconsolidated shore, seasonally flooded R2USC = Riverine, lower perennial, unconsolidated shore, seasonally flooded E2US1P = Estuarine, intertidal, unconsolidated shore, cobble-gravel, irregularly flooded	0.0	0.2	1.8	2.0	0.2	39.5	4.0
	Wet mud (XIa)	L2USD = Lacustrine, littoral, unconsolidated shore, seasonally flooded/well drained PUSD = Palustrine, unconsolidated shore, seasonally flooded/well drained	2.6	0.5	5.6	8.7	2.7	2.3	0.7
	Bare peat (XIc)	L2USD = Lacustrine, littoral, unconsolidated shore, seasonally flooded/well drained PUSD = Palustrine, unconsolidated shore, seasonally flooded/well drained E2US4P = Estuarine, intertidal, unconsolidated shore, organic, irregularly flooded	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Very Wet Tundra	Aquatic graminoid tundra (IIb)	L2EM2H = Lacustrine, littoral, emergent, nonpersistent, permanently flooded PEM1H = Palustrine, emergent, persistent, permanently flooded	0.1	0.0	1.0	1.1	0.3	4.2	1.1
	Water/tundra complex (IId)	L2UB/EM2H = Lacustrine, littoral, unconsolidated bottom/emergent, nonpersistent, permanently flooded PUB/EM2H = Palustrine, unconsolidated bottom/emergent, nonpersistent, permanently flooded PUB/EM1H = Palustrine, unconsolidated bottom/emergent, persistent, permanently flooded	0.0	0.0	0.3	0.3	0.1	3.8	1.6
Wet Tundra	Wet sedge tundra (IIIa)	PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	34.0	0.6	146.1	180.7	4.7	71.3	1.9
	Wet graminoid tundra (IIIb)	E2EM1N = Estuarine, intertidal, emergent, persistent, regularly exposed E2EM1P = Estuarine, intertidal, emergent, persistent, irregularly flooded	0.5	0.0	2.0	2.5	0.5	5.7	1.0
	Wet sedge tundra/water complex (IIIc)	L2EM2/UBH) = Lacustrine, littoral, emergent, nonpersistent/unconsolidated bottom, permanently flooded PEM1/UBH = Palustrine, emergent, persistent/unconsolidated bottom, permanently flooded	0.0	0.0	0.0	0.0	0.0	4.3	0.6
	Wet sedge/moist sedge, dwarf shrub tundra complex (IIId)	PSS1/EM1B = Palustrine, scrub shrub, deciduous/emergent, persistent, saturated PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	113.8	32.3	324.8	470.9	3.8	127.0	1.0
	Wet graminoid, dwarf shrub tundra/barren complex (IIIe) (frost-scar tundra complex)	PSS1/EM1B = Palustrine, scrub shrub, deciduous/emergent, persistent, saturated PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	0.9	0.0	3.8	4.7	1.4	2.8	0.8
	Wet barren/wet graminoid tundra complex (IXh)	E2USN = Estuarine, intertidal, unconsolidated shore, regularly exposed E2USP = Estuarine, intertidal, unconsolidated shore, irregularly flooded E2EM1P = Estuarine, intertidal, emergent, persistent, irregularly flooded	0.0	0.0	0.0	0.0	0.0	5.1	2.0

Table 5.8-9: Alternative D—Summary of Affected Water Body, Wetland, and Vegetation Types

Cover Class	Level C Photo Interpreted Map Unit Types	Wetland Type (NWI Codes)	Gravel Roads, Pads, and Mine: Gravel Roads and Pads (Acres)	Gravel Roads, Pads, and Mine: Gravel Mine (Acres)	Gravel Roads, Pads, and Mine: Dust, Snow Accumulation, Impoundments, Thermokarst (Acres)	Gravel Roads, Pads, and Mine: Total Acres	Gravel Roads, Pads, and Mine: Percent of Mapped Type Affected	Ice Roads and Pads: Total Footprint (Acres)	Ice Roads and Pads: Percent of Mapped Type Affected
Moist Tundra	Moist sedge, dwarf shrub tundra (Va)	PSS1/EM1B = Palustrine, scrub shrub deciduous/emergent, persistent, saturated	28.7	19.1	99.9	147.7	1.2	134.7	1.1
	Moist tussock sedge, dwarf shrub tundra (Vb)	PEM1/SS1B = Palustrine, emergent, persistent/scrub shrub, deciduous, saturated	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Moist graminoid, dwarf shrub tundra/barren complex (Ve)	PSS1/EM1B = Palustrine, scrub shrub deciduous/emergent, persistent, saturated	9.4	7.0	41.8	58.2	4.1	7.7	0.5
Moist/Wet Tundra Complex	Moist sedge, dwarf shrub/wet graminoid tundra complex (IVa)	PSS1/EM1B = Palustrine, scrub shrub, deciduous/emergent, persistent, saturated PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	60.6	0.3	160.1	221.0	2.1	83.8	0.8
Dry Tundra	Dry dwarf shrub, crustose lichens (Vc)	Upland PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	6.3	1.1	12.9	20.3	2.7	6.4	0.9
	Dry dwarf shrub, fruticose lichens (Vd)	Upland PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	0.0	0.0	0.0	0.0	0.0	1.9	0.3
	Dry barren/dwarf shrub, forb-grass complex (IXb)	Upland PSS1/EM1A = Palustrine, scrub shrub, deciduous/emergent, persistent, temporarily flooded	0.0	0.4	0.5	0.9	0.2	4.8	1.3
	Dry barren/ forb complex (IXc)	R2USC = Riverine, lower perennial, unconsolidated shore, seasonally flooded	0.0	0.0	0.0	0.0	0.0	1.3	2.4
	Dry barren/grass complex (IXe)	Upland	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Dry barren/dwarf shrub, grass complex (IXf)	Upland	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dry barren/forb-graminoid complex (IXi)	PSS5/EM1J = Palustrine, scrub shrub, dead/emergent, persistent, intermittently flooded	1.5	0.0	2.6	4.1	0.7	4.6	0.8
Disturbed Barrens	Barren gravel outcrops (Xc)	Disturbed wetland/unknown	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gravel roads and pads (Xe)[a]	Upland/unknown	19.0	0.0	7.8	26.8	13.9	0.9	0.5
		Total area affected	288.8	65.8	842.5	1,197.1	1.9	890.0	1.4
		Total area of water bodies affected	14.0	5.0	38.9	57.9	0.3	419.8	2.3
		Total area of wetlands affected	255.8	60.8	795.8	1112.4	2.4	469.5	1.0
		Total area of upland affected	19.0	0.0	7.8	26.8	13.1	0.9	0.5

[a] Impacts to Xe indicates previously permitted fill areas

Notes:

Emergency response boat launch footprint included in gravel roads and pads footprint.

Potential impacts from trenching for buried power cables would disturb <0.1 acre of tundra surface

Exact locations and alignments of project components would be adjusted during final engineering design stages to further avoid and minimize impacts to sensitive resources as practicable.

Table 5.8-10: Approximate Acreages of Functions Affected by Alternative D Project Components

Wetland Function	Total Acreage of Function in Study Area	Ground Disturbance				Potential Disturbance			Total Area Affected (acres)	Total % of Mapped Function Affected
		Gravel Road and Pad Footprints (acres)	Gravel Mine Site Footprint (acres)	Total Area Affected by Excavation or Fill (acres)	% of Mapped Function	Dust, Snow Accumulation, Impoundments, Thermokarst Effects (acres)[a]	Ice Road and Pad Footprints (acres)	% of Mapped Function		
Flood Flow Moderation and Conveyance	18,187	8	1	9	0.1	53	204	1.4	266	1.5
Shoreline and Bank Stabilization	4,672	1	1	2	<0.1	7	85	2.0	94	2.0
Maintenance of Natural Sediment Transport Processes	14,171	7	1	9	0.1	48	179	1.6	236	1.7
Production and Export of Organic Matter	18,558	82	31	113	0.6	383	241	3.4	737	4.0
Maintenance of Soil Thermal Regime	39,641	237	52	289	0.7	731	420	2.9	1,440	3.6
Waterbird Support	36,103	106	37	143	0.4	505	613	3.1	1,260	3.5
Terrestrial Mammal Support	4,398	0.4	0.4	1	<0.1	2	77	1.8	80	1.8
Resident and Diadromous Fish Support	24,607	7	1	9	<0.1	55	502	2.3	566	2.3
Threatened or Endangered Species Support: Spectacled Eider	33,158	100	33	133	0.4	491	557	3.2	1,181	3.6
Threatened or Endangered Species Support: Polar Bear	21,942	9	0	9	<0.1	99	403	2.3	511	2.3
Scarce and Valued Habitats	1,999	0.1	0	0	<0.1	6	24	1.5	30	1.5

[a] Adjacent effects of gravel from dust, snow accumulation, impoundments, and thermokarst were calculated using 164 ft perimeter around gravel fill.

5.8.5.2 Alternative D: Summary of Impacts

The long-term impacts of Alternative D would occupy a larger area than Alternative B, however the long-term impacts would affect between 0 and 4.7 percent of the total mapped area for each wetland and vegetation type and would be considered minor, not quite meeting the threshold of 5 percent impact to a specific wetland or vegetation type to be considered moderate (Table 5.8-2). Approximately 4.0 percent of the total area identified as upland or potentially containing a mosaic of wetlands and uplands would be impacted; 55.8 percent of this upland impact area would be classified as existing gravel fill areas. Impacts to wetlands and vegetation could also result from the construction of ice roads and pads. These impacts would be limited in extent and temporary in duration. Tussock tundra would not be impacted and the percentage of drier shrub-dominated communities affected would be between 0 and 1.3 percent of the total mapped area for each type.

The effects of water withdrawal and hydrostatic test water discharge have not been quantified but are estimated to be minor. The total acreage of wetland and vegetation affected by trenching and VSM and other support member installation is estimated to total less than one acre and would also be considered minor. The effects on vegetation and wetlands from altered drainage patterns associated with the gravel airstrip have not been quantified; however the change in drainage area would be approximately 3 times less than the area altered under Alternative B and would divert the smallest drainage area among all Alternatives.

Placement of gravel fill and excavation under Alternative D would alter less than 1 percent of the area mapped as performing each function. Alternative D ice infrastructure and hydrologic and dust-related changes adjacent to fill areas would affect up to 3.4 percent of the functional area of any individual function. The highest percentage of total functional area affected by ground disturbance, adjacent effects, and ice infrastructure is 4.0 percent–the affected percentage of the area estimated to produce and export organic matter. These estimated areas of wetland and water body functional changes are considered minor.

Table 5.8-11 summarizes the intensity of impacts for each major type of project component or activity.

Table 5.8-11: Alternative D—Impact Evaluation for Wetlands and Vegetation

Component	Magnitude	Duration	Potential	Extent
Fill Placement (footprint and adjacent) and Gravel Mine[a]	Minor	Long term	Probable	Local
Ice Infrastructure	Minor	Medium term	Possible	Local
Water Removal	Minor	Medium term	Possible	Limited
Stream 24 Diversion	Minor	Temporary	Possible	Limited
VSMs	Minor	Long term	Probable	Limited
Wastewater Disposal	Minor	Unknown	Possible	Local
Trenching	Minor	Temporary	Probable	Local
Offroad Tundra Travel	Minor	Long term	Possible	Local

[a] Adjacent impacts of fill placement begun in construction would continue through operations

5.8.6 Alternative E: Coastal Pads with Seasonal Ice Roads

Alternative E includes multiple project components and activities which have the potential to impact wetlands and vegetation. Direct and indirect impacts of Alternative E would be similar in all project phases to those presented for Alternative B, but would occur over a lesser spatial extent due to reduced footprints of project components and gravel fill placement. Detailed descriptions of the project components and sequencing for Alternative E are described in Chapter 2. Table 5.8-12 identifies the acreage of the potentially-affected wetland and vegetation types associated with the direct and indirect impacts from Alternative E. The project component footprints overlain on the mapped vegetation types are shown in Figure 5.8-13 through Figure 5.8-16 (Figure 5.8-13 shows an overview of the alternative and Figure 5.8-14 through Figure 5.8-16 show additional detail of project features). Table 5.8-13 identifies the acreage of potentially-affected wetland and water body functions associated with Alternative E, as well as the acreage within a zone adjacent to fills and the gravel mine that might be affected by altered hydrology, dust, and gravel spray.

5.8.6.1 Alternative E: Construction, Drilling, and Operations

The types of impacts associated with construction and operations would be similar under Alternative E to those described for Alternative B, and the discussion for project phases are discussed together under this alternative.

Impacts under Alternative E ice pads and roads would replace some gravel fill and barging would occur. 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 well heads and associated required infrastructure. However, the Central Pad would be larger to compensate for the two smaller ice/gravel combination pads. Transportation infrastructure between the pads would be a combination of ice roads and gravel roads, and the use of ice roads would also reduce the area of gravel fill that would be discharged to the tundra surface.

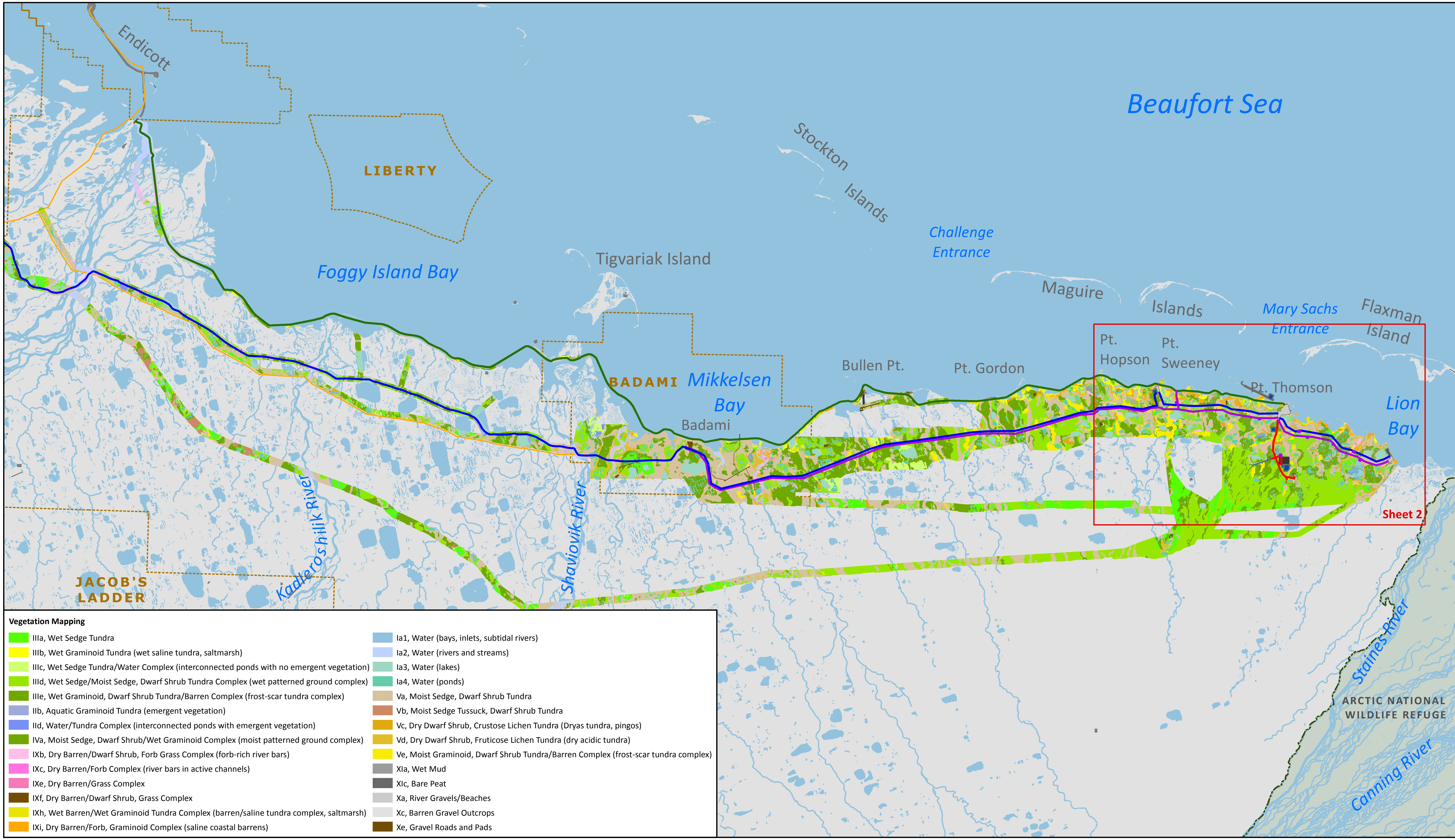
Alternative E incorporates a combination of multiseason ice and gravel pads for drilling to minimize the area of gravel fill. The footprints of the East and West Pads would be a combination of ice and gravel (multiyear, year-round ice pads). A vegetation assessment was conducted on the effects of the Yukon Gold multiseason ice pad that was in place over one summer. The ice pad was located just west of the Staines River and was constructed in an area of wet tundra with prominent strangmoor and frost boils. The effects included a decrease in overall cover of live vegetation within the pad footprint. This effect was magnified along the perimeter of the pad, where an increase of standing water was present. In general, there was no evidence of thermokarst or subsidence. The most apparent impacts within the pad footprint were decreased live cover and compaction of strangmoor ridges. The first year after the pad was allowed to melt, live vegetation cover was 53 percent of that in reference tundra. By the third growing season after the pad had melted, the total live vegetation cover within the majority of the pad footprint increased and met the Corps performance standard of greater than or equal to 70 percent cover of that in reference tundra (Noel and Pollard 1996; BPXA 1996). Vegetation monitoring has also occurred at the Puviaq One exploratory well site multiseason ice pad which was also in place over one summer. The ice pad was located in the Northeast NPR-A and was constructed in an area dominated by moist tussock tundra. Initial reconnaissance level assessment conducted the first year after the pad was removed indicated that most of the vegetation within the pad footprint was dead, although some regrowth had occurred. Based on quantitative vegetation monitoring conducted over the following two years, performance standards were projected to be achieved within 5 years of pad removal, although delayed recovery could occur. Performance standards for this site were defined as at least 60 percent cover of that in reference tundra within 5 years. Quantitative measurements of thaw depth and qualitative observations suggested that site was relatively thermally stable (ABR 2007).

The multiseason ice pads for Alternative E would be approximately 6 feet thick and would be anticipated to remain in place for up to five summers during drilling. After drilling is complete and the ice pads are no longer in use or maintained, they would be allowed to melt. Most of the pad would be expected to melt within the first summer, and any remaining ice would be expected to melt the following summer. The effects of multiseason ice pads in place for more than one summer on vegetation and soil properties are unknown. It is likely that all the vegetation within the footprint of the pads, regardless of vegetation type, would not survive 5 consecutive growing seasons frozen in ice. The pads would be constructed in the winter, when the underlying soils were frozen. The soils would be expected to remain frozen which would lessen the likelihood of soil compaction. If the ice at the perimeter of the pad melts each summer, it would need to be reconstructed each winter. Depending on original site conditions and moisture regimes, forbs and graminoids would be expected to serve as pioneer species and would recolonize the site first from the adjacent tundra and any remaining viable below ground plant parts (rhizomes/root mass) or seed bank. Recovery periods are unknown, but could occur within 10 years. Shrubs are generally slower to re-establish; recovery times could be greater if shrub dominated tundra was impacted.

Most of the infield roads for Alternative E would be ice roads which would be built annually throughout operations, except for the road between the Central Pad and the airstrip which would be gravel. Annual construction of ice roads throughout the operations phase would increase the likelihood of overlapping ice road routes in consecutive years. While contradictory reports exist about the effects of overlapping ice roads on vegetation (Guyer and Keating 2005; Yokel et al. 2007), no rigorous test has been conducted on the effects from overlapping ice roads for more than 2 years. If ice roads were placed within the same footprint for several years, recovery would be delayed and may occur at a slower rate once the route is no longer in use (Yokel et al. 2007).

The dredged material generated for barging would be disposed of on coastal gravels, similar to Alternative B, however the disposal site would be surrounded by nearshore waters and would not be adjacent to vegetated areas which would reduce the possibility of impact to coastal vegetation (Figure 2.4-9).

The gravel airstrip associated with Alternative E would be shorter in length and would require less fill than the gravel airstrips for all other alternatives. The effects on vegetation and wetlands from altered drainage patterns associated with the gravel airstrip have not been quantified; however the acreage affected by changes in drainage area would be slightly greater than the area altered under Alternative B and the airstrip would divert water from the largest drainage area among all action alternatives (see Appendix S).



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

- Pipeline Construction Ice Road
- Tundra Ice Roads
- Sea Ice Road
- Road Centerline
- 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 5.8-13

Vegetation Mapping
Alternative E - Sheet 1 of 4

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

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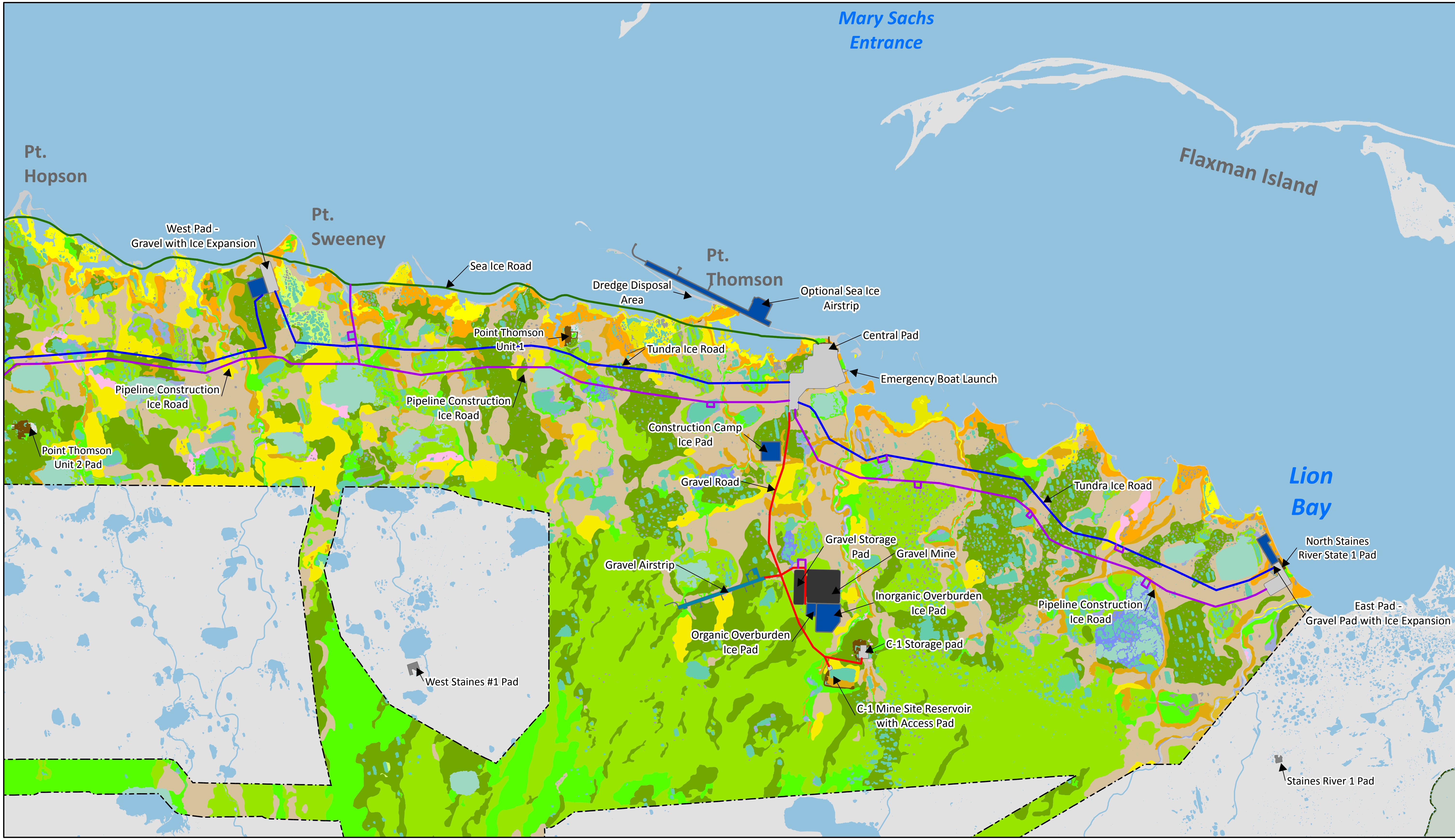

POINT THOMSON
PROJECT EIS

Proposed Project Layout

Pipeline Construction Ice Road
Tundra Ice Roads
Sea Ice Road
Road Centerline
Vegetation Mapping Extent
Gravel Mine
Gravel Pads
Airstrip
Sea Ice Airstrip/Ice Pads

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

N

0 1 2 Miles

Figure 5.8-14

Vegetation Mapping
Alternative E - Sheet 2 of 4

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

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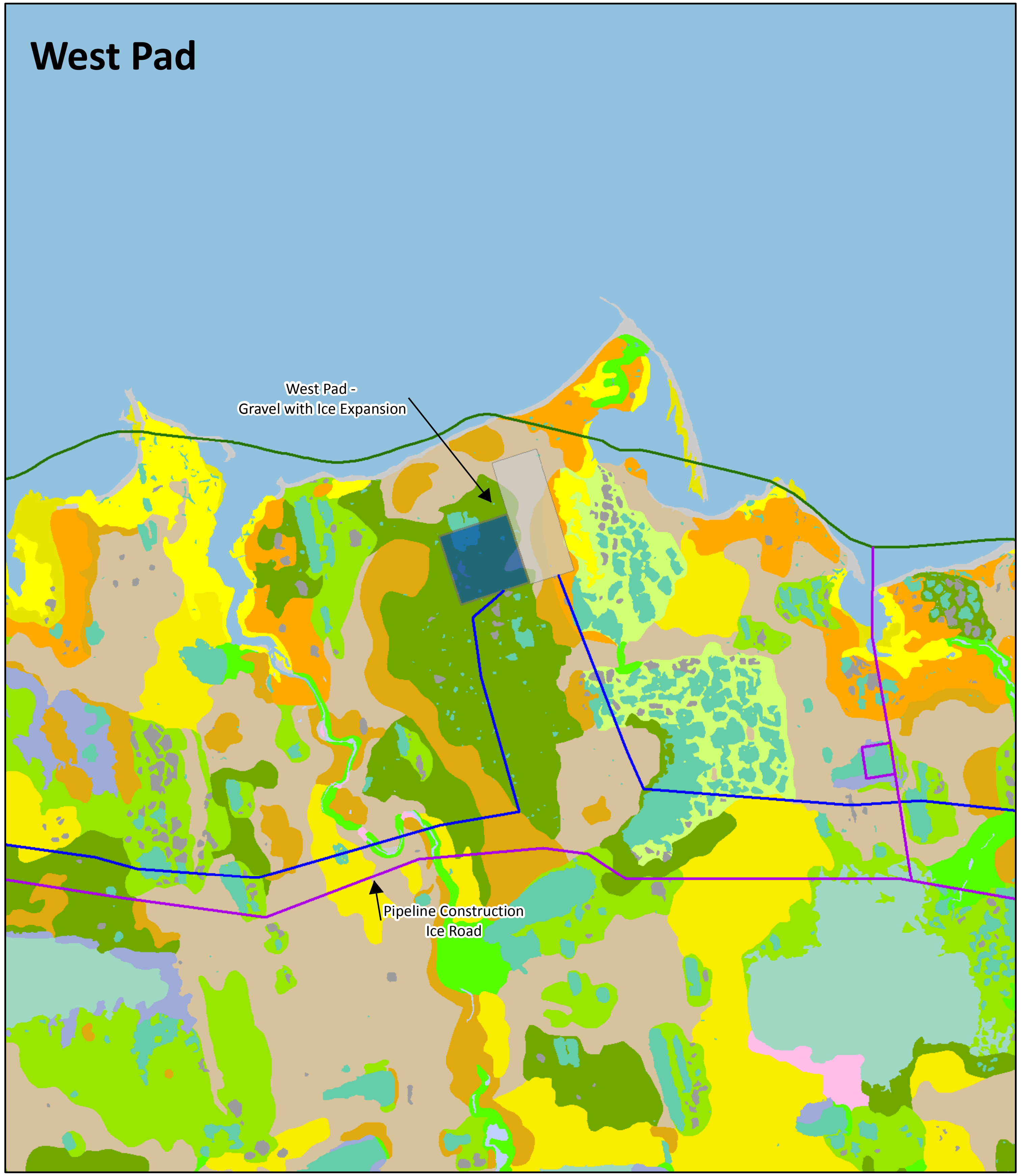

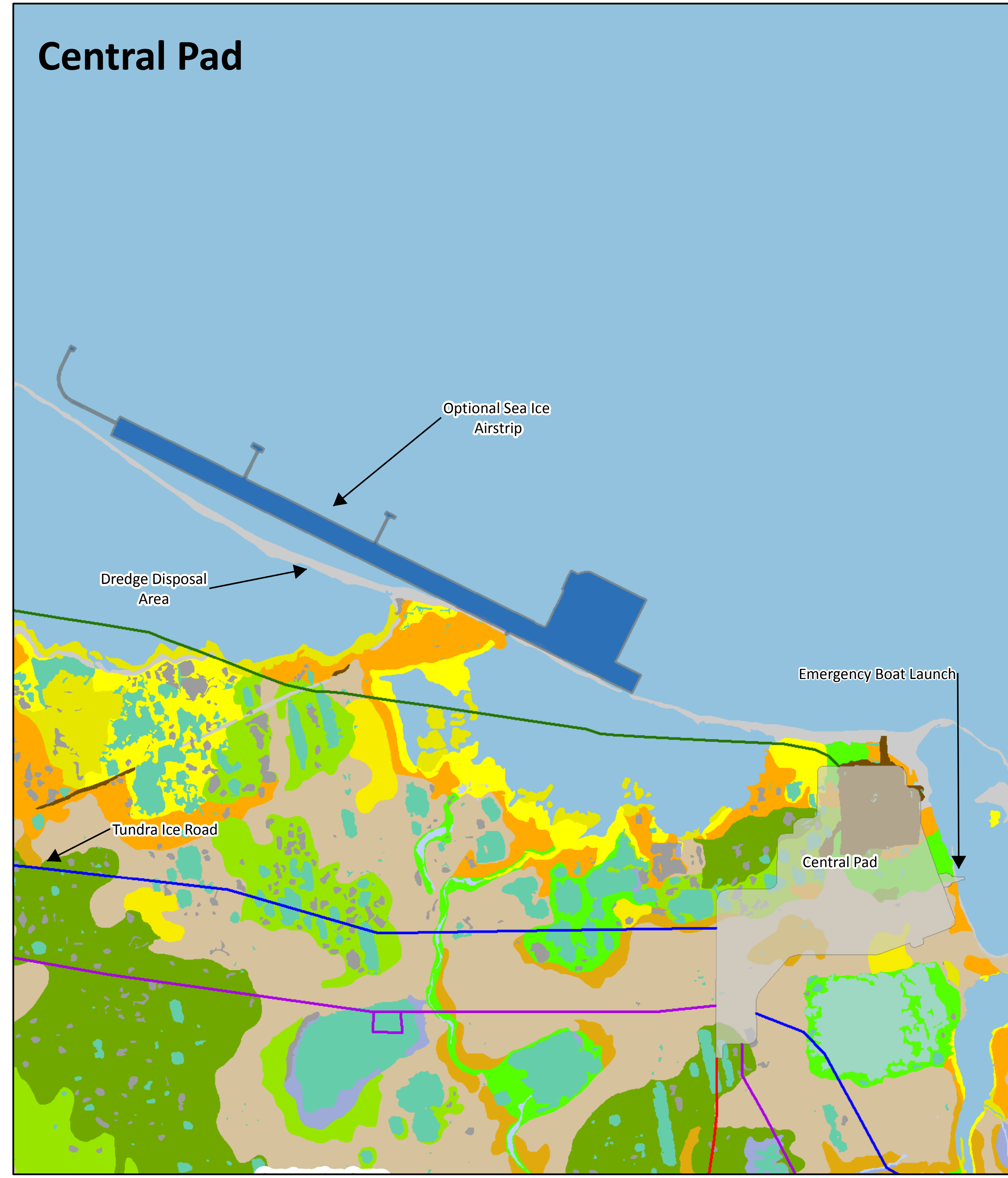

POINT THOMSON PROJECT EIS

Proposed Project Layout

- Pipeline Construction Ice Road
- Tundra Ice Roads
- Sea Ice Road
- Road Centerline
- Gravel Mine
- Gravel Pads
- Airstrip
- Sea Ice Airstrip/Ice Pads

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

0 1,000 2,000 Feet

N

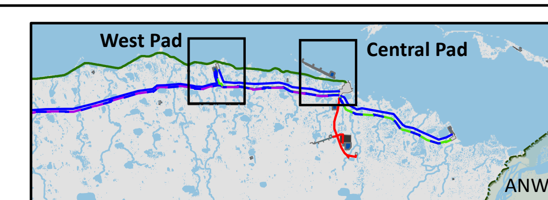

Figure 5.8-15

Vegetation Mapping
Alternative E - Sheet 3 of 4

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

Proposed Project Layout

- Pipeline Construction Ice Road
- Tundra Ice Roads
- Sea Ice Road
- Road Centerline
- Vegetation Mapping Extent
- Gravel Mine
- Gravel Pads
- Airstrip
- Sea Ice Airstrip/Ice Pads

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

0 1,000 2,000 Feet

N

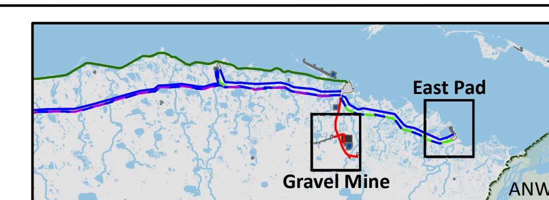

Figure 5.8-16

Vegetation Mapping
Alternative E - Sheet 4 of 4

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

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Table 5.8-12: Alternative E—Summary of Affected Water Body, Wetland, and Vegetation Types											
			Gravel Roads, Pads, and Mine					Seasonal Ice Roads and Pads		Multi-Season Ice Pads	
Cover Class	Level C Photo Interpreted Map Unit Types	Wetland Type (NWI Codes)	Gravel Roads and Pads (Acres)	Gravel Mine (Acres)	Dust, Snow Accumulation, Impoundments, Thermokarst (Acres)	Total Acres	Percent of Mapped Type Affected	Total Footprint (Acres)	Percent of Mapped Type Affected	Total Footprint (Acres)	Percent of Mapped Type Affected
Water Bodies	Bays, lagoons, inlets, subtidal rivers (Ia1)	E1UBL = Estuarine, subtidal, unconsolidated bottom, subtidal	0.1	0.0	3.8	3.9	<0.1	352.7	3.2	0.0	0.0
	Rivers and streams (Ia2)	R1UBV = Riverine, tidal, unconsolidated bottom, permanent tidal influence R2UBH = Riverine, lower perennial, unconsolidated bottom, permanently flooded R3UBH = Riverine, upper perennial, unconsolidated bottom, permanently flooded	0.0	0.0	0.1	0.1	<0.1	30.9	2.4	0.0	0.0
	Lakes (Ia3)	L1UBH = Lacustrine, limnetic, unconsolidated bottom, permanently flooded L2UBH = Lacustrine, littoral, unconsolidated bottom, permanently flooded	0.0	0.0	0.0	0.0	0.0	9.0	0.5	0.0	0.0
	Ponds (Ia4)	PUBH = Palustrine, unconsolidated bottom, permanently flooded	7.0	3.7	12.8	23.5	0.8	20.0	0.7	2.1	0.1
Water - associated Barrens	River gravels/beaches (Xa)	R3USC = Riverine, upper perennial, unconsolidated shore, seasonally flooded R2USC = Riverine, lower perennial, unconsolidated shore, seasonally flooded E2US1P = Estuarine, intertidal, unconsolidated shore, cobble-gravel, irregularly flooded	0.9	0.0	3.3	4.2	0.4	39.5	4.0	0.0	0.0
	Wet mud (XIa)	L2USD = Lacustrine, littoral, unconsolidated shore, seasonally flooded/well drained PUSD = Palustrine, unconsolidated shore, seasonally flooded/well drained	1.5	0.4	2.8	4.7	1.4	3.3	1.0	2.2	0.7
	Bare peat (XIc)	L2USD = Lacustrine, littoral, unconsolidated shore, seasonally flooded/well drained PUSD = Palustrine, unconsolidated shore, seasonally flooded/well drained E2US4P = Estuarine, intertidal, unconsolidated shore, organic, irregularly flooded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Very Wet Tundra	Aquatic graminoid tundra (IIb)	L2EM2H = Lacustrine, littoral, emergent, nonpersistent, permanently flooded PEM1H = Palustrine, emergent, persistent, permanently flooded	0.0	0.0	0.0	0.0	0.0	3.8	1.0	0.0	0.0
	Water/tundra complex (IId)	L2UB/EM2H = Lacustrine, littoral, unconsolidated bottom/emergent, nonpersistent, permanently flooded PUB/EM2H = Palustrine, unconsolidated bottom/emergent, nonpersistent, permanently flooded PUB/EM1H = Palustrine, unconsolidated bottom/emergent, persistent, permanently flooded	0.2	0.0	0.7	0.9	0.4	2.9	1.2	0.0	0.0
Wet Tundra	Wet sedge tundra (IIIa)	PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	11.1	0.0	9.6	20.7	0.5	16.6	0.4	0.0	0.0
	Wet graminoid tundra (IIIb)	E2EM1N = Estuarine, intertidal, emergent, persistent, regularly exposed E2EM1P = Estuarine, intertidal, emergent, persistent, irregularly flooded	0.5	0.0	4.0	4.5	0.8	5.5	1.0	0.0	0.0
	Wet sedge tundra/water complex (IIIc)	L2EM2/UBH) = Lacustrine, littoral, emergent, nonpersistent/unconsolidated bottom, permanently flooded PEM1/UBH = Palustrine, emergent, persistent/unconsolidated bottom, permanently flooded	0.0	0.0	0.8	0.8	0.1	3.5	0.5	0.0	0.0
	Wet sedge/moist sedge, dwarf shrub tundra complex (IIId)	PSS1/EM1B = Palustrine, scrub shrub, deciduous/emergent, persistent, saturated PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	23.3	27.1	47.6	98.0	0.8	88.4	0.7	0.0	0.0
	Wet graminoid, dwarf shrub tundra/barren complex (IIIe) (frost-scar tundra complex)	PSS1/EM1B = Palustrine, scrub shrub, deciduous/emergent, persistent, saturated PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	3.1	0.0	11.8	14.9	4.5	1.2	0.4	0.0	0.0
	Wet barren/wet graminoid tundra complex (IXh)	E2USN = Estuarine, intertidal, unconsolidated shore, regularly exposed E2USP = Estuarine, intertidal, unconsolidated shore, irregularly flooded E2EM1P = Estuarine, intertidal, emergent, persistent, irregularly flooded	0.0	0.0	0.4	0.4	0.2	4.9	1.9	0.0	0.0

Table 5.8-12: Alternative E—Summary of Affected Water Body, Wetland, and Vegetation Types

			Gravel Roads, Pads, and Mine					Seasonal Ice Roads and Pads		Multi-Season Ice Pads	
Cover Class	Level C Photo Interpreted Map Unit Types	Wetland Type (NWI Codes)	Gravel Roads and Pads (Acres)	Gravel Mine (Acres)	Dust, Snow Accumulation, Impoundments, Thermokarst (Acres)	Total Acres	Percent of Mapped Type Affected	Total Footprint (Acres)	Percent of Mapped Type Affected	Total Footprint (Acres)	Percent of Mapped Type Affected
Moist Tundra	Moist sedge, dwarf shrub tundra (Va)	PSS1/EM1B = Palustrine, scrub shrub deciduous/emergent, persistent, saturated	58.5	11.7	65.2	135.4	1.1	121.5	1.0	2.9	<0.1
	Moist tussock sedge, dwarf shrub tundra (Vb)	PEM1/SS1B = Palustrine, emergent, persistent/scrub shrub, deciduous, saturated	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Moist graminoid, dwarf shrub tundra/barren complex (Ve)	PSS1/EM1B = Palustrine, scrub shrub deciduous/emergent, persistent, saturated	5.0	0.0	20.6	25.6	1.8	18.0	1.3	0.0	0.0
Moist/Wet Tundra Complex	Moist sedge, dwarf shrub/wet graminoid tundra complex (IVa)	PSS1/EM1B = Palustrine, scrub shrub, deciduous/emergent, persistent, saturated PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	14.2	0.0	49.2	63.4	0.6	109.4	1.0	8.9	0.1
Dry Tundra	Dry dwarf shrub, crustose lichens (Vc)	Upland PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	8.5	0.0	10.1	18.6	2.5	6.8	0.9	0.0	0.0
	Dry dwarf shrub, fruticose lichens (Vd)	Upland PEM1B = Palustrine, emergent, persistent, saturated PEM1E = Palustrine, emergent, persistent, seasonally flooded/saturated PEM1H = Palustrine, emergent, persistent, permanently flooded PEM1F = Palustrine, emergent, persistent, semi-permanently flooded	0.0	0.0	0.0	0.0	0.0	3.9	0.7	0.0	0.0
	Dry barren/dwarf shrub, forb-grass complex (IXb)	Upland PSS1/EM1A = Palustrine, scrub shrub, deciduous/emergent, persistent, temporarily flooded	0.0	0.0	0.4	0.4	0.1	6.0	1.6	0.0	0.0
	Dry barren/ forb complex (IXc)	R2USC = Riverine, lower perennial, unconsolidated shore, seasonally flooded	0.0	0.0	0.0	0.0	0.0	0.5	1.0	0.0	0.0
	Dry barren/grass complex (IXe)	Upland	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
	Dry barren/dwarf shrub, grass complex (IXf)	Upland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Dry barren/forb-graminoid complex (IXi)	PSS5/EM1J = Palustrine, scrub shrub, dead/emergent, persistent, intermittently flooded	6.3	0.0	6.9	13.2	2.3	4.3	0.7	4.2	0.7
Disturbed Barrens	Barren gravel outcrops (Xc)	Disturbed wetland/unknown	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Gravel roads and pads (Xe)[a]	Upland/unknown	21.7	0.0	11.8	33.5	17.3	0.8	0.4	0.7	0.4
		Total area affected	161.9	42.9	261.9	466.7	0.7	853.4	1.3	21.0	<0.1
		Total area of water bodies affected	9.5	4.1	22.8	36.4	0.2	455.5	2.5	4.3	<0.1
		Total area of wetlands affected	130.6	38.8	227.2	396.8	0.9	397.2	0.9	16.0	<0.1
		Total area of upland affected	21.7	0.0	11.8	33.5	16.3	0.9	0.4	0.7	0.3

[a] Impacts to Xe indicates previously permitted fill areas.

Notes:

Impacts from pipeline VSM and other support member placement are not shown in table but are anticipated to total less than 1 acre

Impacts from dredge disposal area are not shown in table due to unspecified location.

Barge facility and emergency response boat launch footprints included in gravel roads and pads footprint.

Impacts from mooring dolphins have not been quantified and are not included in the table, but are anticipated to be less than 0.1 acre and would occur in map unit type 1a1.

Potential impacts from trenching for buried power cables would disturb <0.1 acre of tundra surface.

Exact locations and alignments of project components would be adjusted during final engineering design stages to further avoid and minimize impacts to sensitive resources as practicable.

Table 5.8-13: Approximate Acreages of Functions Affected by Alternative E Project Components											
		Ground Disturbance				Potential Disturbance					
Wetland Function	Total Acreage of Function in Study Area	Gravel Road and Pad Footprints (acres)	Gravel Mine Site Footprint (acres)	Total Area Affected by Excavation or Fill (acres)	% of Mapped Function	Dust, Snow Accumulation, Impoundments, Thermokarst Effects (acres)[a]	Seasonal Ice Road and Pad Footprint (acres)	Multi Season Ice Pad Footprint (acres)	% of Mapped Function	Total Area Affected (acres)	Total % of Mapped Function Affected
Flood Flow Moderation and Conveyance	18,187	2	0	2	<0.1	24	183	0	1.1	210	1.2
Shoreline and Bank Stabilization	4,672	0.1	0	0	<0.1	10	84	0	2.0	94	2.0
Maintenance of Natural Sediment Transport Processes	14,171	2	0	2	<0.1	19	157	0	1.2	177	1.3
Production and Export of Organic Matter	18,558	33	25	58	0.3	69	167	0	1.3	294	1.6
Maintenance of Soil Thermal Regime	39,641	107	39	146	0.4	172	355	12	1.4	684	1.7
Waterbird Support	36,103	37	31	68	0.2	85	563	4	1.8	720	2.0
Terrestrial Mammal Support	4,398	0	0	0	0.0	3	74	0	1.8	77	1.8
Resident and Diadromous Fish Support	24,607	2	0	2	<0.1	36	523	5	2.3	566	2.3
Threatened or Endangered Species Support : Spectacled Eider	33,158	35	27	62	0.2	84	505	4	1.8	655	2.0
Threatened or Endangered Species Support : Polar Bear	21,942	3	0	3	<0.1	78	527	11	2.8	618	2.8
Scarce and Valued Habitats	1,999	0.2	0	0	<0.1	12	22	4	1.9	39	1.9

[a] Adjacent effects of gravel from dust, snow accumulation, impoundments, and thermokarst were calculated using 164 ft perimeter around gravel fill.

5.8.6.2 Alternative E: Summary of Impacts

The acreage affected by the placement of gravel fill for roads and pads under Alternative E would be less than all other alternatives requiring fill, ranging from 1.4 times less than Alternative B, to 3.8 times less than Alternative C. Similarly, the acreage that would be affected by changes in drainage, dust production gravel spray and sloughing, thermokarst, and snow accumulation resulting from gravel fills would be less for Alternative E than all other Alternatives requiring fill, and would range from 2.3 times less than Alternative B to 10.3 times less than Alternative C. The gravel mine area required for Alternative E would be slightly less than that of Alternatives B and D, but would be 3.0 times smaller than that required for Alternative C. When combined, these long-term impacts would affect between 0 and 4.5 percent of the total mapped area for each wetland and vegetation type and would be considered minor, not quite meeting the threshold of 5 percent impact to a specific wetland or vegetation type to be considered moderate (Table 5.8-2). Approximately 4.4 percent of the total area identified as upland or potentially containing a mosaic of wetlands and uplands would be impacted; 63.8 percent of this upland impact area would be classified as existing gravel fill areas. Impacts to wetlands and vegetation could also result from the construction of seasonal ice roads and pads and multiseason ice pads. These impacts would be limited in extent and temporary to medium in duration. Tussock tundra would not be impacted and the percentage of drier shrub-dominated communities affected would be up to 4.0 percent of the total mapped area for each type.

The effects of water withdrawal, hydrostatic test water discharge, dredge disposal, and off-road tundra travel have not been quantified but are estimated to be minor. The possibility of impacts to coastal vegetation from disposal of dredged material would be less for Alternative E than for Alternative B, because the disposal site would be surrounded by nearshore waters and would not be adjacent to vegetated areas. The potential for off-road tundra travel for emergency response would be higher for Alternative E than all other alternatives due to the reduced gravel infrastructure. The total acreage of vegetation and wetlands affected by VSM and other support member installation is estimated to total less than one acre.

The majority of the power cables would be installed on the pipeline supports or be distributed to the airstrip and water supply via cables buried in the tundra. The impacts from trenching into the tundra surface would be one order of magnitude less than Alternative B. Due to the reduced footprint of gravel fill, the risk of nonnative plant species establishment would be less than all the other alternatives requiring fill.

Placement of gravel fill and excavation under Alternative E would alter 0 to 0.4 percent of the area mapped as performing each function. Alternative E ice infrastructure and hydrologic and dust-related changes adjacent to fill areas would affect up to 2.8 percent of the functional area of any individual function. The highest percentage of total functional area affected by ground disturbance, adjacent effects, and ice infrastructure is less than 3 percent–the affected percentage of the area estimated as polar bear habitat. These estimated areas of wetland and water body functional changes are considered minor.

Table 5.8-14 summarizes the intensity of impacts for each major type of project component or activity.

Table 5.8-14: Alternative E—Impact Evaluation for Wetlands and Vegetation				
Component	Magnitude	Duration	Potential	Extent
Fill Placement (footprint and adjacent) and Gravel Mine[a]	Minor	Long term	Probable	Local
Seasonal Ice Infrastructure	Minor	Medium Term	Probable	Local
Multiseason Ice Pads	Minor	Medium term	Probable	Limited
Water Removal	Minor	Medium term	Possible	Limited
Dredge Disposal	Minor	Medium term	Probable	Limited
VSMs	Minor	Long term	Probable	Limited
Wastewater Disposal	Minor	Unknown	Possible	Local
Trenching	Minor	Temporary	Probable	Local
Offroad Tundra Travel	Minor	Long term	Probable	Local

[a] Adjacent impacts of fill placement begun in construction would continue through operations

5.8.7 Mitigative Measures

This section describes measures to mitigate impacts to vegetation and wetlands from the Point Thomson Project. The Applicant has proposed design measures that would be included as part of the project; BMPs and permit requirements would be stipulated by federal, state, and local agencies, and the Corps has considered additional mitigation measures.

5.8.7.1 Applicant's Proposed Design Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on vegetation and wetlands.

- Minimizing gravel fill by utilizing three existing gravel pads in the area to the greatest extent possible, thereby reducing overall new tundra footprint by more than 20 acres.
- Minimizing the size of the gravel pads through optimizing project design and equipment layout.
- Using a temporary barge-bridge system to avoid placement of fill for a module offloading causeway/dock (Alternatives B and E only).
- Limiting module weights and barge loads, which eliminates the need to dredge an access channel for docking sealift barge, with associated offshore disposal of dredged materials (Alternatives B and E only).
- Designing pads, roads, bridges, and culverts to maintain natural drainage patterns and stream flows to the extent possible.
- Routing the infield gravel roads to minimize overall length and footprint, with consideration for hydrologic impacts and project needs.
- Combining the East Pad road with the Central Pad road, minimizing hydrology impacts without increasing the tundra footprint.
- Routing the West Pad road to avoid coastal marshes and estuarine habitat, while minimizing the wetlands footprint and hydrologic impacts.

- Utilizing ice roads and pads for project access, pipeline construction, and temporary storage of mine site overburden.
- Watering gravel roads and pads, as necessary, to control dust generation.
- Slotting ice roads at designated stream crossings to facilitate drainage during breakup.
- Requiring workers to stay on gravel surfaces unless their job duties require them to be on the tundra.
- Requiring strict guidelines for travel on ice roads to avoid tundra damage, including ice road training, establishing speed and weight limits, and installing delineators along both sides of the road.
- Reducing surface discharge of wastewaters through use of a disposal well, including zero discharge of produced water and drilling wastes.
- Implementing spill prevention and response programs, as detailed in Section 5.24, Spill Risk and Impact Assessment.

5.8.7.2 BMPs and Permit Requirements

Permits from the Corps, ADNR, and NSB would address impacts to vegetation and wetlands. As discussed above in Section 5.8.3, Alternative B: Applicant's Proposed Action, permits would include the following BMPs and requirements that would avoid, minimize, and mitigate impacts to vegetation and wetlands:

- **Ice roads:** conducting preconstruction routing surveys and designing ice roads to avoid tussock tundra areas, steep streambanks, and deep water holes; using as-built data from previous year's ice roads to design ice road alignments that change from year to year; having construction crews deviate alignments in the field if unexpected conditions are encountered.
- **Water use:** water sources must be permitted for water withdrawal; the amount of water permitted for withdrawal is stipulated for each water source, and water sources must recharge sufficiently during the summer for a water source to be used as a water withdrawal source the following winter.
- **Tundra travel:** adequate snow cover must be present for winter tundra travel; tundra travel after April 15 is subject to termination based on snow cover to protect surface vegetation; summer tundra travel includes the following additional stipulations:
    - Operations are restricted to drier areas.
    - Avoid crossing deep water or vegetation with more than 2-3 inches of water.
    - Ponds, lakes, and wetlands bordering ponds and lakes cannot be crossed.
    - Avoid minimum radius turns with sharp articulations.
    - Keep multiple passes over the same area to a minimum.
    - All operators must be familiar with tundra vegetation types to ensure compliance with these stipulations.
    - Incidents of damage to the vegetation mat and follow-up corrective actions that have occurred must be reported to the Division of Mining, Land, and Water within 72 hours of occurrence.
    - Vehicles are tested to determine their ability to operate on the tundra without causing extensive damage.

- o The state reserves the right to limit, restrict, or require retesting of vehicles at any time.
- o Vehicles cannot carry more payload than was carried during the certification test.
- o Movement of equipment through willow stands must be avoided where possible.
- o Incorporate the best available technologies to prevent disturbance to permafrost that would result in habitat damage. Where disturbance to the organic mat is unavoidable, the disrupted area must be stabilized to avoid disturbance to the permafrost layer.
- o Include measures to monitor effects of tundra travel and to avoid damage to permafrost soils including using vehicles that will not result in damage to the tundra.

5.8.7.3 Corps-considered Mitigation

In addition to the Applicant's proposed design measures and BMPs and permit requirements, the Corps, in consultation with others, is considering the following actions to avoid or minimize impacts to vegetation and wetlands:

- Direct discharge of mine dewatering water and hydrostatic test water toward a natural drainage gradient to minimize warming of the near-surface soils and ponding of surface water. Control the discharge flow rate to avoid erosion of tundra or tundra vegetation.
- Maintain slopes of gravel roads and pads to prevent sloughing.
- Grade roads without pushing material off the embankments.
- If summer tundra travel is necessary using tundra-safe low-pressure vehicles, limit traffic as much as possible, avoid tight turns, use different tracks with each pass, avoid vegetation communities most sensitive to damage from tundra travel (e.g., tussock tundra), and follow the shortest path from origination to destination.
- Prepare and implement an invasive species plan that addresses plants and aquatic species. The plan should include monitoring of gravel pads and roads for nonnative plant species and eradication of invasive species before populations become well established and implementation of measures to prevent import of weed seed on equipment and materials brought to Point Thomson. This plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.
- Prepare and implement a plan for dust suppression that addresses gravel roads/pads, and year-round mining activities. Consider use of environmentally safe chemical palliatives, use of chip-seal on the infield roads, and other methods, as applicable. This plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.
- Restrict public access to the gravel access road to prevent off-road vehicle use and spread of nonnative plant species.

To mitigate for unavoidable losses to wetlands and waters of the U.S., the Corps will work with the Applicant during the permitting process to identify appropriate compensatory mitigation.

5.8.8 Climate Change and Cumulative Impacts

5.8.8.1 Climate Change

Studies of climate change in the Arctic under the current conditions have shown that warming temperatures (see Section 4.3, Climate Change) affect the distributions and growth rates of plant species, resulting in a northward expansion of the range of shrubs and other plants (Callaghan 2005); increased growth rates of shrubs and graminoids; and decreased cover of mosses and lichens (Hintzman et al. 2005). Overall, establishment of nonnative plant species has not been an issue in the region, but a warming climate could also be favorable to nonnative plant species if they were introduced to the Arctic, with the potential to alter the composition of existing vegetation communities (NRC 2003a, Global Change Assessment 2008). Bioclimatic models of current and predicted species ranges through 2080 have predicted that the ACP could provide suitable habitat for nonnative species, and their establishment is predicted to occur by 2080 if vectors, such as contaminated barges or trucks supporting an action alternative, are present to facilitate their introduction (Bella 2009).

Both published studies and local inhabitants have reported that wetlands and ponds are drying across the North American Arctic (Hintzman et al. 2005). While there is continued uncertainty regarding the long-term effects of climate change on ACP vegetation and wetlands, these general trends could be expected to continue under any of the project alternatives, including the No Action Alternative.

There would be some potential for synergy between some effects of the action alternatives and climate change. In particular, climate change could cause vegetation changes and wetland drying that could exacerbate tundra drying that might occur on the downgradient sides of gravel fills. These effects would be greater for Alternative C, due to the size of the gravel access road, and lesser for Alternative E, which would have a fraction of the area of gravel roads as the other action alternatives.

Warming may also increase the potential for thermokarst development resulting from disturbance of organic mats or creation of impoundments. As the climate warms, spread of invasive plants northward would be possible, and project components would provide vectors and establishment sites for such plants.

5.8.8.2 Cumulative Impacts

This section describes cumulative impacts primarily on the vegetation itself and on the regulatory aspects of wetlands and water bodies. Other sections in this chapter address cumulative effects on resources and processes often associated with vegetation and wetlands (see Sections 5.2, Soils and Permafrost; 5.4, Air Quality; 5.5, Physical Oceanography and Coastal Processes; 5.6, Hydrology; 5.7, Water Quality; and 5.24, Spill Risk and Impact Assessment).

Relevant past, present, and RFFAs that affect vegetation and wetlands in the analysis area include: oil and gas exploration and development (especially projects located between Duck Island and the Arctic Refuge, such as Endicott, Badami, or full field development at Point Thomson; past exploration activities; and the potential future gas pipeline), roads (the Dalton Highway, potential Bullen Point Road, and potential Foothills West Road), community development (pads for buildings, other use of natural areas for community infrastructure, and degradation of natural areas from off-road vehicle travel and pollutant discharge), DEW line stations and infrastructure, and release of air pollutants worldwide that result in deposition of pollutants on Alaska’s North Slope. See Section 4.2, Cumulative Impacts Methodology for the full list of past, present, and RFFAs.

Gravel roads and pads cover more than 8,800 acres of the ACP, not including the Trans-Alaska Pipeline and the Dalton Highway, and gravel mines have affected nearly 6,400 acres (NRC 2003a). In addition, placing infrastructure on permafrost requires the construction of gravel pads, which require substantial amounts of gravel fill to avoid foundation issues. Gravel airstrips and pipeline VSMs also have resulted in additional gravel infrastructure on the North Slope. As discussed in Section 5.2, Soils and Permafrost, the total impact to soils and permafrost from all past and present oil industry-related activity projects on the

North Slope is approximately 17,700 acres (NRC 2003a). Despite these impacts, wetlands are still abundant on the ACP; roughly 8 million of the over 12 million acres that make up the ACP have been identified as having wet tundra or moist tundra vegetation cover (NRC 2003a). In the eastern portion of the North Slope, however, past and present oil and gas development has been relatively limited Table 5.2-10 in Section 5.2, Soils and Permafrost, presents the cumulative acreage of gravel infrastructure in the eastern portion of the North Slope, east of Foggy Island, and the additional gravel acreage that each Point Thomson action alternative would contribute to the cumulative total (NRC 2003a).

In terms of acres affected by direct impacts, construction causes more than 99 percent of the impacts to vegetation and wetlands, with spills having a very minor role (BLM 2004). Potential cumulative impacts to wetlands and vegetation include incremental loss of wetlands and habitat, fragmentation of habitat, loss or degradation of wetland function, and increased potential for the introduction of invasive species. The increased potential for introduction of invasive species would also be exacerbated by climate change.

Construction activities have and would continue to disturb soil, physically injure vegetation, or remove vegetation within the disturbed area. In areas with a high proportion of wetlands, such as the ACP, or during construction of large projects, such as new production and pipeline facilities, wetlands could be filled. The placement of gravel to construct production pads, airstrips, or service roads would eliminate local vegetation and alter local hydrologic regimes, which could adversely affect upland and wetland communities. These activities would also produce fugitive dust, which could injure or kill vegetation and alter vegetative communities by reducing vegetative cover, altering local soil and permafrost conditions, and changing species composition. In particular, the construction of linear features such as gravel roads and airstrips perpendicular to the predominant hydraulic gradient has a greater potential to impound sheet flow and water moving through the active layer. Erosion from construction sites could result in the sedimentation of vegetative communities, particularly wetland communities. Sediments could injure or kill vegetation and alter vegetative communities. Losses of vegetative communities could result from direct removal, sedimentation, or spills. These communities could include wetland and upland tundra. However, less than 1 percent of the vegetation of the 56.8 -million-acre ACP would likely be impacted by oil development (BLM 1998).

Potential direct impacts to wetlands from these construction activities are regulated by Section 404 of the Clean Water Act, which provides an avenue for continued avoidance, minimization, and compensation of unavoidable impacts on a project-by-project basis. Disturbances to vegetative communities would generally require restoration of the affected site and revegetation efforts. Some nonnative species could be introduced in seed mixtures during rehabilitation; however, these species would not likely persist or spread beyond the sites where they are introduced (NRC 2003a).

Although oil and gas exploration, development, and production are expected to continue on the North Slope, the area of impact from individual drilling or production sites has become considerably smaller over the past 30 years due to advances in technology which have reduced the area required for well pads and by substituting ice for gravel in some roads and pads (NRC 2003a). The long-term trend in the North Slope oil and gas industry is towards reduction in vegetation/wetlands impacts by overall reduction in footprint (long reach drilling technology allows drilling from fewer pads) and improvements in providing cross drainage.

The action alternatives would contribute incrementally to the loss, disturbance, and transition of wetlands and vegetation on the ACP caused by past, present, and future actions. The proposed project would be generally distant from other developments, so its effects would be mostly in watersheds that have seen little other disturbance, and affected areas would generally not overlap with areas already affected by other developments. Among alternatives, the incremental contribution to vegetation and wetland impacts would be greater under Alternative C due to the larger area filled and the long-term operation of the gravel Point Thomson-Endicott access road and less under Alternative E due to the smaller gravel footprint and winter-only surface access within the project area.

While vegetation and wetland impacts are additive, the total and incremental amount of disturbed area is small compared to the total resource within the North Slope region, and no substantial concerns related to adverse cumulative impacts have been identified at this time.

5.8.9 Alternatives Comparison and Consequences

All of the proposed action alternatives would impact vegetation and wetlands through the excavation of one or more gravel mines; placement of gravel for roads and pads; habitat changes from gravel placement including drainage pattern modification, dust production, thermokarst, and snow accumulation; and habitat modifications from placement of ice roads and pads. The differences in fill impacts are compared in Table 5.8-15. The primary impacts and differentiators among the alternatives include the following:

- Because of the all-season gravel road, longer infield roads, and addition of a fourth pad (Central Processing Pad), Alternative C would impact up to 3.5 times the amount of acreage from gravel fill and up to 10 times more acreage by changes in drainage, dust production, thermokarst, and snow accumulation compared to other action alternatives.
- Alternative C would necessitate gravel mines four times as great as other action alternatives.
- The permanent gravel road associated with Alternative C would increase the risk of nonnative plant species establishment.
- The multiseason ice pads under Alternative E may take 10 years or more to revegetate depending on the underlying vegetation type.

Table 5.8-15: Comparison of Vegetation and Wetland Impacts by Alternative

Alternative	Total area affected (acreage) (percent of study area)			Total area of water bodies affected (acreage) (percent of study area water bodies)			Total area of wetlands affected (acreage) (percent of study area wetlands)			Total area of upland affected[a] (acreage) (percent of study area upland)		
	Gravel Fill or Excavation	Dust, Snow, Impoundment, Thermokarst Effects	Ice Roads/Pads	Gravel Fill or Excavation	Dust, Snow, Impoundment, Thermokarst Effects	Ice Roads/Pads	Gravel Fill or Excavation	Dust, Snow, Impoundment, Thermokarst Effects	Ice Roads/Pads	Gravel Fill or Excavation	Dust, Snow, Impoundment, Thermokarst Effects	Ice Roads/Pads
A	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact
B	283.9 (0.4%)	609.2 (0.9%)	985.1 (1.5%)	13.2 (0.1%)	37.8 (0.2%)	459.0 (2.5%)	248.0 (0.5%)	561.1 (1.2%)	521.6 (1.1%)	22.7 (11.1%)	10.3 (5.0%)	4.5 (2.2%)
C	741.7 (1.2%)	2,683.8 (4.2%)	1,125.8 (1.7%)	39.8 (0.2%)	200.8 (1.1%)	430.3 (2.3%)	683.5 (1.5%)	2,475.7 (5.4%)	694.7 (1.5%)	18.4 (9.0%)	7.3 (3.6%)	0.9 (0.4%)
D	354.6 (0.6%)	842.5 (1.3%)	890.2 (1.4%)	19.0 (0.1%)	38.9 (0.2%)	419.8 (2.3%)	316.6 (0.7%)	795.8 (1.7%)	469.5 (1.0%)	19.0 (9.3%)	7.8 (3.8%)	0.9 (0.5%)
E	204.8 (0.3%)	261.9 (0.4%)	874.6 (1.4%)	13.6 (0.1%)	22.8 (0.1%)	459.8 (2.5%)	169.5 (0.4%)	227.3 (0.5%)	413.2 (0.9%)	21.7 (10.6%)	11.8 (5.7%)	1.6 (0.8%)

[a] All upland areas are bare ground or gravel roads and pads. No upland areas are vegetated.

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5.9 BIRDS

The key findings of effects for birds are outlined below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

Habitat Loss and Alteration:

<u>Alternative C:</u> Minor impacts are probable and would occur for the life of the project. Impacts would be localized to infrastructure across the study area.

<u>Alternatives B, D, and E:</u> Minor impacts are probable and would occur for the life of the project. Impacts would be limited to near project components.

<u>Alternative A:</u> No impacts

Conservation Birds of Concern:

<u>Alternatives B and E:</u> Moderate impacts are possible and would occur for the life of the project. Impacts would be limited to near project components.

<u>Alternatives A, C, and D:</u> Minor impacts are possible and would occur for the life of the project. Impacts would be limited to near project components.

Differentiators:

- Barge-related activities could moderately affect common eiders under Alternatives B and E.
- Moving infrastructure inland from the coast under Alternatives C and D may reduce potential impacts from bird collisions during migration.
- Noise from helicopter traffic under Alternative E could moderately affect surf scoters.

The Point Thomson Project has the potential to affect birds, bird behavior, and their nesting, brood-rearing, foraging, and molting habitats through:

- Habitat loss, alteration, and disturbance:
  - Physical changes resulting in loss of habitat
  - Displacement from habitats altered by vehicle noise, dust deposition, and thermokarst
  - Attraction to habitats altered by thermokarst and early green-up adjacent to gravel infrastructure
  - Disturbance from expansive aircraft or barge noise or visual stimuli

- Habitat fragmentation:
    - Reduced habitat patch size or increased habitat edge because of gravel or ice infrastructure
    - Barriers to movements from roads, pads, and pipelines
- Vehicle or infrastructure collision mortality
- Altered survival or productivity:
    - Changes in predator abundance, distribution, and predation risks
    - Reduced or enhanced reproduction
- Exposure to spills or leaks of toxic materials

These impacts and their severity are described below for each of the proposed alternatives.

5.9.1 Methodology

The analyses evaluated potential impacts to birds based on nesting, breeding, and post-breeding (including molting and staging) habitat use; bird-habitat associations; and seasonal use patterns. The Point Thomson study area is between and including the Sagavanirktok River and the Canning River deltas, coastal lagoons, barrier islands, and inland to about 9 miles as described in Section 3.9, Birds. For development of bird density estimates and quantification of potential impacts to birds, a bird project area was developed as a subset of the larger study area. The project area includes all gravel and ice components for all alternatives with a surrounding buffer of approximately 2.5 miles, totaling approximately 375 mi^2 or 240,000 acres. Bird data used in analyses are presented below, in Section 3.9, Birds, and in the tables in Appendix L. Reported population density estimates for ACP include ACP, Bird Conservation Region 3 or the Beaufort Sea Coast of ACP, depending on extent of individual surveys used in analyses.

Bird habitat analyses were based on the vegetation and wetland mapping described in Sections 3.8 and 5.8, Vegetation and Wetlands. Quantitative analyses were conducted for three types of impacts to birds from proposed gravel and ice features (e.g.; roads and pads): habitat loss, habitat alteration, and traffic disturbance areas. Impacts to birds from habitat fragmentation, vehicle and infrastructure collision mortality, and altered survival or productivity were evaluated qualitatively.

Bird habitat loss (i.e., areas of ice and gravel footprints) includes all land impacted to the extent that the area is made unusable by birds for nesting, foraging, and other activities. This includes areas with long-term loss of use such as sealift bulkheads and service pier footprints, and gravel mining and gravel fill areas, as well as temporary loss of areas from ice roads and pads that may be used for up to two winter seasons.

Alterations to bird habitat bordering “habitat loss” areas may be caused by gravel deposition or removal; these were estimated using a 330-foot buffer distance from proposed gravel footprints. Gravel fill would be expected to alter bird habitat and use in areas adjacent to the actual footprints of roads and pads due to dust deposition, snow drifting and piling, thermokarst, altered wetland hydrology, and increased human disturbance. These habitat alteration mechanisms are expected to cause changes in bird use, which may also result in changes in reproductive success or survival (TERA 2000, Liebezeit et al. 2009). The buffer distance was defined using multiple studies as guidance. For instance, Rodgers and Smith’s study (1997) of 16 species of ground or water loafing and foraging birds, where the birds were exposed to four types of vehicular and pedestrian approach and the distance at which they took flight was recorded. The authors concluded, “[a] buffer of about 330 ft should minimize disturbance to most species of waterbirds…” Additionally, in a study of the effects of ecotourism on waterbird distribution in a wildlife refuge, birds remained as far as 260 ft from the game drive roads (Klein et al. 1995).

Project features constructed from ice were not buffered for adjacent areas of alteration or disturbance, as much of the construction and use would occur in winter when birds are generally not present. The footprints would be anticipated to break up in late spring and early summer. Thus, these areas may not be available when birds initiate nesting the year following ice road construction, but would be available for other post-breeding activities and future years' breeding. Habitat loss for ice components is calculated for the short-term (less than two breeding seasons) from each alternative's ice footprint, while habitat alteration from ice is calculated by using the same footprint extended to a medium-term timeframe (two to ten breeding seasons) to allow for habitat recovery (Impact Criteria from Table 5.9-1). For more discussion on impact mechanisms and recovery related to wetland habitats, refer to Section 5.8, Vegetation and Wetlands

Air and boat traffic in areas such as the helipad, airstrip, dock, and barge landing locations would likely cause farther reaching noise and visual disturbances to birds. For these locations, disturbance impacts were estimated using a 1,640-foot buffer.

Impacts for buffer areas were calculated independent of each other, such that the area altered does not include the area lost, and the area disturbed includes neither the areas that are lost nor the areas that are altered.

The consequences to nesting, breeding and post-breeding birds from these three types of impacts (habitat loss, alteration, and disturbance) were quantitatively evaluated based on:

- Nest densities from ground-based plots completed during 2000 to 2003 (see Appendix L; Rodrigues 2002a, b; Liebezeit et al. 2009)
- Average ACP breeding season bird densities during 1992 to 2008 (see Appendix L; Larned et al. 2010)
- Post breeding season bird densities during 1998 to 2003 (see Appendix L; Noel et al. 1999, 2000, 2002b, c, d; Johnson et al. 2005)
- Breeding season observations of spectacled eiders (see Figure 3.9-4; Day et al. 1995; Day and Rose 2000; TERA 2000, 2002; Ritchie et al. 2003b; Schick et al. 2004; Frost et al. 2007; OASIS 2008; Larned et al. 2010)
- Breeding and post-breeding observations of yellow-billed loons (see Figure 3.9-5; Noel et al. 2003a; Fischer and Larned 2004)

Figure 5.9-1 provides a map of recorded occurrences of birds relative to the project area defined to analyze bird impacts (terrestrial area within approximately 2.5 miles of gravel and ice components for all alternatives). Bird location data shown on Figure 5.9-1 represent the aerial and ground-level survey efforts listed above. Note that the observations depicted on the map, and quantitative output used in the bird impact analyses, are multi-year observations derived from a variety of survey types (air, ground, nesting, breeding pairs, etc.) conducted at different times of the year with different protocols (different areas searched, etc.). It is important to note that blank areas on the map do not necessarily indicate the non-existence of birds, but rather, may indicate that the area was not surveyed during that study. Barge routes and potential aircraft flight patterns are included in the figure for reference during impact assessments described below. Finally, a smaller inset map reflects existing gravel features within the bird project area; these will be discussed below in Alternative A, No Action.

Nest data gathered by ground-based surveys were used to estimate nesting shorebird and songbird abundance because these small birds are not highly visible from the air and are not generally the focus of aerial surveys. Where available, data collected for large birds during these ground-based surveys has also been included for consideration. Aerial surveys were primarily used to estimate breeding and post-breeding bird counts for waterfowls, loons, seabirds, and large landbirds. They are effective for larger bird species because of the wider area sampled, the visibility of these birds from the survey aircraft, and the more irregular distribution of nesting habitats for these birds.

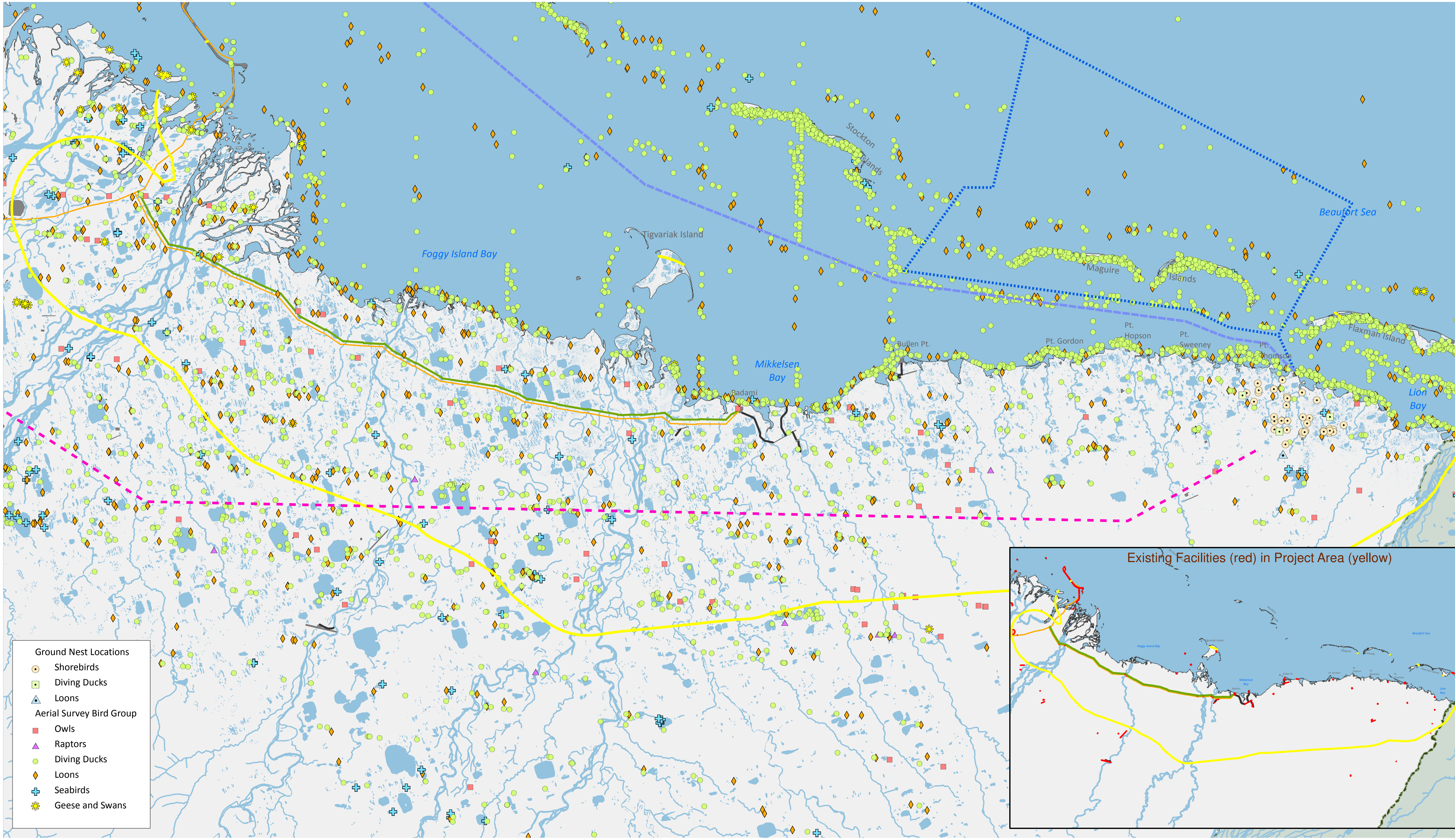
Impact analysis criteria used in this assessment for local and regional birds are presented below in Table 5.9-1. These impact criteria were developed based on a range of possible outcomes and to provide a frame of reference for impacts.

Table 5.9-1: Impact Criteria–Birds

Impact Category*	Intensity Type*	Specific Definition for Birds
Magnitude	Major	Potentially affecting ≥25% of a local bird population or ≥ 5% of an ACP bird population
	Moderate	Potentially affecting ≥5% but less than 25% of a local bird population, or ≥0.5% but less than 5% of an ACP bird population
	Minor	Potentially affecting ≥1% but less than 5% of a local bird population, or > 0.1% but less than 0.5% of an ACP bird population
	No Effect	Potentially affecting <1% of a local bird population or <0.1% of an ACP bird population
Duration	Long term	Lasting longer than 10 breeding seasons
	Medium term	Lasting longer than 2 breeding seasons but less than 10 breeding seasons
	Temporary	Lasting less than 2 breeding seasons
Potential to Occur	Probable	Not avoidable
	Possible	Potential to occur (may be able to mitigate)
	Unlikely	May occur, but unlikely to take place
Geographic Extent	Extensive	Arctic Coastal Plain
	Local	Between the Sagavanirktok and Canning River deltas
	Limited	Within 0.3 mile of project components

* Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Criteria Methodology.

Qualitative evaluations were conducted for the potential effects of habitat fragmentation on habitat patch size, edge effects, and movement barriers by overlaying each alternative's components on vegetation maps. These overlays identified areas of contiguous habitat, or habitat patches that would be crossed and possibly further fragmented by various alternative components. Also, aspects of infrastructure components (e.g., communication towers) were evaluated for their potential to block bird movements.



POINT THOMSON PROJECT EIS

Existing Road
Existing Ice Road
Existing Pipeline
Existing Facilities
Aircraft Route
Coastal Barge Route
Sealift Barge Route
Stream
Water Body
Arctic National Wildlife Refuge
2.5 Mile Buffer Around All Project Alternative Features

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

0 1 2 Miles

N

Figure 5.9-1

Occurrence of Birds and Existing Project Features in Point Thomson Bird Project Area

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

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Following the discussion of general impacts for all birds with potential to occur in the project area of a specific alternative, focus shifts to conservation birds of concern. Sections 3.9.8 and 3.9.9 provided life history information for these species. This section also addresses birds that are listed as threatened (spectacled eider and Steller's eider) or under consideration as a candidate for listing (yellow-billed loon) by USFWS. The Applicant requested designation as the "non-federal representative" to prepare the Biological Assessment (BA) for birds as part of the Section 7 ESA process and the Corps accepted the request. As the non-federal representative, the Applicant initiated informal Section 7 consultation through a meeting with USFWS in May 2010 at the USFWS's Fairbanks, Alaska office. The Corps was in attendance. A BA has been prepared that addresses federally listed endangered, threatened, and candidate birds for Corps verification and approval, and is included in Appendix M.

Following the analyses for each alternative, Section 15.7.6 includes a summary of design measures proposed by the Applicant to proactively avoid and minimize effects of project implementation. Finally, potential climate change and cumulative impacts are discussed.

5.9.2 Alternative A: No Action

The No Action Alternative, as described in detail in Chapter 2, involves suspension of hydrocarbon resources production at Point Thomson. The two production wells located on the existing central pad were capped and all other equipment and camp structures were demobilized in 2011. Future activities at the site would be limited to wellhead monitoring and inspection until the time that they are closed or brought into production in a future project. Actions related to maintenance could include periodic helicopter flights to PTU-3 from Deadhorse.

Because production wells have been drilled and capped, and all other equipment and camp structures, other than rig mats, were removed during demobilization in 2011, Alternative A is not anticipated to cause habitat loss or alteration to bird habitats. Aircraft disturbance during maintenance activities has the potential for minor impacts (displacement) to six conservation bird species of concern (black scoter, common eider, king eider, long-tailed duck, surf scoter, and white-winged scoter) based on these species choice of habitats and types of habitat use (Table 5.9-2). The inset map in Figure 5.9-1 shows the current gravel footprint at the project site, and the larger map displays the aircraft disturbance area (proposed flight paths) associated with Alternative A.

Table 5.9-2: Alternative A—Impact Evaluation for Birds

Impact Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Habitat Loss and Alteration	No effect	None	None	None
Boat/Air Traffic Disturbance	No effect	Long term	Possible	Limited
Productivity and Mortality	No effect	Long term	Unlikely	Limited
Conservation Birds of Concern (21 species)	No effect	Long term	Unlikely	Limited
Conservation Birds of Concern (6 species)	Minor	Long term	Possible	Limited
Threatened Birds (spectacled and Steller's eiders)	No effect	Long term	Unlikely	Limited

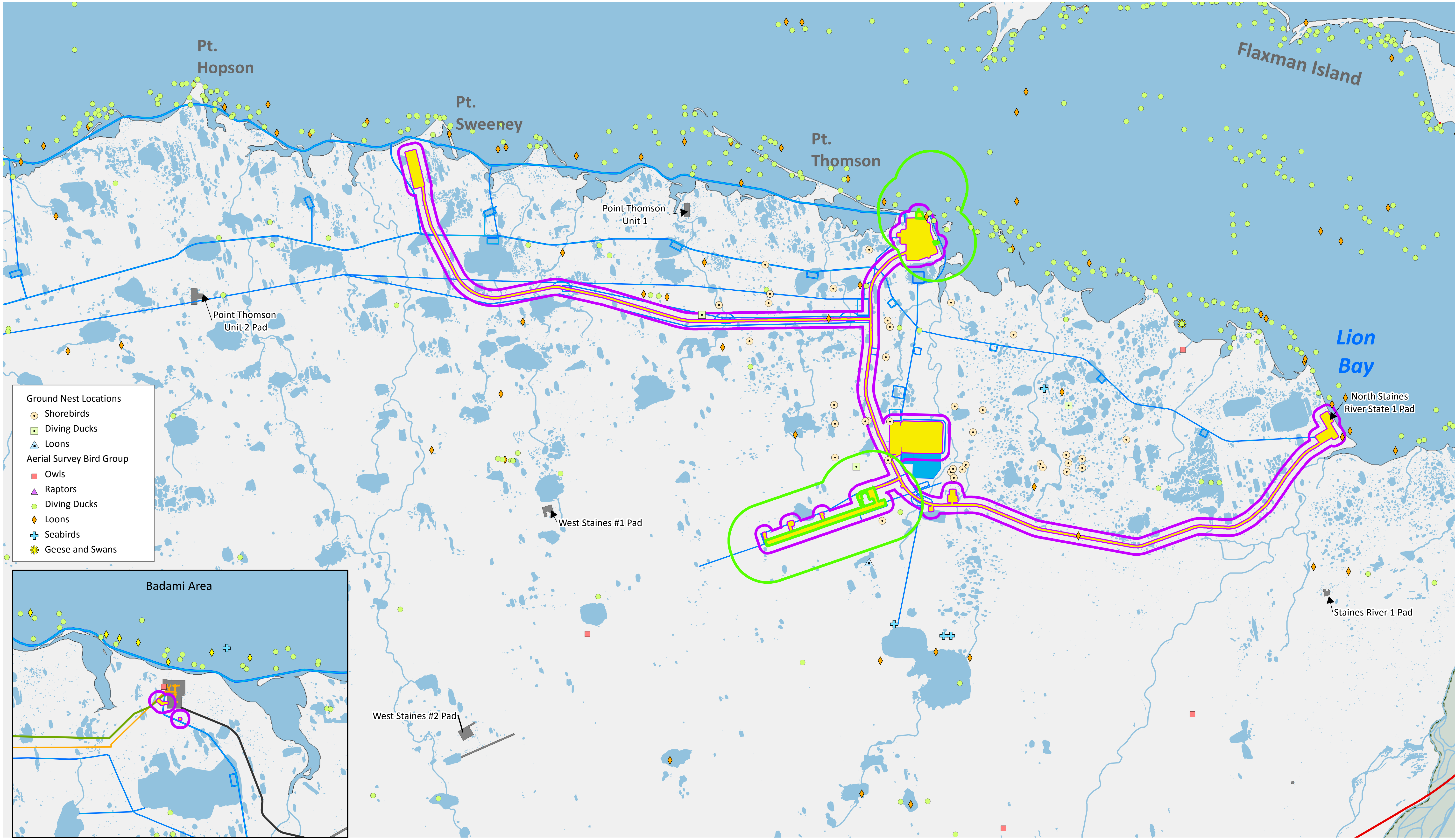
5.9.3 Alternative B: Applicant's Proposed Action

Construction of Alternative B would initiate long-term physical changes to bird habitat by placement of gravel fill for roads and pads (see Figure 5.9-2). Gravel fill covers habitat used by birds and also causes alteration to adjacent habitat. Once these physical habitat changes occur, many would continue through drilling and the operational lifespan of the project, although some would decrease in magnitude after construction. Transport and placement of the process modules, operations camp, and associated vertical structures would also occur during construction, and as with placement of gravel fill, the effect of these persisting physical structures on birds would continue for the life of the project.

Three phases (construction, drilling, and operations) are proposed for each of the action alternatives, Alternatives B through E, and, for many features, such as ice roads and pads, different levels of impact on birds and their habitat would occur as the project proceeds through these phases. These impacts and their severity are discussed by phase in the following sections. Note that the drilling phase for Alternative B overlaps with construction in the early years and operations later in the project schedule (see Section 2.4.3.5 for proposed project sequencing). Following these subsections, a review of impacts specific to birds of concern is provided. Finally, a summary of impacts and corresponding intensity (see Table 5.9-1) for Alternative B is included.

5.9.3.1 Alternative B: Construction

Construction of Alternative B would affect birds and their habitats through temporary, medium-, and long-term habitat loss and alteration. Table 5.9-3 provides a summary of habitat community impacts resulting from construction of Alternative B. As shown, the highest proportion of project impacts is to wet sedge and moist sedge-shrub communities. Together these two communities make up about two-thirds of the total available bird habitat (Table 5.9-3) and both are associated with most shorebird species in the Point Thomson area (Table 3.9-1). Overall, it is anticipated that approximately 1.3 percent of total bird habitat would be impacted by Alternative B project features. Approximately 0.8 percent of total available bird habitat would be impacted due to habitat loss and alteration: less than 0.1 percent would include long-term loss from gravel roads, pads, and mining, 0.2 percent from temporary loss from ice roads and pads (Table 5.9-3), and the remainder related to habitat alteration.



POINT THOMSON PROJECT EIS

Existing Road
Existing Ice Road
Existing Pipeline
Existing Facilities
Stream
Water Body
Arctic National Wildlife Refuge

Ice Footprint for Roads and Facilities
Gravel Footprint for Roads and Facilities
Disturbance - Traffic (1,640 ft)
Alteration - Gravel (330 ft)
2.5 Mile Buffer Around All Project Alternative Features

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

0 1 2 Miles

Figure 5.9-2
Alternative B – Summary of Bird Habitat Loss, Alteration, and Disturbance Areas and Occurrence of Birds of Conservation Concern

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

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Table 5.9-3: Alternative B—Summary of Estimated Project Effects on Bird Habitats in Point Thomson Bird Project Area

	Bird Habitats [a] (acres)								
Habitat Types	Lakes & Ponds	Emergent Marsh	Wet Sedge	Moist Sedge-Shrub	Coastal Barrens	Coastal Wet Sedge	Coastal Water	Total in Acres	Total in mi²
Available Habitat	17,968	2,251	64,108	97,659	2,228	3,020	40,779	228,013	356
% of Total Habitat Mapped [b]	7	1	27	41	1	1	17	95	95
Habitat Loss: Gravel	11	0	108	137	2	1	0	259	0.40
Habitat Alteration: Gravel	61	3	398	598	19	5	21	1,104	1.72
Habitat Loss/Alteration: Ice [c]	—	8	143	337	3	8	—	499	0.78
Boat/Air Traffic Disturbance	42	2	516	194	16	8	293	1,071	1.67
Total Affected Habitat	114	13	1,165	1,266	40	22	314	2,933	4.57
% of Available Habitat Affected	0.6	0.6	1.8	1.3	1.8	0.7	0.8	1.3	1.3

[a] Lakes and ponds includes areas of lakes (Ia3) and ponds (Ia4). Emergent marsh includes very wet tundra (IIb and IId). Wet sedge includes freshwater very wet/wet tundra (IIIa, IIIc, IIId, and IIIe). Moist sedge-shrub includes moist and moist/wet sedge-shrub tundra (Va, Vb, Ve and IVa) and dry shrub tundra (Vc and Vd). Coastal Barrens includes dry barren grass, dwarf shrub, and forb-graminoid complexes (IXe, IXf, and IXi). Coastal wet sedge includes saline wet graminoid tundra (IIIb) and wet barren/wet graminoid tundra complex (IXh). Coastal water includes bays, lagoons, inlets, and subtidal rivers (Ia1). See Section 3.8, Vegetation and Wetlands

[b] The *Available Habitat* estimate is based on the proportion of mapped habitat types extrapolated to a 375 mi^2 (240,000 acre) area, or the approximate area within about 2.5 miles of gravel and ice components for all alternatives. This estimate does not include 11,987 acres (5% of 375 mi^2 area) of water associated barrens (Xa, XIa, XIc), non-coastal dry/barren tundra complex (IXb, IXc, IXe), and disturbed barrens (Xc, Xe) that may be used by birds but that do not accurately fall within the habitat categories. Total Mapped Habitat percentage, therefore, does not equal 100%.

[c] For most ice features, the temporary habitat loss due to ice cover remaining through nest initiation is followed by a medium-term impact to allow for the reestablishment of standing dead vegetation which may require several growing seasons. Note: Ice on water not considered habitat impact, denoted with dash (—).

Estimates for nesting, breeding, and post-breeding birds potentially displaced because of habitat loss, habitat alteration, and bird disturbance during the construction phase are shown in Table 5.9-4. Habitat loss and alteration would likely have the greatest potential for effects on nesting songbirds and shorebirds, while disturbance from barges, aircraft, and vehicles would likely effect birds in both nesting and post-breeding stages (Table 5.9-4). From Table 5.9-4, estimates for bird displacement from combined habitat loss and alteration (both gravel and ice) reflect less than a 1 percent estimated impact to Point Thomson total birds for either nesting or breeding birds, and less than 0.5 percent impact to post-breeding birds. Traffic disturbance for all life history stages combined reflects less than a 1.6 percent potential displacement impact to the total Point Thomson estimated bird population. Additional discussion of each of these bird displacement impact types follows.

Table 5.9-4: Alternative B—Estimated Annual Number of Bird Nests, Breeding Birds, and Post-Breeding Birds Potentially Displaced by Habitat Loss, Habitat Alteration, and Air and Vessel Traffic Disturbance[a]

	Nests—Ground-based Estimate					Breeding Birds—Aerial Estimate					Post-Breeding Birds—Aerial Estimate				
Bird Group	Habitat Loss – Gravel	Habitat Alteration – Gravel	Habitat Loss/Alteration – Ice	Traffic Disturbance	Total Nests	Habitat Loss – Gravel	Habitat Alteration – Gravel	Habitat Loss/Alteration – Ice	Traffic Disturbance	Total Breeding Birds	Habitat Loss – Gravel	Habitat Alteration – Gravel	Habitat Loss/Alteration – Ice	Traffic Disturbance	Total Post-Breeding Birds
Geese and Swans	<1	<1	<1	<1	2	4	19	9	18	51	7	29	16	25	77
Dabbling Ducks	<1	<1	<1	<1	2	2	8	4	6	20	<1	<1	<1	<1	2
Diving Ducks	2	6	3	4	15	2	27	5	46	80	1	13	3	140	157
Loons	<1	1	<1	<1	3	<1	4	2	4	11	<1	2	1	2	6
Cranes	0	0	0	0	0	0	0	0	0	0	<1	<1	<1	<1	1
Seabirds	0	0	0	0	0	1	9	3	12	25	<1	1	<1	3	5
Shorebirds	39	150	81	114	385	<1	3	1	2	7	<1	3	2	3	8
All waterbirds	41	158	86	121	405	11	70	23	88	192	10	50	22	174	255
Raptors	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	<1
Owls	0	0	0	0	0	0	<1	<1	<1	1	0	<1	0	0	<1
Ptarmigan	<1	1	<1	<1	3	0	0	0	0	0	0	<1	0	0	<1
Songbirds	34	130	71	99	334	0	0	0	0	0	0	<1	0	0	<1
All landbirds	34	131	71	100	336	0	<1	<1	<1	1	0	<1	<1	<1	<1
Total	75	290	157	221	742	11	70	24	88	193	10	50	22	174	255
% of Point Thomson Estimate	0.1	0.5	0.2	0.3	1.2	0.1	0.6	0.2	0.8	1.7	<0.1	0.2	0.1	0.5	0.8
% of ACP Estimate	UK	UK	UK	UK	UK	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	0.1

Source: Noel et al. 1999, 2000, 2002c, d; Rodrigues 2002a, b; Johnson et al. 2005; USFWS 2008a; Liebezeit et al. 2009; Larned et al. 2010

[a] Numbers of birds impacted calculated by multiplying estimated project effects on bird habitat totals (from Table 5.9-3) by estimated density of bird nests, breeding birds, or post-breeding birds. More detail regarding densities provided in footnote of Table 5.9-5. Totals rounded to include nests or birds with densities of <0.1 per mi^2. Columns and rows may not total exactly due to rounding. UK = unknown.

Habitat Loss and Alteration

Long-term bird habitat loss and alteration would be initiated during gravel extraction and placement of fill. These activities would be completed during the winter, when most birds are absent from the ACP, so no birds or nests would be lost as a result of gravel mining or fill. After placement, a few birds may use the gravel fill for roosts, displays, and as a grit- or dust-bath source, and in areas with little activity some birds may nest on gravel fill (Pollard et al. 1990, TERA 2000).

On the ACP, availability of nesting habitat is not generally considered a limiting factor for distribution or abundance of birds (TERA 2000). Although many birds on the ACP nest, forage, or molt in or near the same areas used in previous years (Monda 1991; Limpert and Earnst 1994; Johnson 2000a; Ritchie and King 2000; Sedinger and Stickney 2000; TERA 2000; Noel et al. 2003a, b, 2004, 2005; Johnson et al. 2005), birds displaced from previously-used nesting sites have been shown to nest in adjacent undisturbed habitats (Troy and Carpenter 1990, TERA 2000).

Habitats within 330 feet of gravel fill may be degraded (altered) by dust deposition, snow drifting and piling, thermokarst, altered wetland hydrology, and disturbance. These altered sites would likely still be used by some birds (Troy 1986, Troy and Carpenter 1990, TERA 2000). Early access to vegetation for forage may benefit geese, swans, and ptarmigan, but nesting near gravel fill may reduce nest survival due to flooding, increase exposure to predators, and increased mortality of birds from vehicle collision.

Long-term habitat loss and temporary habitat alteration of offshore and coastal habitats would result from construction of the barge service pier for coastal barges, sealift facility for oceangoing barges, offshore mooring dolphins, and dredging for the combined barge offloading system. Installation of the in-water features would result in a long-term loss of a small amount of benthic habitat that would potentially provide or support forage organisms for birds using nearshore habitats. The same structures may, however, provide an alternative substrate that could support forage organisms that would be used by birds.

Disposal of the dredge material along the beach may also result in reduced forage for birds and may cover gravel habitats that could be used by nesting common eiders and Baird's sandpipers (see Section 5.8, Vegetation and Wetlands). Dredging through the ice would have little effect on birds, but screeding or dredging during the open water season would result in temporarily-increased turbidity that may reduce foraging efficiency for birds, especially long-tailed ducks and loons.

Tundra ice roads would cause temporary bird habitat loss and medium-term habitat alteration. These ice roads remain until after most birds have initiated nesting, causing temporary nesting habitat loss. Ice roads also compress the vegetation, especially standing dead vegetation used for concealment by some nesting birds. Standing dead vegetation would require multiple growing seasons to reestablish, likely resulting in medium-term habitat alteration. Water withdrawal from freshwater lakes during the winter for ice road construction could also result in temporarily reduced nesting habitat availability and suitability if shoreline and island habitats in the ponds are altered because water levels do not recharge the following spring from snowmelt runoff.

Disturbance

Potential disturbance sources during construction include noise from grading and compaction in gravel fill areas, vessel traffic in nearshore and offshore habitats, air traffic, and vehicle traffic. Responding to disturbance results in an energetic cost to a bird and alters the suitability of the habitat near the source of the disturbance (Hampton and Joyce 1985, Anderson 1992, Anderson et al. 1992, Murphy and Anderson 1993, Johnson et al. 2003). However, the energetic cost of response may not equate to reduced survival or productivity. Most waterfowl did not appear to be disturbed by noise at the Gas Handling Expansion Project at Prudhoe Bay; although pre-nesting Canada geese and nesting spectacled eiders tended to use areas farther away from facility noise (Anderson et al. 1992). Noise would likely cause the greatest disturbance to birds between June 1 and July 15 when birds on nests would be unable to move away from the disturbance. Following nesting, many birds typically move with their young from nest sites to different habitats, and are thus able to avoid disturbance sources.

General Construction

Although gravel extraction and fill would be completed during winter, grading, compacting, and reshaping of roads and pads would occur during summer when birds are present. Noise and vehicle traffic during these activities would likely disturb and displace birds away from gravel roads and pads. Similarly, noise and visual disturbance from construction of the barge offloading system, including summer dredging and screeding, may also temporarily displace birds in the immediate construction area, although most of the heavy construction for barge facilities, including all pile and sheet driving, would take place during the winter when bird occurrence is limited.

Vessel Traffic

Coastal barges would deliver equipment and supplies from Prudhoe Bay to the Central Pad each year, making frequent round trips during the open water period between July 15 and August 25 (Table 2.4-3, Alternative B). Disturbance at barge landing sites would potentially displace breeding and post-breeding birds (Table 5.9-4).

Sealift barges would deliver production modules and other equipment and supplies to the Central Pad during 2 to 4 weeks each summer for up to three construction seasons. Sealift landings would primarily occur late July/early August, when open water becomes available, to late August when subsistence bowhead hunting agreements take affect (Chapter 2, Alternative B). Sealift and coastal barge traffic present the greatest potential disturbance to birds when molting and brood-rearing waterfowl congregate along coastlines and barrier islands, and within coastal lagoons. Long-tailed ducks and other waterfowl are most abundant in Lion Bay and nearshore waters from July to September, with peak numbers exceeding 2,000 birds/mi^2 (Fischer and Larned 2004, Johnson et al. 2005, Noel et al. 2005). Boats approaching within 0.6 mile of long-tailed ducks have been observed to cause birds to dive or scatter, however, the ducks often returned to the same area after the disturbance (Petersen et al. 1999).

Air Traffic

After completion of the airstrip, an estimated 990 fixed-wing and helicopter flights each between Deadhorse and the Point Thomson airstrip would occur over the entire construction period (Table 2.4-3, Alternative B).

Noise and visual cues from air traffic would disturb birds. Aircraft noise levels would be highest during take-offs and landings, and most aircraft-related disturbance would be concentrated around airstrips. Bird responses to aircraft include alert and concealment postures, interrupted foraging behavior, flight, and a reduction in nest attendance. Behavioral responses to aircraft disturbance would not necessarily result in lowered nest success, and few nesting birds appeared to have been negatively affected by aircraft operations at the Alpine oil field near the Colville River delta. Greater white-fronted geese shifted their nest distribution away from the Alpine airstrip, but while aircraft disturbance reduced nest attentiveness, nest success for geese and swans was not reduced (Johnson et al. 2003). A similar response might be expected at Point Thomson.

Vehicle Traffic

Vehicles are a common source of disturbance on oil field roads, but appear to cause less severe behavioral responses from birds than pedestrians and airplanes (Johnson et al. 2003). Birds close to roads respond differently to various types of vehicular traffic, and large, noisy vehicles, such as gravel-hauling trucks, or equipment with unusual profiles, such as boom cranes, have been reported to cause the highest rates of behavioral response. Documented bird reactions, especially among pre-nesting and brood-rearing birds, to vehicle traffic include head lifting, walking, running, or flying. The strongest reactions to vehicles may occur during pre-nesting when birds are attracted to roadsides by early vegetation sprouting (Murphy and Anderson 1993). In addition, disturbance from vehicles may affect the activity and energy budgets of waterfowl and loons by increasing the length of time that the birds are away from the nest during incubation and potentially reducing nest success (Johnson et al. 2003). A study specific to tundra swans found nest success to be higher for nests that are farther from roads (Ritchie and King 2000).

Habitat Fragmentation

Generally roads would not be considered a hindrance to bird movements, as most birds would be able to cross them, although exceptions to this may include waterfowl with broods, and loons. Additionally, steep gravel banks along roads can create a visual barrier that may preclude flightless birds from attempting to cross. However, studies have documented successful movements of brood-rearing geese (Johnson 2000b) and Pacific loons (Kertell 2000) across oil field roads.

Vehicle and Infrastructure Collision Mortality

Birds may collide with structures that would be installed during construction such as communication towers, flare towers, buildings, antenna guy-wires, elevated pipelines, and mooring dolphins (Day et al. 2005, 2007). Temporary satellite dishes, elevated radio antennae, radio repeater sites between Point Thomson and the Badami tie-in site, and the 160-foot communication tower erected at the Central Pad would also add potential collision hazards. At Badami, where collision rates would likely be higher due to its location near coastal migration paths, a 200-foot communication tower would also be constructed. In addition, birds, such as eiders, loons, and ducks that fly low and fast over water along the coast during migration may collide with the mooring dolphins and the grounded barge bridge that are designed for location above sea level. Although bird collisions with oil field structures are expected to be minor, some collisions and mortality are probable, especially during migration when large numbers of birds move along the coast and when visibility is poor because birds are attracted to lighted facilities during these time periods (Day et al. 2003, 2005; Russell 2005; Smith 2012). Bird collision events with infrastructure during poor weather conditions are rare and episodic, but would have the potential to occur for the life of the project (long term) because facilities would always be lighted. The potential for impact is lessened by the mitigative measure of downward shielded lighting. Most infrastructure collisions would involve individual birds or several birds from small flocks, but under certain conditions could involve large flocks.

Traffic from construction, drilling, and operational activities on infield gravel roads poses the greatest threat to birds during the summer, when large numbers of birds are present in the study area, possibly resulting in bird collision mortality. Geese attracted to roadsides by early vegetation sprouting, brood-rearing waterfowl, and ptarmigan using roadside grit become susceptible to collisions with vehicles. Although geese may gain access to nutritious forage near roads, their exposure to vehicle disturbances also increases. Overall, collision mortality is generally thought to be low within North Slope oil fields, although this is poorly documented.

Altered Survival or Productivity

Disturbance (e.g., construction, traffic) could lead to nest abandonment or facilitate predation when nesting adults abandon nests or when flushing birds attract predators to the nest. Exposure to construction noise and disturbance may result in some reduced productivity for nesting Canada and white-fronted geese (Murphy and Anderson 1993), but major changes in habitat use and productivity are not likely. Reijnen and Foppen (1994) found that the numbers of breeding birds in wooded areas declined near roads and in proportion to the density of traffic on the road.

Construction camp operations at the Central Pad would produce food waste, which, if made available to wildlife, would attract ravens, large gulls, foxes, and weasels. Access to food waste would potentially benefit these nest predators, indirectly affecting bird survival and reproduction by attracting predators that may prey on birds nesting near the facility. Solid waste stored and backhauled to Deadhorse or elsewhere could be available to predators beyond the limited area of the Central Pad camp and could contribute to alteration of local predator distribution and abundance. Increased local abundance of predators could in turn lead to reduced nesting and reduced productivity for birds nesting near camps and oil field infrastructure (USFWS 2003, NRC 2003a, Anderson et al. 2009, Liebezeit et al. 2009). In addition, structures such as the drilling rig, storage containers, and other stacks of stored materials provide perches for common ravens and raptors, which facilitate predation on ground-nesting birds.

Consequences of nesting near gravel fill with associated habitat alteration include an increased risk of predation as predators have also been found to be attracted to newly-created edge habitats (Liebezeit and Zack 2008; Liebezeit et al. 2009). Many predators use edge habitats more often than non-edge for their foraging. Liebezeit and Zack (2010) found that nest predation was the most important cause of nest failure accounting for 92 percent of failed nests of 11 species in the Prudhoe Bay oilfields. Liebezeit et al. (2009) found that the risk of songbird nest predation increases within 3.6 miles of infrastructure, resulting in an estimated survival to age of fledging of 32 percent for nests within 0.2 mile of infrastructure, 48 percent for nests within 0.6 mile of infrastructure, and 83 percent for nests within 3.6 miles of the infrastructure. Similar reductions in nest survival were not identified for shorebirds; potentially due to the ***precocial*** (able to move freely post hatching; requiring minimal parental care) development of shorebird hatchlings, which are mobile within days after hatching. TERA (2000) reported that most shorebirds generally avoid areas next to gravel fill during breeding and nesting, but that avoidance diminishes as summer progresses, until late summer, when shorebirds may be attracted to roadside areas. The exception to this observation was that red-necked phalaropes appeared to be attracted to roadside areas during all periods (TERA 2000), and Liebezeit et al. (2009) found that survival models indicated red and red-necked phalarope nests close to infrastructure were less likely to succeed. The observed reduction in nest survival for phalaropes may indicate that the use of areas near infrastructure for this species could ultimately reduce abundance in the area.

If there is a hesitancy in crossing the road corridors between the Central Pad and either the West or East Pads by brood-rearing waterbirds, this may increase their risk of predation. Foxes and gulls, being attracted to the edge habitat, make distracted birds and their young more vulnerable to predation. Structures, including pipelines, communication towers, and buildings are often used as perches for predatory birds, and are likely to facilitate predation on nearby ground-nesting birds (Liebezeit et al. 2009).

5.9.3.2 Alternative B: Drilling

Impacts to birds and their habitats from Alternative B drilling activities include medium-term habitat alteration and disturbance. There may also be medium-term mortality risk resulting from infrastructure and vehicle collision. Further, each of these impacts could in turn cause medium-term altered survival or productivity for birds. During the drilling phase, it is anticipated that coastal barge activity and both fixed-wing and helicopter traffic would be reduced by approximately half (Table 2.4-3), reducing disturbance to birds at the sealift facility and airstrip. In addition, by this phase, infield ice roads would no longer be required as all gravel road and pipeline construction would be complete, so that vegetation impacted by the infield ice road footprints could begin to recover. There would continue to be one ice road between Endicott Spur and Point Thomson, but if possible, it would be a sea ice road, limiting impacts to tundra vegetation. The annual ice road between Badami and Point Thomson would end with the close of the construction phase (Year 3).

Habitat Loss and Alteration

Storage of drill pipe, materials, and supplies for drilling creates voids that may provide cover for nesting songbirds. Drill pipe stacks, the drilling rig, and other materials and buildings provide vantage perches that may be used by raptors, owls, songbirds, and seabirds.

Disturbance

Drilling produces noise and would occur year-round, although penetration into the hydrocarbon reservoir would be restricted to winter months. Noise would likely cause the greatest disturbance to birds during surface drilling, casing, or testing between June 1 and July 15 when birds on nests would be unable to move away from the disturbance. More information on noise levels anticipated during each phase can be found in Section 5.20, Noise.

Vessel Traffic

A considerable number of coastal barge loads would be required to support overlapping construction and drilling activities (Table 2.4-3, Alternative B). Coastal barges would land at the Central Pad and disturbance from barge traffic and landing would cause minor, temporary displacement of brood-rearing and molting waterfowl and loons from the vicinity of the landing location (see discussion under Construction).

Air Traffic

An estimated total of 400 fixed-wing aircraft flights between Deadhorse and the Point Thomson airstrip would be necessary to support the proposed 2.5 years of drilling activities. Low-level over-flights can cause birds to flush from nests or roosts, although most disturbances would occur during take-off and landing at the airstrip as discussed under construction.

Vehicle Traffic

Vehicle traffic and associated disturbance to birds would increase on infield roads during drilling as personnel and supplies are moved between the three drill pads and camp locations. Traffic would, however, likely be more predictable with increases around change shifts followed by periods with reduced or no traffic, resulting in potential reduction in overall traffic disturbance effects on birds, as discussed under construction.

Vehicle and Infrastructure Collision Mortality

Besides other permanent structures discussed in the Construction section, during the drilling period birds may also collide with the drilling rig and the rig camp. Collision mortality risk would be highest during spring and fall migrations during periods of poor visibility, as discussed under construction.

Temporary flaring may be necessary during drilling, well completion, and well testing at all three pads. Gas flaring may attract migrating birds, increasing their risk for collision or injury (Day et al. 2003). Birds flying near or through the flare would likely be injured or killed, although flaring would be a rare event and noise produced by the flaring may offset the attraction of the light from the flare to night-migrating birds.

Altered Survival or Productivity

Continuing access and benefits from food waste, perching habitat, and cover could lead to additional increases in abundance and distribution of common raven, glaucous gull, and arctic fox predators. This would result in increased predation on other birds and nests as discussed under construction.

5.9.3.3 Alternative B: Operations

Alternative B operations would affect birds and their habitats through long-term habitat alteration, long-term disturbance, and long-term infrastructure and vehicle collisions. These could in turn result in long-term altered survival or productivity. These effects, along with the habitat losses accounted for during the construction phase, would last for the duration of field life and through potential future field development. Use of ice roads, both infield and to/from Point Thomson would be terminated by the end of the drilling phase, other than the possibility of an ice road linking to the Endicott Spur that may be constructed every five years or so. Coastal barge activity would be reduced further during this phase, to an estimated 15 roundtrips per year (Table 2.4-3). Use of the airstrip is anticipated to increase, primarily for fixed-wing aircraft, for resupply of equipment and supplies, and transport of personnel.

Habitat Alteration

As discussed in drilling, ongoing storage of materials and supplies for drilling and operations can create voids that may provide cover for nesting songbirds. Large infrastructure, drill rigs, and other materials and buildings provide vantage perches that may be used by raptors, owls, songbirds, and seabirds. Some bird species, such as snow buntings, nest in cavities between pipeline VSMs and the bracket holding the pipeline. Common ravens often nest near exhaust vents or other platform like surfaces. Raptors may use communication towers for perches; but as long as facilities are manned, they are unlikely to nest on communication towers.

Disturbance

Noise from the processing facility at Central Pad would add disturbance, which could displace geese, swans, and eiders from the vicinity of the facility (Anderson et al. 1992) as discussed under construction.

Vessel Traffic

During operations, an estimated fifteen coastal barge round trips between Prudhoe Bay and Central Pad between July 15 and August 25 each year could displace brood-rearing and molting waterfowl and loons as discussed under construction.

Small boats used for spill response and training would disturb brood-rearing, foraging, and molting waterfowl in the lagoon and along shoreline and barrier island habitats within the project area. Spill response vessels travel at higher speed than barges, change directions quickly, and would cause minor temporary displacement of long-tailed ducks, eiders, scoters, and loons (Fischer and Larned 2004; Noel et al. 2003a, 2005; Johnson et al. 2005).

Air Traffic

During operations, an estimated total of 550 fixed-wing aircraft and helicopter flights would transport personnel and supplies between Deadhorse and the Point Thomson airstrip (Table 2.4-3, Alternative B). Helicopter flights would be used for specific purposes such as pipeline inspections. Helicopter pipeline overflights would add to aircraft disturbances outside of the normal transit route for air traffic, and could potentially be more disturbing to birds than scheduled flights.

Vehicle Traffic

Once construction and drilling are completed, a smaller workforce with fewer vehicles would be required to run the production facility. Traffic rates and associated impacts within the project area would be reduced from initial project development phases and would likely cause less disturbance to birds. Between the Endicott Spur and Point Thomson, it is conservatively estimated that an ice road could be needed every 5 years to transport large equipment or modules.

Vehicle and Infrastructure Collision Mortality

During operations, bird collisions with the processing facility, communication towers, camps, other outbuildings, and flares are probable. The coastal location for Alternative B components increases the likelihood that migrating birds would collide with structures, especially eiders and long-tailed ducks (Day et al. 2003, 2005). Alternatively, reduced infield traffic levels during operations compared to construction and drilling would likely result in a reduced risk of collision mortality.

Permanent high- and low-pressure flare stacks would be built during the construction phase at the Central Pad and used during operations. As discussed above in drilling, gas flaring may attract migrating birds, increasing their risk for collision or injury (Day et al. 2003). Birds flying near or through the flare would likely be injured or killed, although flaring would be a rare event and noise produced by the flaring may offset the attraction of the light from the flare to night-migrating birds.

5.9.3.4 Alternative B: Conservation Birds of Concern

Annual estimates for habitat loss, alteration, and disturbance effects from Alternative B on conservation birds of concern are included in Table 5.9-5. Potential construction, drilling, and operations impacts caused by components of Alternative B would be the same as those described above for other nesting, breeding, and post-breeding birds and their habitats. The greatest potential for Alternative B to affect nesting and brood-rearing conservation birds of concern is through habitat loss and alteration. For brood-rearing and molting waterfowl (post-breeding), the greatest potential impact would be disturbance from barge, aircraft, and vehicle traffic during summer maintenance, drilling, and operations activities. The common eider population on the ACP could have moderate impacts under Alternative B primarily because of potential disturbance to nesting and post-nesting habitat from the barge landing facilities. The 3.8 percent impact to the local Point Thomson population does not rank the common eider as “moderate” impact magnitude for the local population (see Table 5.9-1), but given the ACP Abundance estimate of only ~2,500, an impact to 13 individuals meets the criteria of $\geq$ 0.5 percent for impacts to ACP abundance. Figure 5.9-2 shows the distribution of conservation birds of concern by species group in relation to facilities proposed under Alternative B.

Alternative B impacts would be long term, lasting for the life of the project, for all conservation birds of concern, but the impact would be limited in extent to within 0.3 miles of project infrastructure. The potential for impacts to occur would be probable for species with a minor magnitude. It is less probable (possible) for a moderate impact to occur to common eiders. Because of the rarity of bald eagles in the study area, it is unlikely that this species would be impacted.

Table 5.9-5: Alternative B—Estimated Annual Number of Conservation Birds of Concern Potentially Displaced by Habitat Loss, Habitat Alteration, and Disturbance

Species (Migration)[a]	Point Thomson Breeding Estimate (375 mi^2)[b]	Point Thomson Post-Breeding Estimate (750 mi^2)[c]	ACP Abundance[d]	Estimated Number of Birds and Percent of Point Thomson Project Area and ACP Estimate					
				Nests	Breeding Birds	Post-Breeding Birds	% of Point Thomson[e]	% of ACP Abundance[e]	Estimated Impact Magnitude
American Golden Plover (L)	4,327	✓	100,000	25	✓	✓	1.2	<0.1	Minor
Arctic Tern (L)	371	81	~13,000	0	5	<1	1.3	<0.1	Minor
Bald Eagle (S)	—	✓	NS	—	✓	✓	✓	✓	NE
Bar-tailed Godwit (L)	✓	✓	~100,000	✓	✓	✓	✓	✓	Minor
Black Scoter (S)	11	51	~100	0	<1	<1	2.7	0.3	Minor
Brant (S)	266	409	~12,000	0	4	4	1.5	<0.1	Minor
Buff-breasted Sandpiper (L)	715	✓	~7,500	4	✓	✓	1.1	0.1	Minor
Common Eider (S)[f]	340	5,913	~2,500	0	13	5	3.8	0.5	Mod.
Dunlin (L)	5,571	✓	~475,000	33	✓	✓	1.2	<0.1	Minor
Golden Eagle (S)	—	✓	~40	—	✓	✓	✓	✓	Minor
King Eider (S)	1,779	81	~16,000	10	11	<1	1.1	0.1	Minor
Long-tailed Duck (S)	1,505	60,050	~62,000	3	32	150	2.1	0.2	Minor
Northern Harrier (L)	—	2	~900	—	—	✓	✓	✓	Minor
Pacific Loon (S)	693	543	~21,000	1	9	5	1.3	<0.1	Minor
Peregrine Falcon (L)	—	✓	~1,800	—	—	✓	✓	✓	Minor
Red Knot (L)	✓	✓	✓	✓	✓	✓	✓	✓	Minor
Red-throated Loon (L)	282	116	~2,000	2	1	1	1.4	0.1	Minor
Rough-legged Hawk (S)	✓	9	~4,000	✓	✓	<1	1.1	<0.1	Minor
Sanderling (L)	✓	✓	~30,000	✓	✓	✓	✓	✓	Minor
Sharp-shinned Hawk (L)	—	✓	NS	✓	✓	✓	✓	✓	Minor
Short-eared Owl (S)	3	4	~90,000	✓	✓	<1	2.5	<0.1	Minor
Snowy Owl (S)	36	✓	~800	0	1	0	1.7	<0.1	Minor
Spectacled Eider (S)	144	✓	6,635	1	3	✓	1.8	<0.1	Minor
Steller's Eider (S)	—	✓	168	—	—	✓	✓	✓	NE
Surf Scoter (S)[g]	—	1,297	~4,000	—	16	<1	1.2	0.4	Minor
Whimbrel (L)	✓	✓	21,000	✓	✓	✓	✓	✓	Minor
White-crowned Sparrow (L)	✓	✓	21,900,000	✓	✓	✓	✓	✓	Minor
White-winged Scoter (S)	29	230	100,000	0	1	0	2.8	<0.1	Minor
Yellow-billed Loon (L)	37	8	1,119	0	<1	0	1.4	<0.1	Minor

Table 5.9-5: Alternative B—Estimated Annual Number of Conservation Birds of Concern Potentially Displaced by Habitat Loss, Habitat Alteration, and Disturbance

Species (Migration)[a]	Point Thomson Breeding Estimate (375 mi²)[b]	Point Thomson Post-Breeding Estimate (750 mi²)[c]	ACP Abundance[d]	Estimated Number of Birds and Percent of Point Thomson Project Area and ACP Estimate					
				Nests	Breeding Birds	Post-Breeding Birds	% of Point Thomson[e]	% of ACP Abundance[e]	Estimated Impact Magnitude

Sources: Noel et al. 1999, 2000, 2002b, c, d; Rodrigues 2002a, b; Rosenberg 2004; ADFG 2006; Dau and Bollinger 2009; Liebezeit et al. 2009; Larned et al. 2010.

[a] (R) = Resident; (S) = Short-distance migrant; (L) = Long-distance migrant.

[b] Point Thomson nest density multiplied by 375 mi², multiplied by 2 birds per nest; or ACP breeding density multiplied by 375 mi² plus Average Point Thomson coastal breeding density multiplied by 75 miles; value is greater of the two estimates, except for spectacled eiders which is based on a combine nest and aerial density of 0.191 pairs per mi².

[c] Point Thomson post-breeding estimates are combined shoreline density multiplied by 75 mi², lagoon density multiplied by 225 mi², barrier island density multiplied by 75 mi², and tundra density multiplied by 375 mi².

[d] NS = not estimated, NR = not recorded.

[e] Percent of Point Thomson = Largest of three stages of bird impacts: Nests times 2 or Breeding Birds divided by Point Thomson Breeding Estimate, or Post Breeding Birds divided by Point Thomson Post-Breeding Estimate. Percent of ACP Estimate = Largest of Nests times 2, Breeding Birds, or Post-Breeding Birds divided by the ACP Abundance Estimate.

[f] The Point Thomson common eider post-breeding estimate is a product of the Point Thomson-specific common eider density multiplied by the total project area being considered for all species of birds (i.e.; 750 mi²). Therefore, for common eider, the estimate is larger than the ACP total abundance as provided by literature. This discrepancy is noted and considered in the analyses. In order to keep calculation methodologies consistent, this number was not altered in tables.

[g] Although identified by experts during breeding bird surveys over multiple survey years, and therefore presented under the "Breeding Birds" column for numbers of birds potentially impacted, there are no definitive nesting records of surf scoter along the Alaska portion of the Beaufort Sea. Therefore, these birds are assumed to be non-breeding, although resident during periods when other species are actively nesting.

Check (✓) indicates documented to occur but no quantitative data available; dash (—) indicates not documented to occur. No Effect (NE), estimated effect is less than minor in magnitude (i.e., <1% of local population exposed, or <0.1% of ACP population exposed).

Threatened, Endangered, and Candidate Birds

As discussed in Section 3.9.9, there are two bird species federally protected by the ESA that have the potential to occur in the project area: the Steller's eider (threatened) and spectacled eider (threatened). In addition, the yellow-billed loon is addressed in this section as it is a candidate species under evaluation for listing under the ESA and could be listed during project planning or implementation. The BA for these three species is included in Appendix L.

Steller's Eider

As discussed in Chapter 3, the Steller's eider is ESA listed as threatened. Based on nesting, breeding, and post-nesting abundance, estimated habitat alteration, and disturbance, Alternative B components would potentially affect less than one Steller's eider (Table 5.9-5). Steller's eiders are unlikely to occur near proposed project infrastructure or in the vicinity of barge traffic between Prudhoe Bay and Point Thomson. Because of this, no conservation measures are proposed for the Steller's eider. Mitigation measures identified for all alternatives to avoid or reduce potential effects to water birds would likely benefit Steller's eiders should they occur within the project area.

Steller's eiders are not likely to nest in the project area, but post-breeding Steller's eiders that occur near the barge landing at Central Pad, or between Barrow and Central Pad along the shipping route, could be temporarily displaced by human disturbance. Alternative B infrastructure and traffic could present collision hazards, especially for spring and fall migrating Steller's eiders. Because Steller's eiders rarely occur in the study area and because the project would be generally east of Steller's eiders distribution in Alaska, potential effects of Alternative B on Steller's eiders would be unlikely.

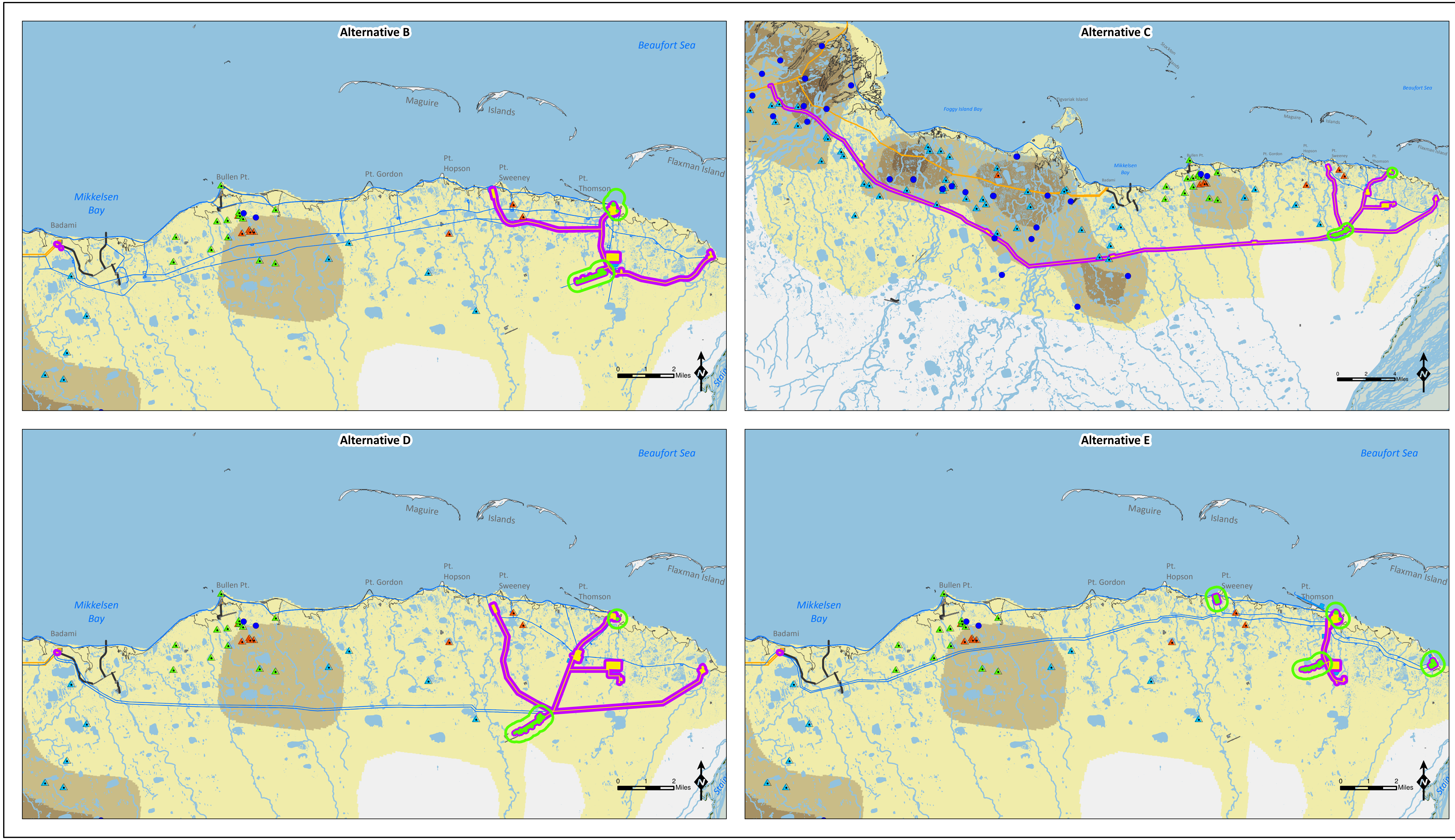
Spectacled Eider

Spectacled eiders, also listed as threatened under ESA, may occur near the proposed Central Pad, West Pad, East Pad, or in the vicinity of barge traffic between Prudhoe Bay and Central Pad. Surveys between 1998 and 2001 found seven pair within the Point Thomson study area, including dependent young near Point Sweeney (TERA 2002). Six years of surveys within ten miles of the site at Bullen Point found one to 14 spectacled eiders each year. While the species occurs in the study area, it is rare. Based on nesting, breeding, and post-nesting abundance, the impacts of Alternative B would potentially affect up to five spectacled eiders (Table 5.9-5). Standard conservation measures proposed for spectacled eiders include preconstruction surveys to identify any habitats used for nesting or brood-rearing that would potentially be altered by any of the action alternatives. Design measures identified to avoid or reduce potential effects to waterbirds would likely benefit the few spectacled eiders that have the potential to occur within the study area.

A few spectacled eiders are likely to nest in the study area. One spectacled eider was documented within 0.5 mile of proposed gravel infrastructure during 2001 near the West Pad (see Figure 5.9-3). Post-breeding spectacled eiders may be present, though no recent sightings have been documented along the shoreline, in the lagoon near the barge landing at Central Pad, or along the barging route between Prudhoe Bay and Central Pad. If spectacled eiders were present in these areas they would likely be temporarily displaced by the disturbance. Alternative B infrastructure and traffic could present collision hazards especially for spring and fall migrating spectacled eiders. Because few spectacled eiders are likely to occur in the study area, potential effects of Alternative B on spectacled eiders would likely be minor, local in extent, and long term.

Yellow-billed Loon

Yellow-billed loons, a candidate species for federal ESA listing, may occur near the Central Pad, East Pad, and in the vicinity of barge traffic between Prudhoe Bay and Point Thomson, but they are unlikely to be abundant. Three yellow-billed loon sightings have been documented within 0.5 mile of proposed gravel infrastructure during 1999, 2000, and 2001; one each near Badami, West Pad, and Central Pad (Figure 5.9-4). Foraging yellow-billed loons are likely to be present along the shoreline or in the lagoon near the Central Pad, East Pad, and along the barge route between West Dock and the Central Pad. Yellow-billed loons in these areas would likely be temporarily displaced by disturbance. Alternative B infrastructure and traffic could present collision hazards especially for spring- and fall-migrating yellow-billed loons. Because few yellow-billed loons are likely to nest near project facilities, the potential effects of Alternative B components on yellow-billed loons would likely be minor, local in extent, and long term. Based on nesting, breeding, and post-nesting abundance, estimated habitat alteration, and disturbance would potentially affect less than one yellow-billed loon under Alternative B (Table 5.9-5). Standard conservation measures include preconstruction surveys to identify any habitats used for nesting or foraging that could potentially be altered by the alternatives. Design measures identified for all action alternatives to avoid or reduce potential effects to waterbirds would likely benefit any yellow-billed loons that may occur within the study area.



POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Existing Facilities
- Water Body
- Existing Pipeline
- Existing Road
- Stream
- Gravel Footprint for Roads and Facilities
- Ice Footprint for Roads and Facilities
- Alteration - Gravel (330 ft)
- Disturbance - Traffic (1,640 ft)
- Spectacled Eider Breeding Survey Observations (1992-2009)

Spectacled Eider Nesting Aerial Surveys

- Point Thomson
- Bullen Point
- Kuvlum

Spectacled Eider Pre-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

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

Figure 5.9-3

Alternatives B to E – Summary of Spectacled Eider-Habitat Loss, Alteration, Disturbance Areas, and Occurrence of Spectacled Eiders

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

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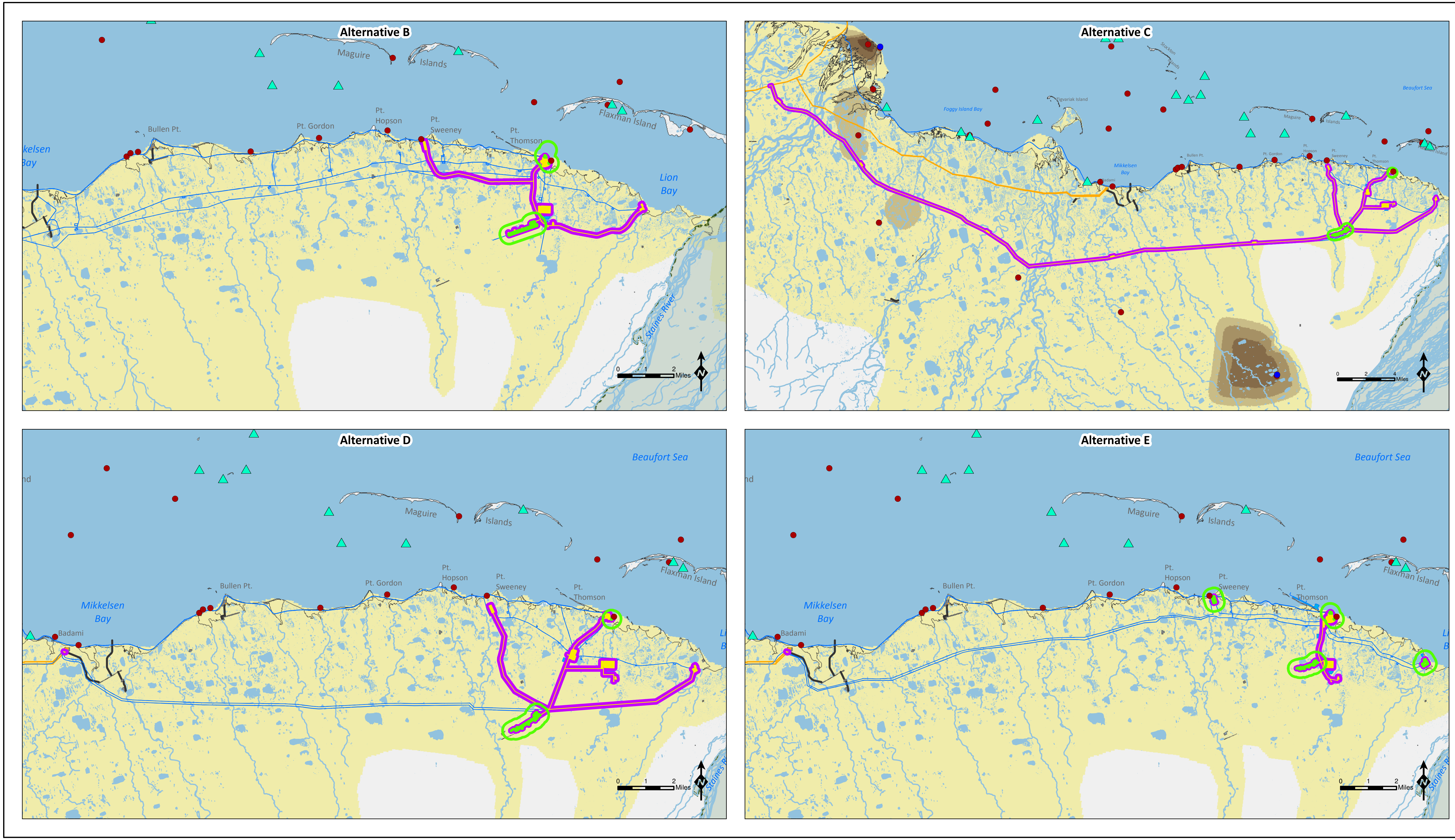

POINT THOMSON PROJECT EIS

Legend

- Arctic National Wildlife Refuge
- Existing Facilities
- Water Body
- Existing Pipeline
- Existing Road
- Stream
- Gravel Footprint for Roads and Facilities
- Ice Footprint for Roads and Facilities
- Alteration - Gravel (330 ft)
- Disturbance - Traffic (1,640 ft)
- Yellow-billed Loon Post-nesting Coastal Observations (1999-2001)
- 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 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

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

Figure 5.9-4

Alternatives B to E – Summary of Yellow-billed Loon-Habitat Loss, Disturbance Areas, and Occurrence of Yellow-billed Loons

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

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5.9.3.5 Alternative B: Summary of Effects on Birds

Habitat effects resulting from construction, drilling and operations of Alternative B would likely have the greatest potential effect on wet sedge, moist sedge-shrub, and coastal barren habitats for both waterbirds and landbirds (Table 5.9-3). This is primarily due to disturbance from barges and aircraft, which would likely have the greatest potential effects on breeding and post-breeding waterbirds. However, overall, Alternative B is anticipated to impact less than 4 percent of the Point Thomson total bird population, and less than 0.5 percent of the overall ACP population of birds found in the Point Thomson study area (Table 5.9-4). For conservation birds of concern, all but the common eider have estimated impacts that are of a magnitude of either minor or no effect. With a 3.8 percent impact to the Point Thomson estimated population of common eiders, the impact to this species is categorized as moderate.

Table 5.9-6: Alternative B—Impact Evaluation for Birds

Impact Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Habitat Loss and Alteration	Minor	Long term	Probable	Limited
Boat/air Traffic Disturbance	Minor	Long term	Probable	Limited
Productivity and Mortality	Minor	Long term	Possible	Limited
Conservation Birds of Concern (1 species)	No effect	Long term	Unlikely	Limited
Conservation Birds of Concern (25 species)	Minor	Long term	Probable	Limited
Conservation Birds of Concern (1 species)	Moderate	Long term	Possible	Limited
Threatened Bird (spectacled eider)	Minor	Long term	Unlikely	Limited
Threatened Bird (Steller’s eider)	No effect	Long term	Unlikely	Limited
Candidate Bird (yellow-billed loon)	Minor	Long term	Unlikely	Limited

5.9.4 Alternative C: Inland Pads with Gravel Access Roads

Potential long-term Alternative C effects on birds and their habitats from gravel fill and structure placement mirror the types of effects described for Alternative B, but with increased acreages for inland habitat loss and alteration due to the construction of a gravel access road from Point Thomson to the Endicott Spur Road. In addition, the above-ground waterline proposed under Alternative C could cause habitat fragmentation to some waterbird species. However, potential impacts to waterbirds could be reduced by the movement of project components inland and no construction of barging and sealift facilities. As discussed for Alternative B, potential habitat effects have been evaluated by acres of habitat type impacted and by estimates of number of breeding and post-breeding birds potentially displaced by individual project components. Figure 5.9-5 provides a map of the areas of potential impacts from project components of Alternative C.

5.9.4.1 Alternative C: Construction

Construction of Alternative C would affect birds and their habitats through long-term habitat loss and alteration from gravel roads and pads; temporary and medium-term habitat alteration from ice roads and pads; and long-term disturbance primarily due to airstrip usage. Table 5.9-7 provides a summary of habitat community impacts resulting from construction of Alternative C. The highest proportion of project impacts would be to wet sedge, moist sedge-shrub, and emergent marsh communities, although impacts for any one of these habitats would be less than 6 percent of the total available in the project area. Less than 3 percent of total available bird habitat would be impacted due to habitat loss and alteration: less than 0.3 percent of this amount would include long-term loss from gravel roads, pads, and mining, and 0.3 percent would include temporary habitat loss from ice roads and pads.

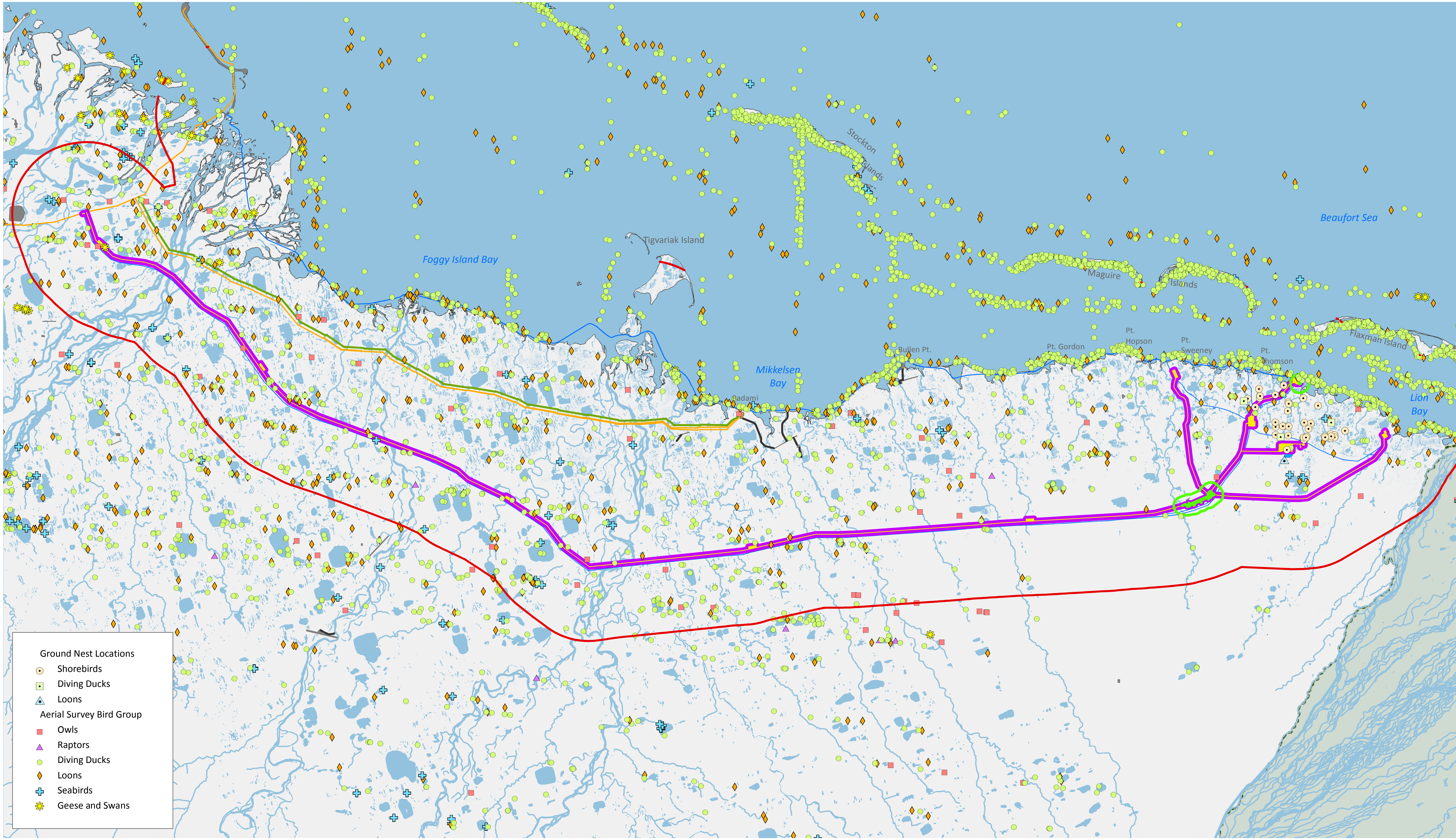
Table 5.9-7: Alternative C—Summary of Estimated Project Effects on Bird Habitats in Point Thomson Bird Project Area

	Bird Habitats [a] (acres)								
Habitat Types	Lakes & Ponds	Emergent Marsh	Wet Sedge	Moist Sedge-Shrub	Coastal Barrens	Coastal Wet Sedge	Coastal Water	Total in Acres	Total in mi²
Available Habitat	17,968	2,251	64,108	97,659	2,228	3,020	40,779	228,013	356
% of Total Habitat Mapped [b]	7	1%	27	41	1	1	17	95	95
Habitat Loss: Gravel	23	5	355	321	2	1	0	706	1.10
Habitat Alteration: Gravel	220	50	2,375	2,342	4	4	11	5,005	7.82
Habitat Loss/alteration: Ice [c]	—	5	326	343	3	6	—	683	1.07
Boat/air Traffic Disturbance	33	0	575	164	12	4	103	891	1.39
Total Affected Habitat	276	60	3,631	3,170	21	15	114	7,285	11.38
% of Available Habitat Affected	1.5	2.7	5.7	3.2	0.9	0.5	0.3	3.2	3.2

[a] Lakes and ponds include areas of lakes (Ia3) and ponds (Ia4). Emergent marsh includes very wet tundra (IIb and IId). Wet sedge includes freshwater very wet/wet tundra (IIIa, IIIc, IIId, and IIIe). Moist sedge-shrub includes moist and moist/wet sedge-shrub tundra (Va, Vb, Ve and IVa) and dry shrub tundra (Vc and Vd). Coastal barren includes dry barren grass, dwarf shrub, and forb-graminoid complexes (IXe, IXf, and IXi). Coastal wet sedge includes saline wet graminoid tundra (IIIb) and wet barren/wet graminoid tundra complex (IXh). Coastal water includes bays, lagoons, inlets, and subtidal rivers (Ia1). See Section 3.2.

[b] The *Available Habitat* estimate is based on the proportion of mapped habitat types extrapolated to a 375 mi² (240,000 acre) area, or the approximate area within about 2.5 miles of gravel and ice components for all alternatives. This estimate does not include 11,987 acres (5% of 375 mi² area) of water associated barrens (Xa, XIa, XIc), non-coastal dry/barren tundra complex (IXb, IXc, IXe), and disturbed barrens (Xc, Xe) that may be used by birds but that do not accurately fall within the habitat categories. Total Mapped Habitat percentage, therefore, does not equal 100%.

[c] For most ice features, the short-term habitat loss due to ice cover remaining through nest initiation is followed by a medium-term impact to allow for the reestablishment of standing dead vegetation which may require several growing seasons. Note: Ice on water not considered habitat impact, denoted with dash (—).



POINT THOMSON PROJECT EIS

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

Figure 5.9-5

Alternative C – Summary of Bird Habitat Loss, Alteration, and Disturbance Areas and Occurrence of Birds of Conservation Concern

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

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Estimates for nesting and post-breeding birds potentially displaced from habitat loss, habitat alteration, and bird disturbance during the construction phase are shown in Table 5.9-8 and discussed below. Habitat loss and alteration would likely have the greatest potential for effects on nesting songbirds and shorebirds, while disturbance from aircraft and vehicle traffic would likely effect birds in both nesting and post-breeding stages (Table 5.9-8). It is anticipated that approximately 7.4 percent of the total Point Thomson bird population would be displaced by Alternative C project features through habitat loss, alteration, or traffic disturbance. Less than 1.4 percent of these birds would be displaced due to complete habitat loss: 0.7 percent long-term loss from gravel roads, pads, and mining, and 0.7 percent temporary loss from ice roads and pads (Table 5.9-8).

Habitat Loss and Alteration

Long-term bird habitat loss and alteration due to gravel fill in Alternative C would be of greater consequence than that described in Alternative B because of the greater area of gravel fill and mining. While many birds nesting on the ACP return annually to the same nesting, foraging, brood-rearing, and molting areas, birds displaced by habitat alteration or loss have nested in adjacent, undisturbed habitat. Changes in bird habitat use caused by snow drifting and piling, thermokarst, altered wetland hydrology, and dust deposition would be similar to those described in Alternative B; some birds may be attracted to the impoundments, the early vegetation sprouting, and some birds may nest along roads. The consequences of these potential behavioral shifts would be the same as described for Alternative B, in that the early available forage may benefit some species, but nesting near gravel fill may reduce nest success due to flooding, increase exposure to predators, and increase the risk of vehicle collision mortality.

Ice roads built on tundra for pipeline construction and site access would cause temporary bird habitat loss and potential medium-term habitat alteration, as described in Alternative B. There would be similar temporary reductions in nesting habitat availability and suitability if shoreline and island habitats in water source lakes are altered if water levels do not recharge from snowmelt runoff the following spring.

Since Alternative C does not include the construction of a barging and sealift facility, it is not anticipated that there would be any offshore habitat loss or alteration as described in Alternative B, other than the construction of an emergency boat launch. In addition, there would be no dredging along the shoreline, eliminating impacts from the disposal of dredge material.

Disturbance

Birds would respond to construction disturbances in Alternative C as described in Alternative B. Disturbances would include noise from road and pad grading and compaction during summer, and air and vehicle traffic. Noise would likely cause the greatest disturbance to nesting birds between June 1 and July 15. After nesting, many birds typically move with their young to different habitats, avoiding disturbance sources.

Air Traffic

Noise and visual cues from air traffic would disturb birds as described in Alternative B. After completion of the gravel airstrip, and before completion of the gravel access road, an estimated 1,040 fixed-wing and 6,210 helicopter flights would occur between Deadhorse and the Point Thomson airstrip to support construction (Table 2.4-9: Alternative C). Peak air traffic would occur during combined construction and drilling activities and could increase as much as another 540 fixed-wing and 1,200 helicopter flights between Deadhorse and the Point Thomson airstrip during drilling. The proposed Alternative C location for the airstrip would be unlikely to result in flight patterns over Lion Bay.

Table 5.9-8: Alternative C—Estimated Annual Number of Bird Nests, Breeding Birds, and Post-Breeding Birds Potentially Displaced by Habitat Loss, Habitat Alteration, and Air and Vessel Traffic Disturbance[a]

Bird Group	Nests—Ground-based Estimate					Breeding Birds—Aerial Estimate					Post-Breeding Birds—Aerial Estimate				
	Habitat Loss – Gravel	Habitat Alteration – Gravel	Habitat Loss/Alteration – Ice	Traffic Disturbance	Total Nests	Habitat Loss – Gravel	Habitat Alteration – Gravel	Habitat Loss/Alteration – Ice	Traffic Disturbance	Total Breeding Birds	Habitat Loss – Gravel	Habitat Alteration – Gravel	Habitat Loss/Alteration – Ice	Traffic Disturbance	Total Post-Breeding Birds
Geese and Swans	<1	3	<1	<1	4	11	76	11	18	116	19	131	20	24	195
Dabbling Ducks	<1	3	<1	<1	4	5	34	5	7	50	<1	3	<1	<1	4
Diving Ducks	4	26	4	5	38	6	46	6	41	99	3	26	3	54	86
Loons	<1	4	<1	<1	7	2	17	3	4	25	1	10	2	2	15
Cranes	0	0	0	0	0	0	<1	0	0	<1	<1	1	<1	<1	1
Seabirds	0	0	0	0	0	3	25	4	11	43	<1	4	<1	2	7
Shorebirds	101	683	103	121	1,009	2	12	2	2	17	2	13	2	3	19
All Waterbirds	107	720	109	128	1,063	29	209	30	82	350	29	209	30	82	350
Raptors	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	<1
Owls	0	0	0	0	0	<1	<1	<1	<1	1	0	<1	0	0	<1
Ptarmigan	<1	4	<1	<1	7	0	0	0	0	0	0	<1	0	0	<1
Songbirds	88	593	90	105	876	0	0	0	0	<1	0	<1	0	0	<1
All Landbirds	89	597	90	106	882	<1	<1	<1	<1	1	<1	<1	<1	<1	1
Total	195	1,317	199	234	1,945	29	210	30	83	351	27	188	28	85	328
% of Point Thomson Estimate	0.3	2.1	0.3	0.4	3.1	0.3	1.8	0.3	0.7	3.0	0.1	0.6	0.1	0.3	1.0
% of ACP Estimate	UK	UK	UK	UK	UK	<0.1	0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	0.1

Source: Noel et al. 1999, 2000, 2002c, d; Rodrigues 2002 a, b; Johnson et al. 2005; USFWS 2008a; Liebezeit et al. 2009; Larned et al. 2010

[a] Numbers of birds impacted calculated by multiplying estimated project effects on bird habitat totals (from Table 5.9-7) by estimated density of bird nests, breeding birds, or post-breeding birds. More detail regarding densities provided in footnote of Table 5.9-9. Totals rounded to include nests or birds with densities of <0.1 per mi^2. Columns and rows may not total exactly due to rounding.
UK = unknown.

Vehicle Traffic

Vehicles are a common source of disturbance on oil field roads. The strongest reactions to vehicles from birds may occur during pre-nesting when birds are attracted to roadsides with early vegetation emergence due to dust deposition and early roadside melt. The early growth along the gravel access road as portions are completed would likely attract large numbers of geese. Disturbance from vehicles may affect activity and energy budgets of waterfowl and loons by increasing the length of time birds are away from the nest during incubation, and potentially reducing nest success.

Vessel Traffic

While no barge shipments would occur to the Point Thomson facility, modules would be transported to Prudhoe Bay by sealift barge, staged, and moved in the winter via ice road transport to Point Thomson. Barge traffic to and from Prudhoe Bay would likely temporarily displace some molting sea ducks, and loons (Noel et al. 2003a, Johnson et al. 2005).

Habitat Fragmentation

The gravel access road crosses multiple riparian corridors and fragmentation of these habitats may reduce their suitability as nesting habitat for birds such as the buff-breasted sandpiper that breed or nest in or near these habitats.

As described in Alternative B, roads would not generally be considered a blockage to bird movements, except perhaps waterfowl with broods and loons. Gravel roads have steep gravel banks that create a visual barrier that may be avoided by flightless birds, although studies have documented successful movements of brood-rearing geese and Pacific loons across oil field roads.

Construction of an aboveground water pipeline to convey freshwater for operational use from the water source to the Central Processing Pad may inhibit movements of brood-rearing waterbirds across the road and waterline corridor. While most adult and young ducks and geese should be physically able to cross the waterline either by hopping over or ducking under the line designed to be elevated on timber supports approximately 12 inches above the tundra (see Section 2.4.4.1), the close association of the pipeline and the road may lead to avoidance and an interruption of movement.

Vehicle and Infrastructure Collision Mortality

Birds may collide with project structures such as communication towers (both at Point Thomson and potentially Badami or Deadhorse), flare towers, buildings, and antenna guy-wires. As with Alternative B, collision rates would likely be higher at Badami than at Deadhorse because of Badami’s location near coastal migration paths. Bird collisions would likely be reduced under Alternative C compared to Alternative B because some of the infrastructure (communication and other towers, flare stack, processing facilities, camp and all facilities on the East and West Pads) would be moved inland. However, some bird mortalities would still be probable, especially during migration when large numbers of birds move along the coast and when weather and visibility are poor.

Similar to impacts discussed under Alternative B, traffic from construction, drilling, and operational activities pose the greatest threat to birds during the summer, when large numbers of birds are present in the study area. Traffic could result in collision mortality of birds, particularly those attracted to the roadside by forage, brood-rearing habitat, and grit availability. Of all of the proposed roads, the gravel access road would have the greatest potential for resulting in vehicle collisions because of its overall length and the potential for vehicles to drive at higher rates of speed than on infield gravel roads.

Altered Survival or Productivity

Exposure to noise and disturbance during oil field construction and drilling may result in some decrease in nest success (reduced productivity) for nesting Canada and white-fronted geese. Alternative C would include a construction camp at the Central Processing Pad and an additional camp somewhere along the gravel access road. These camps would have effects similar to those discussed for camps in Alternative B, in terms of food waste and artificial habitat benefits, to common ravens, glaucous gulls, raptors, and arctic foxes. Increasing the abundance of local predators and would reduce productivity of birds nesting near the camps and infrastructure.

The waterline between the Central Processing Pad and the freshwater source would likely delay brood-rearing waterbird movements, which may make these birds and their young more vulnerable to predation. Structures, including pipelines, communication towers, and buildings, are often used as perches for predatory birds, which facilitates predation on ground-nesting birds.

5.9.4.2 Alternative C: Drilling

Drilling activities under Alternative C would have the same type and duration of effects as described in Alternative B (Section 15.7.2.2), including habitat alteration, noise and traffic disturbance, vehicle and infrastructure collision mortality, and altered survival or productivity. One exception is that Alternative C, due to its lack of barge resupply for drilling, would not result in vessel traffic disturbance as described in Alternative B.

5.9.4.3 Alternative C: Operations

Alternative C operations would affect birds and their habitats in the same manner as described for Alternative B (Section 15.7.2.3), with two exceptions. Because Alternative C does not include either coastal or sealift barging during operations, there would be no disturbance impacts due to vessel traffic except in August, during spill response drills. However, construction and operation of the gravel access road would physically fragment riparian habitats at several river and stream crossings, and disturbance associated with the vehicle traffic could compound the physical fragmentation with disturbance effects. Habitats along and within rivers and streams are preferentially used by several types of songbirds and shorebirds for breeding and nesting, and the road would constitute a long-term habitat alteration for those birds. Completion and use of the gravel access road would also likely result in minor to moderate levels of annual collision mortality to birds. Moderate levels of annual collision mortality could result in substantial effects to birds that concentrate within specific habitats crossed by the road, such as riparian corridors.

5.9.4.4 Alternative C: Conservation Birds of Concern

Estimated habitat loss, alteration, and disturbance effects from Alternative C on conservation birds of concern are listed in Table 5.9-9. Potential construction, drilling, and operations effects caused by components of Alternative C would be the same as those described for nesting, breeding and post-breeding birds and their habitats above. Components of Alternative C with the greatest potential to affect conservation birds of concern include habitat loss and alteration for nesting and brood-rearing birds. There is also potential for disturbance to brood-rearing and molting waterfowl from vehicle and air traffic during summer maintenance, drilling, and operations activities. Conservation birds of concern that have been observed nesting or foraging near proposed infield roads and the gravel access road include brant, king eider, long-tailed duck, red-throated loon, and Pacific loon (Figure 5.9-5). While there are no ground survey data for the gravel access road, buff-breasted sandpipers would likely breed and nest in riparian corridors crossed by the road and its construction could result in fragmentation of breeding habitat. Coastal spill response training could disturb long-tailed ducks.

Alternative C impacts would be long term, lasting for the life of the project, for all conservation birds of concern, but the impact would be limited in extent to within 0.3 miles of project infrastructure. The potential for impacts to occur would be probable for species with a minor magnitude. Because of the rarity of bald eagles in the study area, it is unlikely that this species would be impacted.

Table 5.9-9: Alternative C—Estimated Annual Number of Conservation Birds of Concern Potentially Displaced by Habitat Loss, Habitat Alteration, and Disturbance

Species (Migration)[a]	Point Thomson Breeding Estimate (375 mi²)[b]	Point Thomson Post-Breeding Estimate (750 mi²)[c]	ACP Abundance[d]	Estimated Number of Birds and Percent of Point Thomson and ACP Estimate					
				Nests	Breeding Birds	Post-Breeding Birds	% of Point Thomson[e]	% of ACP Abundance[e]	Estimated Impact Magnitude
American Golden Plover (L)	4,327	✓	100,000	67	✓	✓	3.0	0.1	Minor
Arctic Tern (L)	371	81	~13,000	0	11	1	3.0	<0.1	Minor
Bald Eagle (S)	—	✓	NS	—	✓	✓	✓	✓	NE
Bar-tailed Godwit (L)	✓	✓	~100,000	✓	✓	✓	✓	✓	Minor
Black Scoter (S)	11	51	~100	0	<1	<1	2.7	0.3	Minor
Brant (S)	266	409	~12,000	0	8	11	3.0	<0.1	Minor
Buff-breasted Sandpiper (L)	715	✓	~7,500	11	✓	✓	3.0	0.1	Minor
Common Eider (S)[f]	340	5,913	~2,500	0	10	2	2.9	0.4	Minor
Dunlin (L)	5,571	✓	~475,000	86	✓	✓	3.0	<0.1	Minor
Golden Eagle (S)	—	✓	~40	—	✓	✓	✓	✓	Minor
King Eider (S)	1,779	81	~16,000	27	18	1	3.0	0.3	Minor
Long-tailed Duck (S)	1,505	60,050	~62,000	9	45	82	3.0	0.1	Minor
Northern Harrier (L)	—	2	~900	—	—	✓	✓	✓	Minor
Pacific Loon (S)	693	543	~21,000	2	21	13	3.0	0.1	Minor
Peregrine Falcon (L)	—	✓	~1,800	—	—	✓	✓	✓	Minor
Red Knot (L)	✓	✓	✓	✓	✓	✓	✓	✓	Minor
Red-throated Loon (L)	282	116	~2,000	4	3	2	3.5	0.4	Minor
Rough-legged Hawk (S)	✓	9	~4,000	✓	✓	<1	3.3	<0.1	Minor
Sanderling (L)	✓	✓	~30,000	✓	✓	✓	✓	✓	Minor
Sharp-shinned Hawk (L)	—	✓	NS	✓	✓	✓	✓	✓	Minor
Short-eared Owl (S)	3	4	~90,000	✓	<1	<1	3.3	<0.1	Minor
Snowy Owl (S)	36	✓	~800	0	1	0	3.1	0.1	Minor
Spectacled Eider (S)	144	✓	6,635	2	7	✓	4.5	0.1	Minor
Steller's Eider (S)	—	✓	168	—	—	✓	✓	✓	NE

Table 5.9-9: Alternative C—Estimated Annual Number of Conservation Birds of Concern Potentially Displaced by Habitat Loss, Habitat Alteration, and Disturbance

Species (Migration)[a]	Point Thomson Breeding Estimate (375 mi²)[b]	Point Thomson Post-Breeding Estimate (750 mi²)[c]	ACP Abundance[d]	Estimated Number of Birds and Percent of Point Thomson and ACP Estimate					
				Nests	Breeding Birds	Post-Breeding Birds	% of Point Thomson[e]	% of ACP Abundance[e]	Estimated Impact Magnitude
Surf Scoter (S)[g]	—	1,297	~4,000	—	12	<1	✓	✓	Minor
Whimbrel (L)	✓	✓	21,000	✓	✓	✓	✓	✓	Minor
White-crowned Sparrow (L)	✓	✓	21,900,000	✓	✓	✓	✓	✓	Minor
White-winged Scoter (S)	29	230	100,000	0	1	0	3.1	<0.1	Minor
Yellow-billed Loon (L)	37	8	1,119	0	1	0	3.0	<0.1	Minor

Sources: Noel et al. 1999, 2000, 2002b, c, d; Rodrigues 2002a, b; Rosenberg 2004; ADFG 2006; Dau and Bollinger 2009; Liebezeit et al. 2009; Larned et al. 2010.

[a] (R) = Resident; (S) = Short-distance migrant; (L) = Long-distance migrant.

[b] Point Thomson nest density multiplied by 375 mi², multiplied by 2 birds per nest; or ACP breeding density multiplied by 375 mi² plus Average Point Thomson coastal breeding density multiplied by 75 miles; value is greater of the two estimates, except for spectacled eiders which is based on a combine nest and aerial density of 0.191 pairs per mi².

[c] Point Thomson post-breeding estimates are combined shoreline density multiplied by 75 mi², lagoon density multiplied by 225 mi², barrier island density multiplied by 75 mi², and tundra density multiplied by 375 mi².

[d] NS = not estimated, NR = not recorded.

[e] Percent of Point Thomson = Largest of Nests times 2 or Breeding Birds divided by Point Thomson Breeding Estimate or Post Breeding Birds divided by Point Thomson Post-Breeding Estimate. Percent of ACP Estimate = Largest of Nests times 2, Breeding Birds, or Post-Breeding Birds divided by the ACP Abundance Estimate.

[f] The Point Thomson common eider post-breeding estimate is a product of the Point Thomson-specific common eider density multiplied by the total project area being considered for all species of birds (i.e.; 750 mi²). Therefore, for common eider, the estimate is larger than the ACP total abundance as provided by literature. This discrepancy is noted and considered in the analyses. In order to keep calculation methodologies consistent, this number was not altered in tables.

[g] Although identified by experts during breeding bird surveys over multiple survey years, and therefore presented under the "Breeding Birds" column for numbers of birds potentially impacted, there are no definitive nesting records of surf scoter along the Alaska portion of the Beaufort Sea. Therefore, these birds are assumed to be non-breeding, although resident during periods when other species are actively nesting.

Check (✓) indicates documented to occur but no quantitative data available; dash (—) indicates not documented to occur.

Threatened, Endangered, and Candidate Birds

As discussed in Alternative B, there are two bird species federally protected under the ESA and one candidate species being evaluated for listing.

Steller's Eider

Alternative C would have a potential similar to Alternative B to affect Steller's eiders (Table 5.9-9), although Alternative C infrastructure could present less of a collision hazard for spring and fall migrating Steller's eiders because some of the infrastructure is moved inland. Because Steller's eiders rarely occur in the study area and because the project would be generally east of Steller's eiders distribution in Alaska, potential effects of Alternative C on Steller's eiders would be unlikely.

Spectacled Eider

Alternative C has potential to affect spectacled eiders in ways similar to those described for Alternative B. In contrast to Alternative B's single documented eider near the proposed infrastructure, however, a total of 14 sightings of one or more spectacled eiders have been documented within 0.5 miles of proposed gravel infrastructure during 1993, 1994, 1995, and 2000 along the gravel access road and near the West Pad (see Figure 5.9-3). Alternative C infrastructure and traffic could present less of a collision hazard than Alternative B for spring- and fall-migrating spectacled eiders because some of the infrastructure would be moved inland. Because some spectacled eiders are likely to breed within the project area, Alternative C would likely have long-term minor habitat alteration and disturbance effects on spectacled eiders primarily along the gravel access road.

Yellow-billed Loon

Alternative C has the potential to affect yellow-billed loons through habitat loss and alteration disturbance, similar to the effects described for Alternative B. Two yellow-billed loon sightings have been documented within 0.5 mile of proposed gravel infrastructure during 1999 and 2000; one each near West Pad and Central Well Pad (see Figure 5.9-4). Foraging yellow-billed loons are likely to be present along the shoreline or in the lagoon near the Central Well Pad or East Pad. Yellow-billed loons present in these areas would likely be temporarily displaced by disturbance. Alternative C infrastructure could present less of a collision hazard for spring- and fall-migrating yellow-billed loons because some of the infrastructure would be moved inland.

5.9.4.5 Alternative C: Summary of Effects on Birds

The construction and operations phases of Alternative C would likely have the greatest potential effect on emergent marsh, moist-sedge-shrub, and wet sedge habitats, affecting both waterbirds and landbirds. Disturbance from vehicles and aircraft would likely have the greatest potential effects on nesting waterbirds and landbirds, and breeding and post-breeding waterbirds (Table 5.9-8).

Activities proposed for Alternative C would result in probable primarily minor impacts to birds and their habitats. These would be long-term but local or limited in extent. Collision mortality and altered productivity effects are probable but would be minor and limited in extent. The overall impact summary for birds due to activities under Alternative C is shown in Table 5.9-10 below.

Table 5.9-10: Alternative C—Impact Evaluation for Birds

Impact Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Habitat Loss and Alteration	Minor	Long term	Probable	Local
Boat/air Traffic Disturbance	Minor	Long term	Possible	Limited
Productivity and Mortality	Minor	Long term	Probable	Limited
Conservation Birds of Concern (1 species)	No effect	Long term	Unlikely	Limited
Conservation Birds of Concern (26 species)	Minor	Long term	Probable	Limited
Threatened Bird (spectacled eider)	Minor	Long term	Possible	Local
Threatened Bird (Steller's eider)	No effect	Long term	Unlikely	Limited
Candidate Bird (yellow-billed loon)	Minor	Long term	Unlikely	Limited

5.9.5 Alternative D: Inland Pads with Seasonal Ice Access Road

Potential long-term Alternative D effects on birds and their habitats from gravel fill and structure placement mirror the types of effects described for Alternative B. However, potential impacts to waterbirds could be reduced by the movement of project components inland and no construction of barging and sealift facilities. As discussed for Alternative B, potential habitat effects have been evaluated by acres of habitat type impacted and by estimates of number of breeding and post-breeding birds potentially displaced by individual project components. Figure 5.9-6 provides a map of the areas of potential impacts from project components of Alternative D.

5.9.5.1 Alternative D: Construction

Construction of Alternative D would affect birds and their habitats in the manners described in Alternative C (Section 15.7.3.1), except that the gravel access road from the Endicott Spur would not be constructed. Under Alternative D, the gravel access road would be replaced by annual ice roads.

Impacts would include long- and medium-term habitat loss and alteration, as well as long-term disturbance. There would also be long-term habitat fragmentation and long-term structure and vehicle collision mortality. These affects could result in altered survival or productivity. Table 5.9-11 provides a summary of habitat community impacts resulting from construction of Alternative D. As shown, the highest proportion of project impacts is to wet sedge and moist sedge-shrub communities. Together these two communities make up about two-thirds of the total available bird habitat and both are associated with most shorebird species in the Point Thomson area (Table 3.9-1). Overall, it is anticipated that approximately 1.5 percent of total bird habitat would be impacted by Alternative D project features (Table 5.9-11). Approximately 1 percent of total available bird habitat would be impacted due to habitat loss and alteration; of this amount, less than 0.2 percent would include long-term loss from gravel roads, pads, and mining, and 0.2 percent short-term loss from ice roads and pads (Table 5.9-11).

Table 5.9-11: Alternative D—Summary of Estimated Project Effects on Bird Habitats in the Point Thomson Bird Project Area

	Bird Habitats[a] (acres)								
Habitat Types	Lakes & Ponds	Emergent Marsh	Wet Sedge	Moist Sedge-Shrub	Coastal Barrens	Coastal Wet Sedge	Coastal Water	Total in Acres	Total in mi^2
Available Habitat	17,968	2,251	64,108	97,659	2,228	3,020	40,779	228,013	356
% of Total Habitat Mapped [b]	7	1	27	41	1	1	17	95	95
Habitat Loss: Gravel	15	0	182	132	2	1	0	332	0.52
Habitat Alteration: Gravel	65	4	933	603	4	4	11	1,623	2.54
Habitat Loss/Alteration: Ice [c]	—	8	199	238	3	7	—	455	0.71
Boat/Air Traffic Disturbance	37	0	646	150	12	4	103	953	1.49
Total Affected Habitat	117	12	1,960	1,123	21	16	114	3,362	5.26
% of Available Habitat Affected	0.7	0.5	3.1	1.1	0.9	0.5	0.3	1.5	1.5

[a] Lakes and ponds include areas of lakes (Ia3) and ponds (Ia4). Emergent marsh includes very wet tundra (IIb and IId). Wet Sedge includes freshwater very wet/wet tundra (IIIa, IIIc, IIId, and IIIe). Moist sedge-shrub includes moist and moist/wet sedge-shrub tundra (Va, Vb, Ve and IVa) and dry shrub tundra (Vc and Vd). Coastal barrens includes dry barren grass, dwarf shrub, and forb-graminoid complexes (IXe, IXf, and IXi). Coastal wet sedge includes saline wet graminoid tundra (IIIb) and wet barren/wet graminoid tundra complex (IXh). Coastal water includes bays, lagoons, inlets, and subtidal rivers (Ia1). See Section 3.2.

[b] The *Available Habitat* estimate is based on the proportion of mapped habitat types extrapolated to a 375 mi^2 (240,000 acre) area, or the approximate area within about 2.5 miles of gravel and ice components for all alternatives. This estimate does not include 11,987 acres (5% of 375 mi^2 area) of water associated barrens (Xa, XIa, XIc), non-coastal dry/barren tundra complex (IXb, IXc, IXe), and disturbed barrens (Xc, Xe) that may be used by birds but that do not accurately fall within the habitat categories. Total Mapped Habitat percentage, therefore, does not equal 100%.

[c] For most ice features, the short-term habitat loss due to ice cover remaining through nest initiation is followed by a medium-term impact to allow for the reestablishment of standing dead vegetation which may require several growing seasons. Note: Ice on water not considered habitat impact, denoted with dash (—).

Estimates for bird nests, breeding birds, and post-breeding birds potentially displaced from habitat loss, habitat alteration, and bird disturbance during the construction phase are shown in Table 5.9-12 and discussed below. Habitat loss and alteration would likely have the greatest potential for effects on nesting songbirds and shorebirds, while disturbance from aircraft and vehicles would likely effect birds in both nesting and post-breeding stages (Table 5.9-12).

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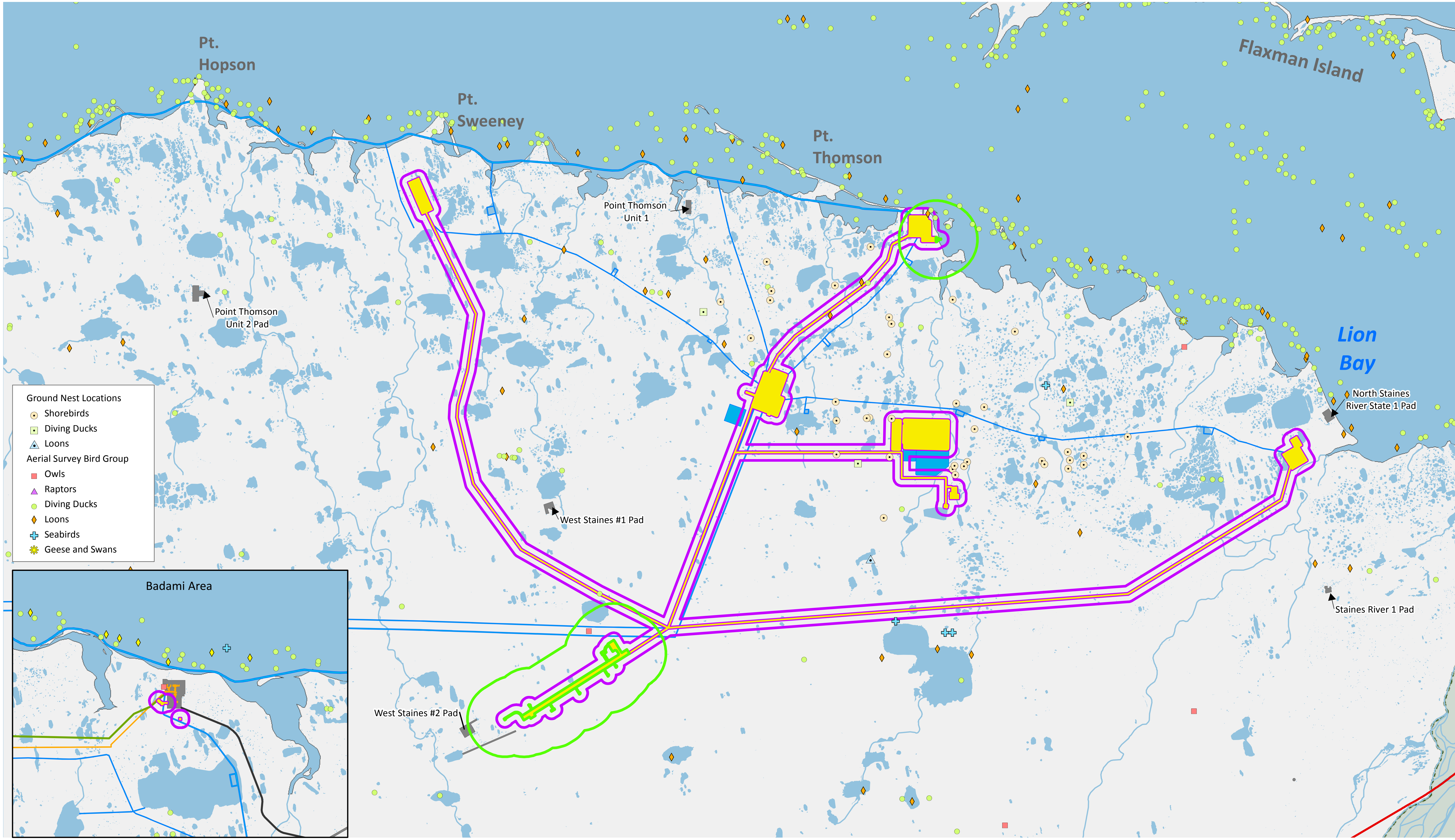

POINT THOMSON PROJECT EIS

Existing Road
Existing Ice Road
Existing Pipeline
Existing Facilities
Stream
Water Body
Arctic National Wildlife Refuge

Ice Footprint for Roads and Facilities
Gravel Footprint for Roads and Facilities
Disturbance - Traffic (1,640 ft)
Alteration - Gravel (330 ft)
2.5 Mile Buffer Around All Project Alternative Features

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

0 1 2 Miles

N

Figure 5.9-6

Alternative D – Summary of Bird Habitat Loss, Alteration, and Disturbance Areas and Occurrence of Birds of Conservation Concern

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

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Table 5.9-12: Alternative D—Estimated Annual Number of Bird Nests, Breeding Birds, and Post-Breeding Birds Potentially Displaced by Habitat Loss, Habitat Alteration, and Air & Vessel Traffic Disturbance[a]

Bird Group	Nests—Ground-based Estimate					Breeding Birds—Aerial Estimate					Post-Breeding Birds—Aerial Estimate				
	Habitat Loss – Gravel	Habitat Alteration – Gravel	Habitat Loss/Alteration – Ice	Traffic Disturbance	Total Nests	Habitat Loss – Gravel	Habitat Alteration – Gravel	Habitat Loss/Alteration – Ice	Traffic Disturbance	Total Breeding Birds	Habitat Loss – Gravel	Habitat Alteration – Gravel	Habitat Loss/Alteration – Ice	Traffic Disturbance	Total Post-Breeding Birds
Geese and Swans	<1	1	<1	<1	2	5	26	8	19	58	9	43	14	26	92
Dabbling Ducks	<1	1	<1	<1	2	2	11	4	7	24	<1	<1	<1	<1	2
Diving Ducks	2	8	3	5	18	3	21	4	41	69	2	12	2	54	70
Loons	<1	1	<1	<1	3	1	6	2	4	12	1	3	1	2	7
Cranes	0	0	0	0	0	0	0	0	0	<1	<1	<1	<1	<1	<1
Seabirds	0	0	0	0	0	2	9	2	11	25	<1	1	<1	2	4
Shorebirds	48	222	71	130	471	<1	4	1	2	8	1	4	1	3	9
All waterbirds	51	234	75	137	496	14	76	20	85	195	13	64	19	88	184
Raptors	0	0	0	0	0	0	0	0	0	0	0	<1	0	0	<1
Owls	0	0	0	0	0	0	<1	<1	<1	1	0	0	0	0	<1
Ptarmigan	<1	1	<1	1	3	0	0	0	0	0	0	<1	0	0	<1
Songbirds	42	193	62	113	409	0	0	0	0	0	0	0	0	0	<1
All landbirds	42	194	62	114	412	0	<1	<1	<1	1	0	<1	<1	<1	1
Total	93	428	137	251	908	14	76	21	85	196	13	65	19	88	184
% of Point Thomson Estimate	0.1	0.7	0.2	0.4	1.4	0.1	0.7	0.2	0.7	1.7	<0.1	0.2	0.1	0.3	0.6
% of ACP Estimate	UK	UK	UK	UK	UK	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1

Source: Noel et al. 1999, 2000, 2002c, d; Rodrigues 2002a, b; Johnson et al. 2005; USFWS 2008a; Liebezeit et al. 2009; Larned et al. 2010.

[a] Numbers of birds impacted calculated by multiplying estimated project effects on bird habitat totals (from Table 5.9-11) by estimated density of bird nests, breeding birds, or post-breeding birds. More detail regarding densities provided in footnote of Table 5.9-13. Totals rounded to include nests or birds with densities of <0.1 per mi^2. Columns and rows may not total exactly due to rounding. UK = unknown.

5.9.5.2 Alternative D: Drilling

Drilling activities under Alternative D would be similar to those described in Alternative C, with the exception that the drill rig would be demobilized by an ice road in the winter following completion of the last well, rather than demobilizing along the gravel access road immediately following well completion. Therefore, drilling activities would be anticipated to have similar types of effects on birds and their habitats as described in Alternative C (Section 15.7.3.2).

5.9.5.3 Alternative D: Operations

Alternative D operations would have the same types of effects on birds and their habitats as Alternative C. The main difference between the operational effects of Alternative D and Alternative C is the absence of impacts from the gravel access road as discussed in Alternative C. In Alternative D, the facility would be resupplied annually via ice road, with similar bird habitat loss impacts as described for construction of on-tundra ice roads.

5.9.5.4 Alternative D: Conservation Birds of Concern

Estimated habitat loss, alteration, and disturbance effects from Alternative D on birds of concern are shown in Table 5.9-13. Potential construction, drilling, and operations effects caused by components of Alternative D would be the same as those described above for breeding and post-breeding birds and their habitats. Although minimal, components of Alternative D with the potential to affect conservation birds of concern include habitat loss and alteration for nesting and brood-rearing birds, and disturbance to brood-rearing and molting waterfowl from air and vehicle traffic during summer construction, drilling, and operations activities. Figure 5.9-6 shows the distribution of conservation birds of concern by species group in relation to facilities proposed under Alternative D.

Alternative D impacts would be long term, lasting for the life of the project, for all conservation birds of concern, but the impact would be limited in extent to within 0.3 miles of project infrastructure. The potential for impacts to occur would be probable for species with a minor magnitude. It would be unlikely for bald eagles and surf scoters to be impacted under Alternative D.

Table 5.9-13: Alternative D—Estimated Annual Number of Conservation Birds of Concern Potentially Displaced by Habitat Loss, Habitat Alteration, and Disturbance

Species (Migration)[a]	Point Thomson Breeding Estimate (375 mi²)[b]	Point Thomson Post-Breeding Estimate (750 mi²)[c]	ACP Abundance[d]	Estimated Number of Birds and Percent of Point Thomson and ACP Estimate					
				Nests	Breeding Birds	Post-Breeding Birds	% of Point Thomson[e]	% of ACP Abundance[e]	Estimated Impact Magnitude
American Golden Plover (L)	4,327	✓	100,000	31	✓	✓	1.4	<0.1	Minor
Arctic Tern (L)	371	81	~13,000	0	6	<1	1.6	<0.1	Minor
Bald Eagle (S)	—	✓	NS	—	✓	✓	✓	✓	NE
Bar-tailed Godwit (L)	✓	✓	~100,000	✓	✓	✓	✓	✓	Minor
Black Scoter (S)	11	51	~100	0	<1	<1	2.7	0.3	Minor
Brant (S)	266	409	~12,000	0	5	5	1.7	<0.1	Minor
Buff-breasted Sandpiper (L)	715	✓	~7,500	5	✓	✓	1.4	0.1	Minor

Table 5.9-13: Alternative D—Estimated Annual Number of Conservation Birds of Concern Potentially Displaced by Habitat Loss, Habitat Alteration, and Disturbance									
				Estimated Number of Birds and Percent of Point Thomson and ACP Estimate					
Species (Migration)[a]	Point Thomson Breeding Estimate (375 mi²)[b]	Point Thomson Post-Breeding Estimate (750 mi²)[c]	ACP Abundance[d]	Nests	Breeding Birds	Post-Breeding Birds	% of Point Thomson[e]	% of ACP Abundance[e]	Estimated Impact Magnitude
Common Eider (S)[f]	340	5,913	~2,500	0	9	2	2.7	0.4	Minor
Dunlin (L)	5,571	✓	~475,000	40	✓	✓	1.4	<0.1	Minor
Golden Eagle (S)	—	✓	~40	—	✓	✓	✓	✓	Minor
King Eider (S)	1,779	81	~16,000	13	11	<1	1.5	0.2	Minor
Long-tailed Duck (S)	1,505	60,050	~62,000	4	29	67	1.9	0.1	Minor
Northern Harrier (L)	—	2	~900	—	—	✓	✓	✓	Minor
Pacific Loon (S)	693	543	~21,000	1	10	6	1.4	<0.1	Minor
Peregrine Falcon (L)	—	✓	~1,800	—	—	✓	✓	✓	Minor
Red Knot (L)	✓	✓	✓	✓	✓	✓	✓	✓	Minor
Red-throated Loon (L)	282	116	~2,000	2	1	1	1.4	0.2	Minor
Rough-legged Hawk (S)	✓	9	~4,000	✓	✓	<1	1.1	<0.1	Minor
Sanderling (L)	✓	✓	~30,000	✓	✓	✓	✓	✓	Minor
Sharp-shinned Hawk (L)	—	✓	NS	✓	✓	✓	✓	✓	Minor
Short-eared Owl (S)	3	4	~90,000	0	0	<1	3.3	<0.1	Minor
Snowy Owl (S)	36	✓	~800	0	1	0	1.7	<0.1	Minor
Spectacled Eider (S)	144	✓	6,635	1	3	✓	2.1	<0.1	Minor
Steller's Eider (S)	—	✓	168	—	—	✓	✓	✓	NE
Surf Scoter (S)[g]	—	1,297	~4,000	—	12	<1	<0.1	<0.1	NE
Whimbrel (L)	✓	✓	21,000	✓	✓	✓	✓	✓	Minor
White-crowned Sparrow (L)	✓	✓	21,900,000	✓	✓	✓	✓	✓	Minor
White-winged Scoter (S)	29	230	100,000	0	1	0	2.4	<0.1	Minor
Yellow-billed Loon (L)	37	8	1,119	0	1	0	1.6	<0.1	Minor

Table 5.9-13: Alternative D—Estimated Annual Number of Conservation Birds of Concern Potentially Displaced by Habitat Loss, Habitat Alteration, and Disturbance

Species (Migration)[a]	Point Thomson Breeding Estimate (375 mi²)[b]	Point Thomson Post-Breeding Estimate (750 mi²)[c]	ACP Abundance[d]	Estimated Number of Birds and Percent of Point Thomson and ACP Estimate					
				Nests	Breeding Birds	Post-Breeding Birds	% of Point Thomson[e]	% of ACP Abundance[e]	Estimated Impact Magnitude

Sources: Noel et al. 1999, 2000, 2002b, c, d; Rodrigues 2002a, b; Rosenberg 2004; ADFG 2006; Dau and Bollinger 2009; Liebezeit et al. 2009; Larned et al. 2010.

[a] (R) = Resident; (S) = Short-distance migrant; (L) = Long-distance migrant.

[b] Point Thomson nest density multiplied by 375 mi^2, multiplied by 2 birds per nest; or ACP breeding density multiplied by 375 mi^2 plus Average Point Thomson coastal breeding density multiplied by 75 miles; value is greater of the two estimates, except for spectacled eiders which is based on a combine nest and aerial density of 0.191 pairs per mi^2.

[c] Point Thomson post-breeding estimates are combined shoreline density multiplied by 75 mi^2, lagoon density multiplied by 225 mi^2, barrier island density multiplied by 75 mi^2, and tundra density multiplied by 375 mi^2.

[d] NS = not estimated, NR = not recorded.

[e] Percent of Point Thomson = Largest of Nests times 2 or Breeding Birds divided by Point Thomson Breeding Estimate or Post Breeding Birds divided by Point Thomson Post-Breeding Estimate. Percent of ACP Estimate = Largest of Nests times 2, Breeding Birds, or Post-Breeding Birds divided by the ACP Abundance Estimate.

[f] The Point Thomson common eider post-breeding estimate is a product of the Point Thomson-specific common eider density multiplied by the total project area being considered for all species of birds (i.e.; 750 mi^2). Therefore, for common eider, the estimate is larger than the ACP total abundance as provided by literature. This discrepancy is noted and considered in the analyses. In order to keep calculation methodologies consistent, this number was not altered in tables.

[g] Although identified by experts during breeding bird surveys over multiple survey years, and therefore presented under the “Breeding Birds” column for numbers of birds potentially impacted, there are no definitive nesting records of surf scoter along the Alaska portion of the Beaufort Sea. Therefore, these birds are assumed to be non-breeding, although resident during periods when other species are actively nesting.

Check (✓) indicates documented to occur but no quantitative data available; dash (—) indicates not documented to occur. No Effect (NE), estimated effect is less than minor in magnitude (i.e., <1% of local population exposed, or <0.1% of ACP population exposed).

Threatened, Endangered, and Candidate Birds

As discussed in Alternative B, there are two bird species federally protected under the ESA and one candidate species being evaluated for listing.

Steller’s Eider

Alternative D’s potential to affect Steller’s eiders would be similar to Alternative B, though its infrastructure and traffic could, like Alternative C, present less of a collision hazard for spring and fall migrating Steller’s eiders because some infrastructure is moved inland. Because Steller’s eiders rarely occur in the study area and because the project would be generally east of Steller’s eiders distribution in Alaska, potential effects of Alternative D on Steller’s eiders would be unlikely (Table 5.9-13).

Spectacled Eider

Like Alternative B, the greatest potential of Alternative D to affect spectacled eiders would come from habitat loss and alteration for nesting and brood-rearing birds; disturbance to nesting and brood-rearing birds from air and vehicle traffic during summer construction, drilling, and operations activities; and collision mortality with communication towers, process modules, and camps during spring and fall migrations. A few spectacled eiders are likely to nest in the project area, though no spectacled eiders have been documented within 0.5 mile of proposed gravel infrastructure (see Figure 5.9-3). Alternative D infrastructure and traffic could present less of a collision hazard than Alternative B for migrating spectacled eiders because of some of the infrastructure would be moved inland.

Yellow-billed Loon

Alternative D has a minor potential to affect yellow-billed loons through habitat loss and alteration, similar to the effects described for Alternatives B and C. Two yellow-billed loon sightings have been documented within 0.5 mile of proposed gravel infrastructure during 1999 and 2000; one each near West Pad and Central Well Pad (see Figure 5.9-4). Foraging yellow-billed loons are likely to be present along the shoreline or in the lagoon near the Central Well Pad or East Pad. Yellow-billed loons present in these areas could be temporarily displaced by disturbance. Alternative D infrastructure could present less of a collision hazard for spring- and fall-migrating yellow-billed loons than Alternative B because some of the infrastructure would be moved inland.

5.9.5.5 Alternative D: Summary of Effects on Birds

Habitat effects resulting from construction and operations of Alternative D would likely have the greatest potential effect on wet sedge and moist-sedge-shrub habitats, affecting both waterbirds and landbirds. Disturbance from aircraft and vehicles would likely have the greatest potential effects on nesting waterbirds and landbirds and post-breeding waterbirds (Table 5.9-11).

Alternative D would result in minor effects on 25 conservation birds of concern and no effects on four conservation birds of concern. These effects are possible and would be long term, but limited in extent (Table 5.9-14). The overall impact summary for birds due to activities under Alternative D is shown below.

Table 5.9-14: Alternative D—Impact Evaluation for Birds

Impact Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Habitat Loss and Alteration	Minor	Long term	Probable	Limited
Boat/air Traffic Disturbance	Minor	Long term	Possible	Limited
Productivity and Mortality	Minor	Long term	Possible	Limited
Conservation Birds of Concern (2 species)	No Effect	Long term	Possible	Limited
Conservation Birds of Concern (25 species)[b]	Minor	Long term	Probable	Limited
Threatened Birds (spectacled eider)	Minor	Long term	Possible	Limited
Threatened Birds (Steller's eider)	No Effect	Long term	Unlikely	Limited
Candidate Bird (yellow-billed loon)	Minor	Long term	Unlikely	Limited

5.9.6 Alternative E: Coastal Pads with Seasonal Ice Roads

Potential long-term Alternative E effects on birds would be from frequent helicopter disturbance during breeding, nesting, post-nesting, and migration periods; from barging activities; and from habitat alteration and disturbance from annual infield ice roads. As discussed for Alternative B, potential habitat effects have been evaluated by acres of habitat type impacted and by estimates of number of breeding and post-breeding birds potentially displaced by individual project components. Figure 5.9-7 provides a map of the areas of potential impacts from project components of Alternative E.

5.9.6.1 Alternative E: Construction

Construction of Alternative E would have components similar to Alternative B, though it would not include gravel roads to the East and West Pads. Transportation between the Central Pad and East and West Pads during construction, drilling, and operations would be by ice road during the winter and by helicopter during the summer. In addition, multi-season ice pads would be used at the East and West Pads during construction and drilling. Ice roads between the pad locations for transport of materials and supplies during construction would introduce temporary and medium-term habitat loss and medium- and long-term habitat alteration. Because the ice roads would not melt before most birds return in the spring, nesting habitat would be lost temporarily. In addition, multiyear ice pads would likely cause long-term damage to tundra beneath the ice pads, resulting in potential habitat changes to these locations.

The reliance on helicopters to transport supplies and personnel between the Central Pad and East and West Pads during construction would result in heavy air traffic throughout the seasons when birds are active on the North Slope (see Table 2.4-22), which could result in frequent disturbance to breeding and post-breeding birds. Alternative E would also require two to three times the number of coastal barge trips between Point Thomson and Prudhoe Bay than would be required in Alternative B (Table 2.4-22). This would be caused by the requirement to supply a 5-year drilling program, as opposed to the two seasons of barge resupply for drilling required in Alternative B.

Thus, the long-term effects to birds from habitat loss, disturbance, and alteration associated with gravel fill would be reduced under Alternative E, but the effects associated with air and barge traffic would be greater than the other action alternatives. Table 5.9-15 provides a summary of habitat community impacts resulting from construction of the components of Alternative E. For this alternative, the highest proportion of impacts would be to the coastal barrens community due to the limited amount found in the project area, but total impact for this community would still be less than 5 percent.

Table 5.9-15: Alternative E—Summary of Estimated Project Effects on Bird Habitats in Point Thomson Bird Project Area

Habitat Types	Bird Habitats [a] (acres)								
	Lakes & Ponds	Emergent Marsh	Wet Sedge	Moist Sedge-Shrub	Coastal Barrens	Coastal Wet Sedge	Coastal Water	Total in Acres	Total in mi^2
Available Habitat	17,968	2,251	64,108	97,659	2,228	3,020	40,779	228,013	356
% of Total Habitat Mapped [b]	7	1	27	41	1	1	17	95	95
Habitat Loss: Gravel	11	0	65	98	6	1	0	180	0.28
Habitat Alteration: Gravel	24	2	133	254	17	8	19	456	0.71
Habitat Loss/Alteration: Ice [c]	—	6	109	286	8	6	—	415	0.65
Boat/Air Traffic Disturbance	134	9	298	524	59	23	510	1,557	2.43
Total Affected Habitat	169	18	605	1,162	90	38	529	2,608	4.07
% of Available Habitat Affected	0.9	0.8	0.9	1.2	4.0	1.3	1.3	1.2	1.2

Table 5.9-15: Alternative E—Summary of Estimated Project Effects on Bird Habitats in Point Thomson Bird Project Area

	Bird Habitats [a] (acres)								
Habitat Types	Lakes & Ponds	Emergent Marsh	Wet Sedge	Moist Sedge-Shrub	Coastal Barrens	Coastal Wet Sedge	Coastal Water	Total in Acres	Total in mi²

[a] Lakes and ponds include areas of lakes (Ia3) and ponds (Ia4). Emergent marsh includes very wet tundra (IIb and IId). Wet sedge includes freshwater very wet/wet tundra (IIIa, IIIc, IIId, and IIIe). Moist sedge-shrub includes moist and moist/wet sedge-shrub tundra (Va, Vb, Ve and IVa) and dry shrub tundra (Vc and Vd). Coastal barrens include dry barren grass, dwarf shrub, and forb-graminoid complexes (IXe, IXf, and IXi). Coastal wet sedge includes saline wet graminoid tundra (IIIb) and wet barren/wet graminoid tundra complex (IXh). Coastal water includes bays, lagoons, inlets, and subtidal rivers (Ia1). See Section 3.2.

[b] The *Available Habitat* estimate is based on the proportion of mapped habitat types extrapolated to a 375 mi^2 (240,000 acre) area, or the approximate area within about 2.5 miles of gravel and ice components for all alternatives. This estimate does not include 11,987 acres (5% of 375 mi^2 area) of water associated barrens (Xa, XIa, XIc), non-coastal dry/barren tundra complex (IXb, IXc, IXe), and disturbed barrens (Xc, Xe) that may be used by birds but that do not accurately fall within the habitat categories. Total Mapped Habitat percentage, therefore, does not equal 100%.

[c] For most ice features, the short-term habitat loss due to ice cover remaining through nest initiation is followed by a medium-term impact to allow for the reestablishment of standing dead vegetation which may require several growing seasons. Note: Ice on water not considered habitat impact, denoted with dash (—).

Although limited, habitat loss and alteration resulting from construction would likely have the greatest potential effect on nesting songbirds and shorebirds, while disturbance from barges, aircraft, and vehicles would likely have the greatest potential effects on post-breeding waterbirds (Table 5.9-16).

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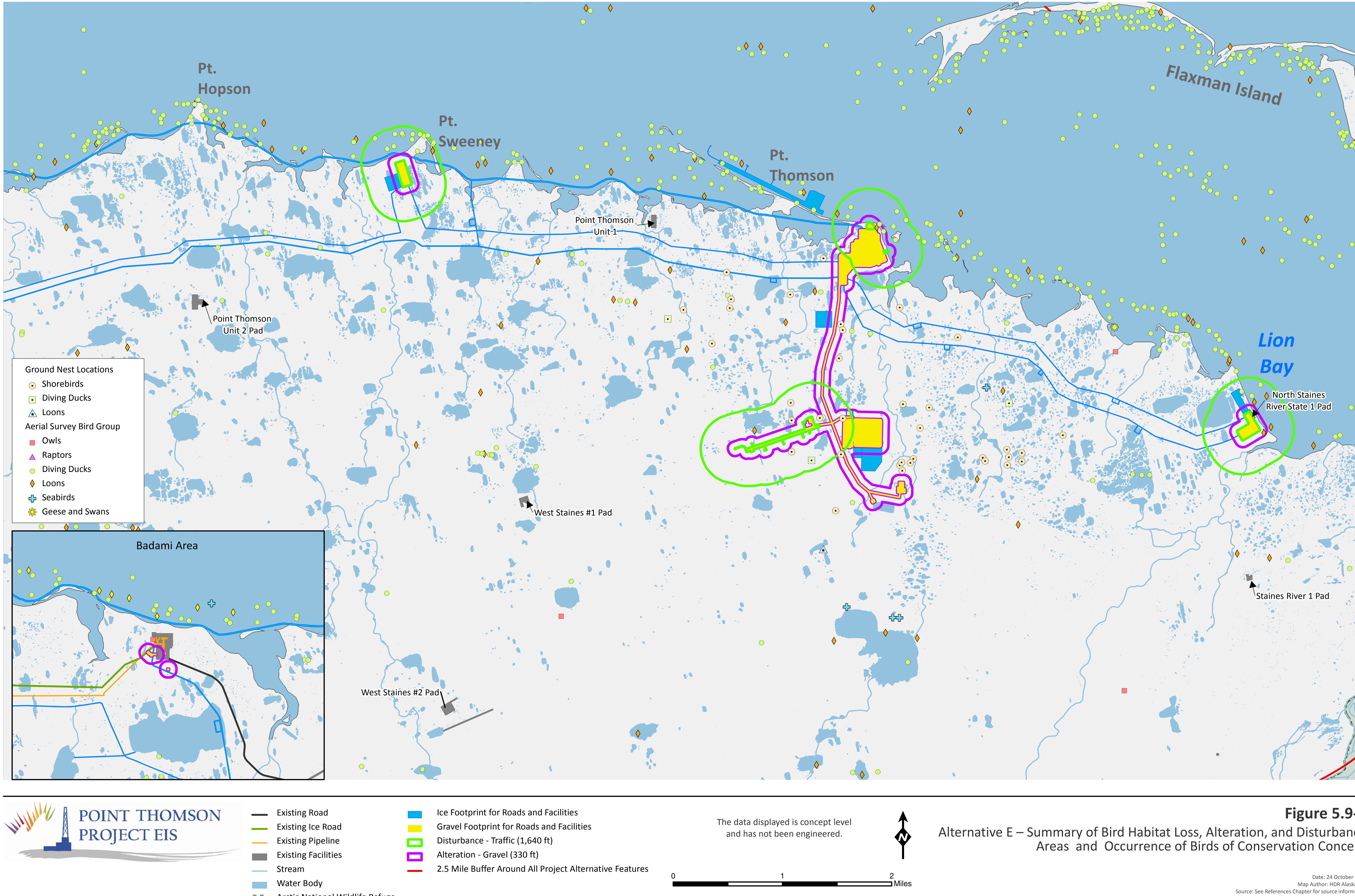

Figure 5.9-7

Alternative E – Summary of Bird Habitat Loss, Alteration, and Disturbance Areas and Occurrence of Birds of Conservation Concern

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

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Table 5.9-16: Alternative E—Estimated Annual Number of Bird Nests, Breeding Birds, and Post-Breeding Birds Potentially Displaced by Habitat Loss, Habitat Alteration, and Air & Vessel Traffic Disturbance[a]

	Nests—Ground-based Estimate					Breeding Birds—Aerial Estimate					Post-Breeding Birds—Aerial Estimate				
	Habitat Loss – Gravel	Habitat Alteration – Gravel	Habitat Loss/Alteration – Ice	Traffic Disturbance	Total Nests	Habitat Loss – Gravel	Habitat Alteration – Gravel	Habitat Loss/Alteration – Ice	Traffic Disturbance	Total Breeding Birds	Habitat Loss – Gravel	Habitat Alteration – Gravel	Habitat Loss/Alteration – Ice	Traffic Disturbance	Total Post-Breeding Birds
Geese and Swans	<1	<1	<1	1	2	3	10	7	33	52	5	12	13	46	76
Dabbling Ducks	<1	<1	<1	1	2	1	3	3	11	19	<1	<1	<1	1	2
Diving Ducks	1	2	3	8	14	2	22	4	76	103	1	11	2	243	258
Loons	<1	<1	<1	1	2	1	2	2	7	11	<1	1	1	4	6
Cranes	0	0	0	0	0	0	0	0	0	0	0	<1	<1	<1	1
Seabirds	0	0	0	0	0	1	6	2	20	29	<1	1	<1	5	7
Shorebirds	28	62	67	212	369	1	1	1	4	6	1	1	1	6	8
All Waterbirds	29	65	70	224	388	8	44	19	150	221	7	27	18	306	357
Raptors	0	0	0	0	0	0	0	0	0	0	0	0	0	<1	<1
Owls	0	0	0	0	0	0	<1	<1	1	1	0	0	0	0	0
Ptarmigan	<1	<1	<1	1	2	0	0	0	0	0	0	0	0	<1	<1
Songbirds	24	54	58	184	320	0	0	0	0	0	0	0	0	<1	<1
All Landbirds	24	54	58	186	322	0	<1	<1	1	1	0	<1	<1	<1	<1
Total	54	120	128	409	711	8	44	19	150	222	8	27	18	306	357
% of Point Thomson Estimate	0.1	0.2	0.2	0.6	1.1	0.1	0.4	0.2	1.3	1.9	<0.1	0.1	0.1	1.0	1.1
% of ACP Estimate	UK	UK	UK	UK	UK	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.1	0.1

Source: Noel et al. 1999, 2000, 2002c, d; Rodrigues 2002a, b; Johnson et al. 2005; USFWS 2008a; Liebezeit et al. 2009; Larned et al. 2010.

[a] Numbers of birds impacted calculated by multiplying estimated project effects on bird habitat totals (from Table 5.9-15) by estimated density of bird nests, breeding birds, or post-breeding birds. More detail regarding densities provided in footnote of Table 5.9-17. Totals rounded to include nests or birds with densities of <0.1 per mi^2. Columns and rows may not total exactly due to rounding. UK = unknown.

5.9.6.2 Alternative E: Drilling

The multiseason ice pads at the East and West Pads would be maintained and resupply of East and West Pads by ice roads in winter and helicopters in the summer would continue through drilling. The impacts discussed under construction would continue through the drilling phase.

In addition, the potential for infrastructure collisions would be the same as Alternative B. The potential for vehicle collisions would be reduced under Alternative E because the length of gravel road would be greatly reduced compared to other action alternatives. However, the use of helicopters for transportation to the East and West Pads may increase the likelihood of bird collisions with helicopters.

5.9.6.3 Alternative E: Operations

Once construction and drilling are completed, a smaller workforce would be required to run the production facility. Air traffic rates and associated disturbance between the pads would be reduced from initial project development phases and would likely cause less disturbance to birds, but overall helicopter disturbance affects would remain higher under Alternative E than the other action alternatives. Barging between Prudhoe Bay and Point Thomson would also continue. These disturbance impacts would continue long term.

Annual ice roads between the Central Pad and East and West Pads would result in long-term nesting habitat loss (from delayed melt) and alteration (from delayed vegetation growth and reduced cover from dead vegetation) because ice roads would be placed in the same location or in close proximity from year to year.

Because ice roads to the East and West Pads would only be available during the winter months, tundra-safe, low-ground-pressure vehicles could be used during the summer if necessary. The use of these vehicles could disturb nesting, brood-rearing, and staging birds, and potentially result in mortality to eggs and birds.

5.9.6.4 Alternative E: Conservation Birds of Concern

Estimated numbers of conservation birds of concern potentially displaced by habitat loss, alteration, and disturbance effects from Alternative E are listed in Table 5.9-17. Potential construction, drilling, and operations effects caused by components of Alternative E would be the same as those described for the general population of nesting, breeding, and post-breeding birds and their habitats. Components of Alternative E with the greatest potential to affect conservation birds of concern include habitat loss and alteration for nesting and brood-rearing birds. There would also likely be long-term disturbance to brood-rearing and molting waterfowl from barge and aircraft traffic during summer construction, drilling, and operations activities. The common eider population on the ACP could have moderate impacts under Alternative E primarily because of potential disturbance to nesting and post-nesting habitat from the barge landing facilities and helicopter disturbance. The surf scoter population could have moderate impacts under Alternative C because of helicopter disturbance. The 5.1 percent impact to the local Point Thomson population ranks the common eider as a “moderate” impact magnitude (see Table 5.9-1), and an impact to 18 breeding birds also exceeds the criteria of $\geq$ 0.5 percent for impacts to percent of ACP abundance. A Point Thomson population estimate for surf scoters is not available, but given the ACP abundance estimate of only ~4,000, an impact to 23 breeding birds also ranks surf scoters with a potential for a moderate impact from implementation of Alternative E. Figure 5.9-7 shows the distribution of conservation birds of concern by species group in relation to facilities proposed under Alternative E.

Alternative E impacts would be long term, lasting for the life of the project, for all conservation birds of concern, but the impact would be limited in extent to within 0.3 miles of project infrastructure. The potential for impacts to occur would be probable for species with a minor magnitude. It is less probable (possible) for a moderate impact to occur to common eiders and surf scoters. It would be unlikely for bald eagles or bar-tailed godwits to be impacted under Alternative E.

Table 5.9-17: Alternative E—Estimated Annual Number of Conservation Birds of Concern Potentially Displaced by Habitat Loss, Habitat Alteration, and Disturbance

Species (Migration)[a]	Point Thomson Breeding Estimate (375 mi²)[b]	Point Thomson Post-Breeding Estimate (750 mi²)[c]	ACP Abundance[d]	Estimated Number of Birds and Percent of Point Thomson and ACP Estimate					
				Nests	Breeding Birds	Post-Breeding Birds	% of Point Thomson[e]	% of ACP Abundance[e]	Estimated Impact Magnitude
American Golden Plover (L)	4,327	✓	100,000	24	✓	✓	1.1	<0.1	Minor
Arctic Tern (L)	371	81	~13,000	0	6	<1	1.6	<0.1	Minor
Bald Eagle (S)	—	✓	NS	—	✓	✓	✓	✓	NE
Bar-tailed Godwit (L)	✓	✓	~100,000	✓	✓	✓	✓	✓	NE
Black Scoter (S)	11	51	~100	0	<1	<1	3.6	0.4	Minor
Brant (S)	266	409	~12,000	0	5	5	1.9	<0.1	Minor
Buff-breasted Sandpiper (L)	715	✓	~7,500	4	✓	✓	1.1	0.1	Minor
Common Eider (S)[f]	340	5,913	~2,500	0	18	8	5.2	0.7	Mod.
Dunlin (L)	5,571	✓	~475,000	31	✓	✓	1.1	<0.1	Minor
Golden Eagle (S)	—	✓	~40	—	✓	✓	✓	✓	NE
King Eider (S)	1,779	81	~16,000	10	13	<1	1.1	0.1	Minor
Long-tailed Duck (S)	1,505	60,050	~62,000	3	40	247	2.7	0.4	Minor
Northern Harrier (L)	—	2	~900	—	—	✓	✓	✓	NE
Pacific Loon (S)	693	543	~21,000	1	9	5	1.3	<0.1	Minor
Peregrine Falcon (L)	—	✓	~1,800	—	—	✓	✓	✓	Minor
Red Knot (L)	✓	✓	✓	✓	✓	✓	✓	✓	Minor
Red-throated Loon (L)	282	116	~2,000	2	1	1	1.1	0.2	Minor
Rough-legged Hawk (S)	✓	9	~4,000	✓	✓	<1	1.1	<0.1	Minor
Sanderling (L)	✓	✓	~30,000	✓	✓	✓	✓	✓	Minor
Sharp-shinned Hawk (L)	—	✓	NS	✓	✓	✓	✓	✓	Minor
Short-eared Owl (S)	3	4	~90,000	✓	0	0	✓	✓	Minor
Snowy Owl (S)	36	✓	~800	0	1	0	2.2	0.1	Minor
Spectacled Eider (S)	144	✓	6,635	1	2	✓	1.7	<0.1	Minor
Steller's Eider (S)	—	✓	168	—	—	✓	✓	✓	NE
Surf Scoter (S)[g]	—	1,297	~4,000	—	23	1	✓	0.7	Mod
Whimbrel (L)	✓	✓	21,000	✓	✓	✓	✓	✓	Minor
White-crowned Sparrow (L)	✓	✓	21,900,000	✓	✓	✓	✓	✓	Minor
White-winged Scoter (S)	29	230	100,000	0	1	0	3.8	<0.1	Minor
Yellow-billed Loon (L)	37	8	1,119	0	1	0	1.4	<0.1	Minor

Table 5.9-17: Alternative E—Estimated Annual Number of Conservation Birds of Concern Potentially Displaced by Habitat Loss, Habitat Alteration, and Disturbance

Species (Migration)[a]	Point Thomson Breeding Estimate (375 mi²)[b]	Point Thomson Post-Breeding Estimate (750 mi²)[c]	ACP Abundance[d]	Estimated Number of Birds and Percent of Point Thomson and ACP Estimate					
				Nests	Breeding Birds	Post-Breeding Birds	% of Point Thomson[e]	% of ACP Abundance[e]	Estimated Impact Magnitude

Sources: Noel et al. 1999, 2000, 2002b, c, d; Rodrigues 2002a, b; Rosenberg 2004; ADFG 2006; Dau and Bollinger 2009; Liebezeit et al. 2009; Larned et al. 2010.

a (R) = Resident; (S) = Short-distance migrant; (L) = Long-distance migrant.

b Point Thomson nest density multiplied by 375 mi^2, multiplied by 2 birds per nest; or ACP breeding density multiplied by 375 mi^2 plus Average Point Thomson coastal breeding density multiplied by 75 miles; value is greater of the two estimates, except for spectacled eiders which is based on a combine nest and aerial density of 0.191 pairs per mi^2.

c Point Thomson post-breeding estimates are combined shoreline density multiplied by 75 mi^2, lagoon density multiplied by 225 mi^2, barrier island density multiplied by 75 mi^2, and tundra density multiplied by 375 mi^2..

d NS = not estimated, NR = not recorded.

e Percent of Point Thomson = Largest of Nests times 2 or Breeding Birds divided by Point Thomson Breeding Estimate or Post Breeding Birds divided by Point Thomson Post-Breeding Estimate. Percent of ACP Estimate = Largest of Nests times 2, Breeding Birds, or Post-Breeding Birds divided by the ACP Abundance Estimate.

f The Point Thomson common eider post-breeding estimate is a product of the Point Thomson-specific common eider density multiplied by the total project area being considered for all species of birds (i.e.; 750 mi^2). Therefore, for common eider, the estimate is larger than the ACP total abundance as provided by literature. This discrepancy is noted and considered in the analyses. In order to keep calculation methodologies consistent, this number was not altered in tables.

g Although identified by experts during breeding bird surveys over multiple survey years, and therefore presented under the "Breeding Birds" column for numbers of birds potentially impacted, there are no definitive nesting records of surf scoter along the Alaska portion of the Beaufort Sea. Therefore, these birds are assumed to be non-breeding, although resident during periods when other species are actively nesting.

Check (✓) indicates documented to occur but no quantitative data available; dash (—) indicates not documented to occur. No Effect (NE), estimated effect is less than minor in magnitude (i.e., <1% of local population exposed, or <0.1% of ACP population exposed)

Threatened, Endangered, and Candidate Birds

As discussed in Alternative B, there are two bird species federally protected under the ESA and one candidate species being evaluated for listing.

Steller's Eider

If Steller's eiders were to occur in the project area, Alternative E would have similar potential to affect as Alternative B. These affects would include habitat loss and alteration for breeding birds and disturbance to post-breeding birds from barge, aircraft, and vehicle traffic during summer construction, drilling, and operations activities. Collision mortality with communication towers, process modules, and camps during spring and fall migrations would also be possible. Because Steller's eiders rarely occur in the study area and because the project would be located generally east of Steller's eiders distribution in Alaska, potential effects of Alternative E on Steller's eiders would be unlikely.

Spectacled Eider

Alternative E has its greatest potential to affect spectacled eiders through habitat loss and alteration for breeding birds and from disturbance to post-breeding birds from barge and aircraft traffic during summer construction, drilling, and operations activities. There would also be the possibility of collision mortality with communication towers, process modules, and camps during spring and fall migrations. A few spectacled eiders are likely to nest in the project area, though no spectacled eiders have been documented within 0.5 miles of proposed gravel infrastructure (see Figure 5.9-3). Post-breeding spectacled eiders may be present along the same areas described for Alternative B, and if spectacled eiders were present in these areas they would likely be temporarily displaced by the disturbance. Alternative E infrastructure could present collision hazards especially for spring- and fall-migrating spectacled eiders. Because few spectacled eiders are likely to occur in the project area, potential effects of Alternative E on spectacled eiders would likely be minor, local in extent, and long term.

Yellow-billed Loon

Alternative E has a minor potential to affect yellow-billed loons through habitat loss and alteration and disturbance from barge and aircraft traffic. Two yellow-billed loon sightings have been documented within 0.5 mile of proposed gravel infrastructure during 1999 and 2000; one each near West Pad and Central Pad (see Figure 5.9-4). Foraging yellow-billed loons are likely to be present along the shoreline or in the lagoon near the Central Well Pad or East Pad. Yellow-billed loons present in these areas could be temporarily displaced by disturbance. Alternative E infrastructure would present a collision hazard for spring- and fall-migrating yellow-billed loons similar to Alternative B.

5.9.6.5 Alternative E: Summary of Effects on Birds

Construction and operation of Alternative E would likely have the greatest potential effect on coastal barrens and coastal water habitats (Table 5.9-15) and would affect both waterbirds and landbirds. Disturbance from barges and aircraft would likely have the greatest potential effects on nesting waterbirds and landbirds and post-breeding waterbirds (Table 5.9-16 and Table 5.9-17).

Activities proposed for Alternative E would result in possible or probable, minor, but long-term effects on birds and their habitats. Alternative E would result in no effects on four conservation birds of concern, minor effects on 20, and moderate effects on two conservation birds of concern: the common eider and the surf scoter (Table 5.9-18). The overall impact summary for birds due to activities under Alternative E is shown below (Table 5.9-18).

Table 5.9-18: Alternative E—Impact Evaluation for Birds

Impact Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Habitat Loss and Alteration	Minor	Long term	Probable	Limited
Boat/Air Traffic Disturbance	Minor	Long term	Probable	Limited
Productivity and Mortality	Minor	Long term	Possible	Limited
Conservation Birds of Concern (4 species)	No effect	Long term	Probable	Limited
Conservation Birds of Concern (20 species)	Minor	Long term	Probable	Limited
Conservation Birds of Concern (2 species)	Moderate	Long term	Possible	Limited
Threatened Bird (spectacled eider)	Minor	Long term	Possible	Limited
Threatened Bird (Steller's eider)	No effect	Long term	Unlikely	Limited
Candidate Bird (yellow-billed loon)	Minor	Long term	Unlikely	Limited

5.9.7 Mitigative Measures

This section describes measures to mitigate impacts to birds from the Point Thomson Project. The Applicant has proposed design measures that would be included as part of the project; BMPs and permit requirements would be stipulated by federal, state, and local agencies, and the Corps has considered additional mitigation measures.

5.9.7.1 Applicant's Proposed Design Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on birds.

- Implementing controls to minimize nesting opportunities for predatory/nuisance birds, including the following:
    - Blocking off nooks and crannies with fabric/netting or other bird-nest deterrent.
    - Using scare devices to deter birds when they land in places likely to be nesting sites.
    - Removing nests as the birds try to construct them (before they have a chance to lay eggs).
- Designing facilities to minimize potential for bird strikes, including the following measures:
    - Careful consideration will be given to facility lighting (e.g., light hoods to reduce outward radiating light) that reduces the potential for disorienting migrating birds and reduces bird strikes.
    - Buildings and stack heights will be the minimum needed to perform their functions, with consideration for associated footprint. The flares will be free standing (no guy wires).
    - The primary Central Pad communications tower will be free standing (no guy wires). The tower will be lighted according to FAA requirements.
    - Other communications towers (e.g., at the airstrip or other pads) will avoid the use of guy wires and will be attached to camps or other, larger structures when possible.
    - Power lines and fiber-optic cables will either be buried or placed on the pipeline VSMs.
    - Aircraft will generally maintain a 1,500-foot altitude to avoid impacts on ground nesting and foraging birds, except as required for takeoff and landing, safety, weather, and operational needs, or as directed by air traffic control.
- Rehabilitating the gravel mine to enhance habitat for waterfowl.
- Limiting removal of water from freshwater lakes during the summer (except for the primary water source, Alaska State C-1 pit), to minimize reductions in amount or quality of nesting and brood-rearing habitat through diminished water levels.
- Monitoring water withdrawal volumes and water body recharge, as needed or directed, by ADNR and/or ADF&G in the future.
- Gravel placement on the tundra will primarily occur during the winter; however, if site preparation and/or construction activities occur on the tundra during the summer, prior to July 31 (when most arctic nesting birds have hatched), areas in the vicinity of such field activities will be searched for nesting birds by a qualified biologist prior to the start of work. If an active nest is found (even after July 31), the appropriate USFWS Field Office will be contacted for instructions on how to avoid or mitigate the potential loss of the active nest.

- Watering gravel roads and pads, as necessary, to control dust generation and minimize effects on vegetation and nearby water bodies.
- Installing mooring dolphins and pilings, and dredging the barge landing area through the ice in the winter to reduce disturbance to birds and marine mammals, and to minimize potential sediment effects on water quality.
- Limiting summer dredging/screeding to the minimum amount needed to maintain the appropriate seabed profile for barge landing.
- Managing snowmelt and runoff under site-specific SWPPPs to protect water quality.
- Employing operational controls and rigorous training programs, including:
    - Adopting strict management procedures specifically relating to the control and containment of waste containers and food, to minimize the attraction of predators to the area.
    - Requiring workers to stay on gravel surfaces unless their job duties require them to be on the tundra, to minimize compaction and disturbance to vegetation and habitat areas.
    - Requiring strict guidelines for travel on ice roads to avoid tundra damage, including ice road training, establishing speed and weight limits, and installing delineators along both sides of the road.
    - Implementing spill prevention and response programs, as detailed in Section 5.24, Spill Risk and Impact Assessment.
    - Prohibiting feeding wildlife.
    - Maintaining a clear space under modules and buildings to prevent creation of artificial den sites for foxes.
    - Limiting speed on project roads and giving right-of-way to animals.
    - Training in site operations, deterrence and hazing, waste management, and ice road operations.

5.9.7.2 BMPs and Permit Requirements

North Slope Area-wide Lease Sale mitigation measures include the following related to birds:

- Permanent, staffed facilities must be sited to the extent practicable outside identified brant, white-fronted goose, snow goose, tundra swan, king eider, common eider, Steller's eider, spectacled eider, and yellow-billed loon nesting and brood rearing areas.

Federal laws pertaining to birds include the Migratory Bird Treaty Act and ESA.

- The Migratory Bird Treaty Act prohibits actions that kill migratory birds and their eggs. Therefore, ground disturbing activities, such as gravel placement, must occur during periods when migratory birds are not nesting in the area.
- The ESA prohibits take of species listed as threatened or endangered. ESA consultation with the USFWS will result in requirements or authorizations relative to listed species that occur in the Point Thomson Project area.

5.9.7.3 Corps-considered Mitigation

In addition to the Applicant's proposed design measures and BMPs and permit requirements, the Corps, in consultation with others, is considering the following actions to avoid or minimize impacts to birds:

- Prepare an Air Traffic Plan to be reviewed and approved by the Corps, in consultation with others, prior to start of construction. Include the following measures to minimize bird disturbance:
  - During the waterfowl molting period, route helicopter flights away from lagoons and stay at altitude until landing. Approach the landing area as far away from lagoon shorelines as possible.
  - Route fixed-wing aircraft and helicopter traffic 5 miles south of the Beaufort Sea shoreline east of Bullen Point and approach the airstrip from the south, weather permitting, to avoid low-level flights over concentrations of waterfowl in coastal lagoons.
- Limit vehicle speeds on roadways and reduce speed during early spring when geese are attracted to early green vegetation along roads and again when brood-rearing waterfowl are present to avoid and reduce bird-vehicle collision mortality.
- Keep crews on gravel surfaces and watching for nesting birds (gravel-nesting plovers, common eiders, snow buntings).
- Limit personnel access to tundra, shoreline, and barrier island habitats whenever possible.
- Conduct surveys of buff-breasted sandpiper lek, breeding, and nesting habit along the gravel access road route prior to construction and adjust the route as needed to avoid the habitat.
- Coordinate vessel, aircraft, and vehicle trips during construction, drilling, and operations to minimize the number of trips.
- Haze waterfowl and seabirds from the vicinity of the airstrip.
- Design and construct facilities such as towers, flare stacks, and lighting to minimize the potential for bird strikes and mortality:
  - Develop facility lighting plans with the Corps and USFWS as part of the visual impact and lighting mitigation plan (see Visual Aesthetics) to minimize the attraction of facilities to birds during inclement weather. The plan should include methods for pointing light downward and directional shielding for outdoor lighting, and methods for shading windows to minimize attraction to indoor lighting.
  - Develop a bird survey and reporting plan with USFWS to assess bird mortality associated with project facilities. Report documented bird mortalities to the Corps and USFWS.
  - If warranted based on survey results, modify facility design in consultation with USFWS.
- Design facilities to prevent access and use by common ravens for nesting sites, including use of anti-roosting devices as appropriate.
- Monitor facilities for arctic fox dens and common raven nests and remove or block access to used sites.

5.9.8 Climate Change and Cumulative Impacts

5.9.8.1 Climate Change

The anticipated warming, increased frequency and severity of storms, and potential for sea level rise in the Arctic (see Section 4.3, Climate Change) have the potential to affect bird species in the study area because of those effects' changes to habitat, food sources, and water locations.

Higher average temperatures could, in turn, warm the lakes in the project area, increasing the availability of macroinvertebrates to feed Pacific and yellow-billed loon chicks. A longer ice-free season would allow Pacific loons more time to fledge their young. Red-necked phalaropes could also benefit from warmer temperatures if thermokarst from permafrost melt allowed them to expand their habitat into the upland areas. However, warming temperatures could also result in a reduction of connectivity between water bodies (see Section 5.6, Hydrology), the drying of wet sedge meadows, change the timing of green-up for plants, and change timing of insect abundance, each of which are tied to temperature. Loss of waterbody connectivity could inhibit fish migration between waterbodies used by yellow-billed loons for feeding. A reduction in wet sedge meadow could reduce the abundance of red-necked phalaropes in the lowlands, since that is their preferred lowland habitat. The wet sedge meadows are also a preferred foraging habitat for pectoral sandpipers and red phalaropes, which would likewise face a potential decrease in food availability from that area. A change in timing for green up and insect abundance could negatively affect shorebird migration, nesting, and chick growth and survival (Martin et al. 2009).

The increased frequency of storms, the severity of storm surges, and the potential for sea level rise could negatively impact those birds that use barrier islands and lagoons, such as the common eider and long-tailed duck. The common eider uses gravel on the barrier islands for nesting habitat, and the long-tailed duck uses those same islands for resting during their molt stage; a loss of the islands due to storm surge or changes in coastal processes (see Section 5.5, Physical Oceanography and Coastal Processes) would reduce the habitat for each species while storm surges on the islands could increase the loss of common eider nests. Additionally, a loss of the barrier islands would change the network of lagoons that the ducks use (Martin et al. 2009).

In addition to these changes to habitat and cyclical patterns, the plants themselves could change in response to climate change, in terms of taste or nutritional value to animals that feed on them. This would be of particular concern to brant and greater white-fronted geese. The growth rates of these species' goslings are sensitive to forage quality during the fledging period, and distaste for changed vegetation could impact gosling size prior to a first migration (Martin et al. 2009).

5.9.8.2 Cumulative Impacts

Past, present, and future activities in the cumulative impact study area, as described in Section 4.2, Cumulative Impacts Methodology, have the potential to add to the impacts of the proposed project. Industrial developments on the North Slope can affect birds through habitat loss and alteration from construction of temporary ice pads and roads, disturbance from construction activities, habitat loss, alteration, and disturbance associated with gravel roads and pads, and operations activities. (See Table 5.2-10 in Section 5.2, Soils and Permafrost, for the cumulative acres of gravel infrastructure in the eastern portion of the North Slope, east of Foggy Island). There is also a risk of collision with drilling rigs, modular buildings, communication towers, and power transmission lines, as well as with vehicles and aircraft. Additionally, there may be risk associated with attraction of birds to gas flares and increased predation from predators attracted to industrial developments. Additional effects specific to migratory birds from collisions with structures associated with offshore developments (e.g., Northstar) also have occurred (Day et al. 2003).

Other past and present activities in the project area involve human developments and hunting associated with NSB villages, the use of the USAF Alaska Radar System sites, and ongoing scientific studies across the North Slope. Features of human developments that can affect birds include those listed above for industrial development, along with the addition of subsistence hunting and egg-collecting, sport hunting, and disturbance during nesting and migration. Effects from scientific studies on the North Slope largely are restricted to disturbance during nesting and migration. Outside Alaska, habitat loss and fragmentation, contamination, changes in predator abundance and prey availability, and other factors at a global scale have contributed to long term bird population declines (Rich et al. 2004, Rosenberg 2004, USFWS 2008a, ANHP 2011).

These past and present activities have caused documented habitat loss, alteration, and disturbance, which has resulted in mortality for bird species (Truett and Johnson 2000, NRC 2003a). In a recent review of cumulative effects of oil and gas development on the North Slope, loons, shorebirds, tundra swan, lesser snow goose, brant, and eiders were identified as species of concern (NRC 2003a). The NRC review identified the following cumulative effects on birds from past, present, and future developments on the North Slope:

- Shifts in nesting distribution of shorebirds in response to oil field facilities
- Artificially high predator populations (arctic and red foxes, gulls, ravens) in the oil fields because of inadequate disposal of garbage and the resulting increased predation on birds' nests and young from the higher predator numbers
- Impacts on nesting raptors due to future development in the Brooks Range foothills
- Potential adverse effects on molting waterfowl, particularly brant, if oil development occurs in the Teshekpuk Lake area within NPR–A
- Increased risk of a major oil spill associated with the shoreline or offshore that could endanger molting flocks of waterfowl in nearshore lagoons

Other potential cumulative issues relative to birds include the following:

- Incremental habitat loss, alteration, and disturbance, particularly in areas of moderate to high nesting density or areas important during spring and fall migration and post nesting; important habitats vary by species (see Section 5.8, Vegetation and Wetlands, for a discussion of habitat loss)
- Increased disturbance from aircraft, particularly in areas where birds are concentrated and during sensitive time periods (e.g., nesting and molting)
- Mortality from collision with towers, drilling rigs, and other infrastructure, particularly in low light conditions during migration; birds can be attracted to lighting at facilities in low light conditions

Regardless of action alternative, the proposed project has the potential to produce impacts on birds that would contribute to the cumulative impacts on birds and their habitats. Specific potential effects would include incremental habitat loss and alteration; disturbance from barge and air traffic; structure, vehicle, and aircraft collision mortality; and reduced productivity from altered predator abundance or distribution. Other RFFAs, including full field development at Point Thomson, the development of an Alaska Gas Pipeline including a large gas treatment plant in Prudhoe Bay, and the development of offshore leases in the Beaufort Sea, may also result in similar impacts on birds and their habitats.

The cumulative loss of habitat from all past and present projects on the North Slope have reduced available nesting habitat for all species, affecting an estimated 4 to 5 percent within the unitized lease sale areas but affecting less than 1 percent of North Slope bird breeding populations. Cumulative habitat loss may have localized effects on the distribution or density of some bird species over the life of the oilfields (BLM 1998). Overall direct mortality effects due to collisions with vehicles, aircraft, buildings, pipelines, transmission lines and communications towers would occur only at very low levels in the North Slope oilfields during present and future developments. The NRC (2003a) concluded that reduced productivity was the most substantial cumulative impact to bird populations due to oil and gas development activities. This determination was based on decreased productivity due to increased levels of predators attracted to the development area. Declines in fitness, survival, or production of young could occur where birds are exposed frequently to various disturbance factors. Human presence that disturbs nesting or brood-rearing birds or attracts predators may result in depredation of unprotected eggs or young. Because the disturbed area resulting from future actions will be smaller due to evolving construction and operation methods that minimize gravel infrastructure, the effect of future project infrastructure on bird populations, although additive to prior effects, is expected to be less severe than that of previous arctic developments. As a result, no concerns related to adverse cumulative effects to birds have been identified at this time.

5.9.9 Alternatives Comparison and Consequences

Impacts to birds from the implementation of any of the Point Thomson Project alternatives would be minor to moderate. Alternatives and project components that have the most potential to impact birds include the following:

- Gravel infrastructure, particularly the gravel access road under Alternative C, would result in habitat loss, alteration and disturbance. Alternative C's gravel access road could result in a moderate impact to breeding and post-breeding habitat for the red-throated loon, a conservation bird of concern.
- Barge facilities under Alternatives B and E could cause small amounts of habitat loss and alteration (from dredge disposal and summer screeding) and a larger temporary disturbance (from barge traffic and noise). Barge operations could result in a moderate impact to breeding and post-breeding habitat for common eiders, a conservation bird of concern.
- Noise disturbance from helicopter flights between the Central Pad and East and West Pads under Alternative E could result in moderate impacts for long-tailed ducks and surf scoters, conservation birds of concern.
- Bird mortality from collisions with infrastructure and vehicles would be possible under all alternatives. Bird collision with infrastructure (particularly towers, the drilling rig, and the flare stack) by large flocks during spring and fall migration is of particular concern. These collisions would be most likely to occur in Alternatives B and E because most of the infrastructure would be located along the coast.
- The threatened Steller's eider is rare in the Point Thomson study area and is not expected to be affected by the project.
- The threatened spectacled eider occurs in the Point Thomson study area and could be affected by the project. Infrastructure near the West Pad under all action alternatives, and the gravel access road under Alternative C, has the potential for minor impacts on spectacled eiders.
- The yellow-billed loon, a candidate species for listing under ESA, occurs in the Point Thomson study area, most commonly on the coast. Coastal activities at the Central Pad have the potential for minor impacts on yellow-billed loons.

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5.10 TERRESTRIAL MAMMALS

The key findings of effects for terrestrial mammals are summarized below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

Alternative C: Major impacts to caribou, muskoxen, and other mammals are probable and would last for the life of the project. Impacts would be localized to the study area.

Alternatives B, D, and E: Minor impacts to mammals are probable and would last for the life of the project. Impacts would be limited to the vicinity of project facilities.

Alternative A: Minor impacts to caribou, muskoxen, and other mammals are possible. Impacts would be limited to the helicopter flight path used for well monitoring.

Differentiators:

- Gravel access road under Alternative C would be placed near possible caribou calving areas and near a muskoxen wintering area. Increased potential for impacts to denning brown bears.
- Caribou and muskoxen would be reluctant to cross the water pipeline elevated 12 inches above the ground under Alternative C, which could fragment herds.
- Alternative E would have the least impacts from gravel infrastructure but the greatest potential disturbance impacts from local helicopter traffic during the summer.

Anticipated project-related direct and indirect impacts to terrestrial mammals and their dens, burrows, foraging, and resting habitats include:

- Habitat loss and alteration due to:
    - Physical habitat changes
    - Displacement from or attraction to altered habitats
    - Disturbance from noise or activity

- Habitat fragmentation causing:
    - Reduced habitat patch size or increased habitat edge
    - Barriers to movements
- Mortality associated with gravel and ice placement, vehicles, and other causes
- Altered survival or productivity through:
    - Changes in predator abundance, distribution, and predation risk
    - Exposure to spills and leaks of toxic materials (discussed in Section 5.24, Spill Risk and Impact Assessment)

5.10.1 Methodology

The analysis presented in this section evaluated potential impacts to terrestrial mammals based on habitat use, seasonal distributions, and seasonal movement patterns. The Point Thomson study area evaluated is the region from the Dalton Highway to the Staines/Canning River and inland within approximately 20 to 30 miles from the coastline as described in Section 3.10. For quantification of potential impacts to terrestrial mammals, a project area was also developed as a subset of the larger study area. The project area includes all gravel and ice components for all alternatives with a surrounding buffer of approximately 2.5 miles, totaling approximately 375 mi^2 or 240,000 acres. Terrestrial mammal habitat loss was based on the vegetation and wetland analyses described in Section 5.8 for gravel mining and fill. Terrestrial mammal habitat alteration was evaluated by using a 165-foot buffer distance (based on Hettinger 1992), from proposed gravel mining and fill sites in response to possible physical changes caused by dust deposition, snow drifting and piling, thermokarst, and altered wetland hydrology, as discussed in Section 5.8, Vegetation and Wetlands.

Loss, alteration, and disturbance of forage habitats were evaluated based on estimated aboveground plant biomass as calculated from the Normalized Difference Vegetation Index (Raynolds et al. 2010). Loss, alteration, and disturbance of habitats suitable for burrows or dens for arctic ground squirrels and arctic foxes were evaluated based on potential impacts to dry dwarf shrub, crustose lichens, and fruticose lichens (vegetation map unit types Vc and Vd) as described in Section 5.8, Vegetation and Wetlands. Loss, alteration, and disturbance of habitats potentially suitable for brown bear dens were evaluated based on polar bear denning impact models (Durner et al. 2001, 2006). The terrestrial maternal polar bear model was used because the model was based on linear features that showed elevation changes of 3 feet or more (e.g., stream and riverbanks, lake shores); features that would also be applicable to brown bears that may den in the study area. The sloped habitats along drainages were considered to approximate the availability of loose, well-drained soils that may be suitable for brown bears to dig dens for hibernation.

Behavioral displacement away from or attraction to facilities and the potential for resulting changes in habitat use were evaluated by using various distances depending on characteristics of individual terrestrial mammal groups:

- Small mammals were not considered behaviorally displaced
- Potential caribou displacement was evaluated within 0.6-mile buffer intervals from gravel infrastructure out to 2.5 miles based on displacement distances evaluated in studies of caribou behavioral responses to disturbance (Dau and Cameron 1986; Cameron et al. 1992, 1995; Wolfe 2000; Noel et al. 2004; Haskell et al. 2006; Haskell and Ballard 2008).

- Potential aircraft overflight disturbance was evaluated within 0.25 mile of anticipated flight paths from the Deadhorse airport to landing locations for the various alternatives (Wolfe et al. 2000)
- Potential occurrence of muskoxen, arctic foxes, and brown bears within 2.5 mile of gravel and ice infrastructure were identified to evaluate potential impacts related to displacement or attraction
- Potential disturbance to arctic fox den or previously-used brown bear den locations and potential fox and bear den habitat was evaluated within 0.5 mile of gravel or ice roads, pads, and airstrips
- It has been reported that caribou crossing is reduced where pipelines are located less than 325 feet from high traffic roads (Lawhead et al. 2006). Potential areas of blockage to caribou movements were identified where roads and pipelines are located within 500 feet of each other based on mitigation guidance developed by the Alaska Caribou Steering Committee (Cronin et al. 1994)

The consequences of habitat loss, alteration, and disturbance were evaluated based on:

- Amount of affected habitat relative to the amount of unaffected habitat in the 375 mi^2 Point Thomson project area
- Reported arctic fox den locations (Perham 2000, 2001)
- Reported previously-used brown bear den locations (Shideler 1998, 1999)
- Average density of caribou and occurrence of other large mammals within the Badami and Point Thomson survey areas between 1997 and 2003 (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; Reynolds 2003)
- Caribou calving and caribou photocensus locations (Arthur 2002; ADF&G 2003b, 2009c)
- Caribou movements from 1983 to 2001 based on radio and satellite telemetry (WCC and ABR 1983, Griffith 2002)

Definitions for impact assessment criteria are listed in Table 5.10-1 and are grouped in the impact categories for magnitude, duration, potential to occur, and geographic extent. These impact criteria were developed based on a range of possible outcomes and to provide a frame of reference for impact analyses.

Unavoidable impacts to terrestrial mammals and their habitats from proposed alternatives that have the potential to accumulate with other oil and gas developments on the North Slope and cause a cumulative effect on these species are identified based on the assessment completed by the National Research Council (2003a).

Table 5.10-1: Impact Criteria—Terrestrial Mammals

Impact Category*	Intensity Type*	Specific Definition for Terrestrial Mammals
Magnitude	Major	Potentially affecting $\geq$ 25% of a local terrestrial mammal habitat or population
	Moderate	Potentially affecting $\geq$ 5% but < 25% of a local terrestrial mammal habitat or population
	Minor	Potentially affecting $\geq$1% but < 5% of a local terrestrial mammal habitat or population
Duration	Long term	Lasting five or longer than five breeding seasons
	Medium term	Lasting two or longer than two breeding seasons, but less than 5 breeding seasons
	Temporary	Lasting less than two breeding seasons

Table 5.10-1: Impact Criteria—Terrestrial Mammals		
Impact Category*	Intensity Type*	Specific Definition for Terrestrial Mammals
Potential to Occur	Probable	Not avoidable
	Possible	Potential to occur (may be able to mitigate)
	Unlikely	May occur, but unlikely to occur
Geographic Extent	Extensive	ACP
	Local	Between Deadhorse and the western edge of the Arctic Refuge
	Limited	Within 2.5 miles of project components

* Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology.

5.10.2 Alternative A: No Action

Potential effects of Alternative A on habitat and terrestrial mammals would be limited to impacts from monitoring and maintenance activities. This alternative would have no new construction activities; therefore, no habitat loss or alteration would occur.

Monitoring of the capped wells would affect terrestrial mammals and their habitats through long-term but infrequent disturbance. Helicopter flights for monitoring purposes are anticipated to occur infrequently (no more than four times per year).

Low-level helicopter overflights for wellhead monitoring may cause flight responses, especially in maternal caribou, large caribou groups, and brown bears, and would cause the animals to expend extra energy. The anticipated flight line, from Deadhorse crossing 5 miles south of the coastline east of Bullen Point and approaching the central pad from the south, would cross habitats used by calving and post-calving caribou. Low altitude approaches during takeoff and landing with associated humans on foot would disturb caribou that may occur in that vicinity during these activities. People on foot can elicit strong reactions from caribou because people are perceived as predators. Helicopter landings at the central pad during the caribou calving period (late May to late June) would be unlikely to disturb caribou, as no caribou have been observed within 0.6 miles of the central pad during the calving period. Helicopter overflights coincident with caribou use of coastal insect relief habitats during late June to mid-July on or near the central pad would likely displace caribou from these habitats.

Site visitors would likely be attractive to arctic foxes. One of the two mature arctic fox dens located within 1.2 miles south of the central pad on a streambank (Dens 203 and 219) has been occupied by arctic foxes during 2 of the 3 years surveyed. Monitoring activities at the pad could attract foxes from this den site.

The monitoring activities would be long term but infrequent and would likely cause no to minor disturbance to terrestrial mammals, depending on timing of the monitoring flight and occurrence of large aggregations of caribou or occurrence of other terrestrial mammals near the central pad.

5.10.3 Alternative B: Applicant's Proposed Action

Construction of Alternative B would initiate long-term physical changes to terrestrial mammal habitat by placement of gravel fill for roads and pads, and removal of overburden at the gravel pit site. Gravel fill covers habitat and gravel pit development removes habitat used by terrestrial mammals. These actions may also cause alteration to adjacent habitat. Once these types of physical habitat changes occur, many would continue through drilling and the operational lifespan of the project, although some would decrease in magnitude after construction. Transport and placement of the processing facilities, operations camp, and associated vertical structures would also occur during construction and, as with placement of gravel fill, the effect of these persisting physical structures on terrestrial mammals would continue for the life of the project.

Three phases—construction, drilling, and operations—are proposed for each of the action alternatives and, for many features, different levels of impact on wildlife and related habitat would occur as the project proceeds through these phases. While these phases are discussed separately, drilling would begin during construction and extend into operations (see Chapter 2 for proposed sequencing), thus some impacts could be increased during periods when multiple activities are occurring. These impacts and their severity are discussed by phase for each of the action alternatives.

5.10.3.1 Alternative B: Construction

Construction of Alternative B would affect terrestrial mammals and their habitats through medium- and long-term habitat loss and alteration; medium- and long-term habitat fragmentation; medium-term construction, vehicle collision, and human safety mortality; and medium-term altered survival or productivity.

Habitat Loss and Alteration

Construction of Alternative B would result in long-term loss of habitat due to extraction and placement of gravel for roads, pads, and an airstrip (Table 5.10-2 and Figure 5.10-1). Lost habitat would potentially provide forage sufficient to support about 111 caribou or muskoxen for 12 months based on Normalized Difference Vegetation Index and estimated ***phytobiomass*** (Raynolds et al. 2010), assuming a 40 percent phytobiomass to dry forage weight conversion, and a forage requirement of 300 pounds per month for caribou or muskoxen (Palmer 1944). The amount of forage affected represents a small proportion of the forage available within 2.5 miles of the proposed Alternative B gravel fill and extraction areas (Table 5.10-2). While the amount of forage loss could support a considerable number of caribou or muskoxen, forage is plentiful in the surrounding areas and these animals would likely move to other areas to forage (Figure 5.10-2). Forage habitat lost to gravel fill may provide insect relief habitat for caribou and possibly also for muskoxen (Pollard et al. 1990, 1996a,b; Noel et al. 1998; Ballard et al. 2000; Murphy and Lawhead 2000).

Table 5.10-2: Alternative B—Estimated Terrestrial Mammal Habitat Impacts

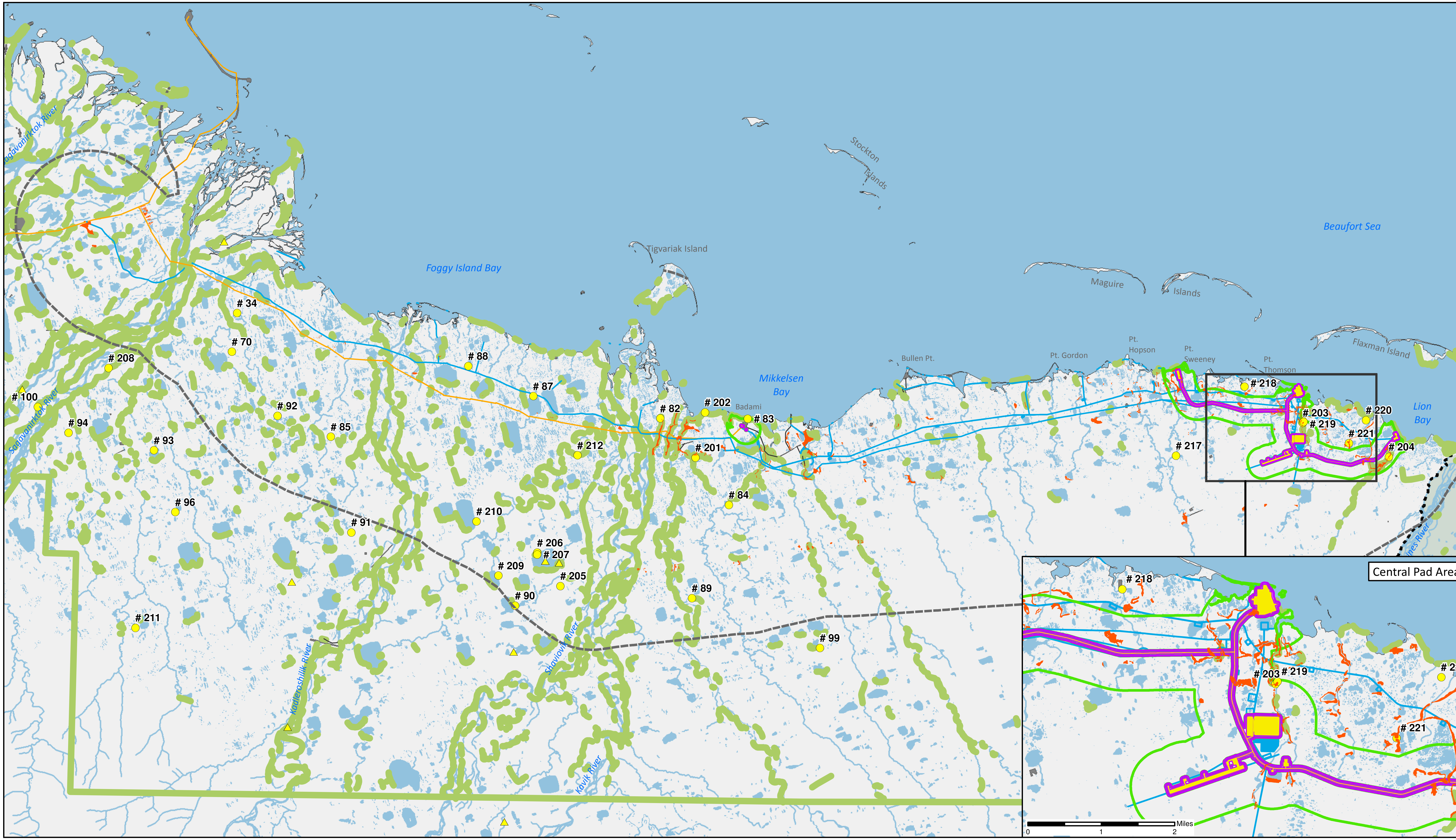
	Habitat[a]					
	All Habitats (acres)	Forage (tons)	Squirrel Burrow/Fox Den Habitat (acres)	Arctic Fox Dens	Bear Den Habitat (miles)	Brown Bear Dens
Available Habitat within Point Thomson Project Area[b]	245,165	432,369	4,982	32	190.9	3
Habitat Impacts from Gravel Extraction or Placement						
Loss from Gravel Extraction/Placement (footprint)	284	501	8	0	0.0	0
Alteration by Proximity (within 165 feet of gravel extraction/placement)	597	1,083	29	0	0.1	0
Proportion of Available Habitat Lost and Altered	<1%	<1%	1%	0%	<1%	0%
Habitat/Forage Potentially Disturbed (within 2.5 miles)	38,505	70,041	—	—	—	—
Proportion of Available Habitat/Forage Potentially Disturbed	16%	16%	—	—	—	—
Burrows/Den Habitat and Known Dens Potentially Disturbed (within 0.5 miles)	—	—	304	4	3.2	0
Proportion of Available Burrow/Den Habitat and Known Dens Potentially Disturbed	—	—	6%	13%	2%	0%
Habitat Impacts from Ice Infrastructure Development						
Loss from Ice Cover (footprint)	596	1,045	19	1	0.2	0
Proportion of Available Habitat Lost	<1%	<1%	<1%	3%	<1%	0%
Burrows/den Habitat and Known Dens Potentially Disturbed (within 0.5 miles)	—	—	942	9	36.1	0
Proportion of Available Burrow/Den Habitat and Known Dens Potentially Disturbed	—	—	19%	28%	19%	0%

Source: Shideler 1998, 1999; Perham 2000, 2001; Raynolds et al. 2010

—: Not applicable

[a] Burrow habitat for arctic ground squirrels and arctic foxes as indicated by mapped dry dwarf shrub-lichen tundra (Vc and Vd). Habitat mapping not available for all assessment area extents (range 19 to 100 percent). Brown bear den habitat estimate as indicated by topographic models for suitable polar bear den habitat (Durner et al. 2001, 2006).

[b] Point Thomson Project Area habitat is based on the proportion of mapped habitat types extrapolated to a 375 mi^2 area or the approximate area within 2.5 miles of gravel and ice components for all alternatives.



Legend

- Stream
- Existing Pipeline
- Existing Road
- Water Body
- Arctic National Wildlife Refuge
- Existing Facilities
- 2.5 Mile Buffer around all Project Alternative features
- Loss - Gravel Mine/Placement Footprint
- Loss - Ice Road Footprint
- Alteration - Within 165 ft of Gravel Mine/Placement
- Disturbance - Within 0.5 mile of Gravel Mine/Placement

Assessment Areas and Data

- Suitable Burrow Habitat (Vc/Vd)
- Polar (and potential Brown) Bear Denning Habitat
- Arctic Fox Den Location (with Den Number)
- Brown Bear Den Location

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

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POINT THOMSON PROJECT EIS

Figure 5.10-1

Alternative B – Areas of Terrestrial Mammal Habitat Loss, Alteration, and Disturbance

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

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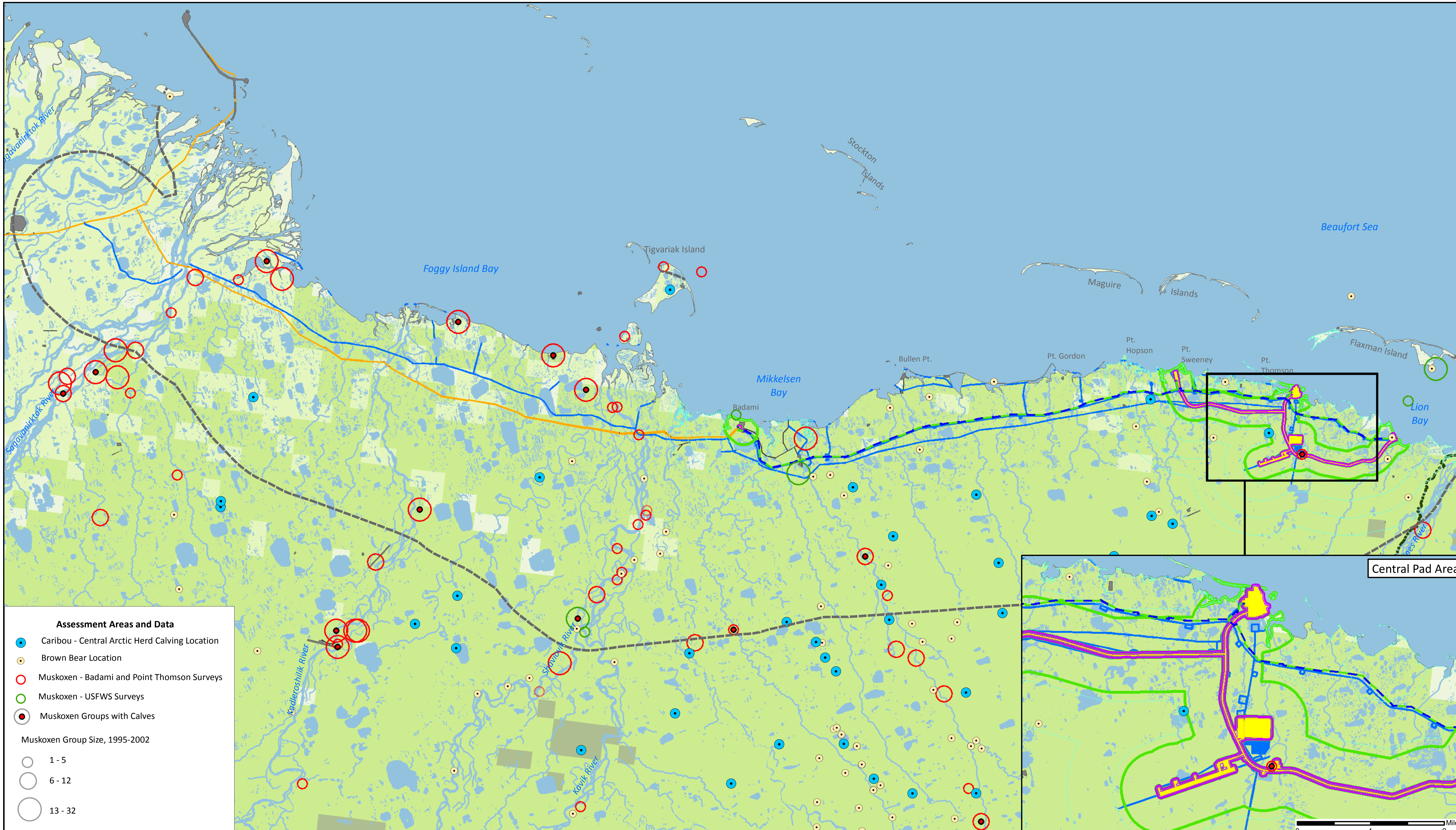

POINT THOMSON PROJECT EIS

Legend

- Stream
- Existing Road
- Existing Pipeline
- Existing Facilities
- Water Body
- Arctic National Wildlife Refuge
- Proposed Pipelines
- 2.5 Mile Buffer around all Project Alternative features
- Loss - Gravel Mine/Placement Footprint
- Loss - Ice Road Footprint
- Alteration - Within 165 ft of Gravel Mine/Placement
- Disturbance - Within 0.5 mile of Gravel Mine/Placement
- Disturbance – 0.6-Mile Buffer from Gravel Infrastructure

Phytobiomass (tons/acre)

- <0.03
- 0.27-0.38
- 0.39-0.50
- >0.50

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

N

0 1 2 Miles

Figure 5.10-2

Alternative B – Estimated Forage Production and Terrestrial Mammal Disturbance and Displacement from Gravel Infrastructure

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

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Arctic fox dens occur within the area potentially disturbed by the development of Alternative B (Table 5.10-2); although no known fox dens would be covered by gravel fill (Figure 5.10-1). Habitats suitable for arctic fox dens have not been identified as limiting fox populations on the North Slope (Burgess 2000), and some foxes are likely to use culverts and other artificial habitat as den sites and for temporary shelter (Sanzone et al. 2009). Arctic ground squirrels and other small mammals would also lose minor amounts of foraging and burrow habitat due to gravel fill and mining (Table 5.10-2).

Brown bears would lose minor amounts of foraging habitat and could lose minor amounts of den habitat (Table 5.10-2). Brown bears generally do not reuse den sites (Shideler and Hechtel 2000). Although brown bear den habitat is available, no brown bear dens have been found in previous years within the project gravel footprint area or within 0.5 mile of the gravel or ice footprint (Table 5.10-2). Most brown bear dens are likely to occur south of the project area and would not be affected by Alternative B.

Ice road construction across tundra habitats causes temporary loss of winter forage for both small and large herbivores, and also causes temporary subnivean habitat loss for small mammals. Initial clearing and piling of snow from the pads, roads, and airstrip during the winter could result in the collapse of subnivean tunnel systems used by small mammals. Ice roads and snow drifts would not melt before most birds begin nesting in late May to early June, altering the distribution and availability to mammalian predators of nests and prey under and near the ice roads and snow piles.

Standing dead vegetation would be knocked down by ice road construction and snow piling, reducing concealment cover for small mammals and potentially increasing their risk of predation. Compaction of standing dead vegetation would be medium-term, requiring several growing seasons to reestablish. Damage to dwarf shrubs and tussock tundra from ice road construction could result in long-term impacts to vegetation cover. Tundra ice roads to support pipeline construction would be required for two winter construction periods, resulting in medium-term loss of winter forage and subnivean habitat. Snow pile habitat losses would be seasonal, but snow piling would likely occur annually in the same locations and would continue as long as the facilities were maintained, resulting in long-term habitat alteration.

Habitats near gravel fill would be altered by snow piles and drifts, dust spray, altered hydrology, and thermokarst, resulting in reduced forage and habitat suitability for small and large terrestrial mammals (Table 5.10-2 and Table 5.10-3). In addition, snow would drift around buildings, roads, and pipelines. Deep drifts would likely reduce the availability of winter forage for caribou or muskoxen, but might provide additional protection for small animals using subnivean habitats. Dust spray on snow caused by vehicle traffic on gravel roads would lead to early melt and green-up that may attract caribou or muskoxen, as well as small herbivores (Lawhead et al. 2004). Dust spray may be increased during construction, when vehicle traffic would be expected to be highest; although disturbance from human presence and noise may reduce caribou or muskoxen use of these areas. Terrestrial mammals attracted by early vegetation sprouting along roadways may also increase their risk of predation and vehicle collision mortality.

Table 5.10-3: Alternative B—Potential Small Mammal Habitat Loss and Alteration						
Small Mammals	Point Thomson Project Area Habitat Estimate (in acres)[b]	Estimated Area (in acres) of Affected Small Mammal Habitat[a]				Proportion of Point Thomson Habitat Estimate (%)
		Habitat Loss from Gravel Extraction and Placement	Habitat Alteration Surrounding Gravel Placement/Extraction /Staging	Habitat Loss from Ice Infrastructure Construction	Total	
Small Herbivores						
Collared Lemming	62,782	96	243	207	545	1
Brown Lemming and Root Vole	163,351	238	518	469	1,224	1
Small Carnivores						
Barren Ground Shrew	94,779	129	315	318	762	1
Ermine and Least Weasel	175,244	271	563	509	1,343	1
Medium Herbivores						
Arctic Ground Squirrel	104,372	162	359	350	872	1

Source: Burgess 1984, Babcock 1985, Nature Serve 2009

[a] Small mammal habitat impacts are estimated based on loss and alteration of habitats typically used by the small mammals as defined in Methodology.

[b] Point Thomson project area habitat estimate is based on the proportion of mapped habitat types extrapolated to a 375 mi^2 area or the approximate area within 2.5 miles of gravel and ice components for all alternatives.

Disturbance

Noise from equipment used to build and maintain the ice road and from traffic on the ice road has the potential to disturb and displace arctic fox, caribou, and muskoxen, which may occur near the ice road during winter. Construction traffic on ice and gravel roads in winter and summer with associated human activity would likely be greater than other project phases and would potentially cause displacement of small mammals, caribou, and muskoxen, and attraction of arctic foxes and food-conditioned brown bears.

Project activities would disturb terrestrial mammals if they cause a change in behavior or stress in the animals. Some project activities would cause animals to avoid an area or be completely displaced from an area such that they would not return.

Many studies have evaluated effects of oil and gas infrastructure and activity on caribou (Dau and Cameron 1986; Cameron et al. 1992, 1995, 2005; Cronin et al. 1994; Ballard et al. 2000; Murphy and Lawhead 2000; Murphy et al. 2000; Noel et al. 2004, 2006; Haskell et al. 2006; Lawhead et al. 2006; Haskell and Ballard 2008; Arthur and Del Vecchio 2009). In general, most behavioral responses of caribou to infrastructure are observed at close range (within 0.6 mile of roads or pads) where it is generally considered that caribou perceive the infrastructure and human activity and react (Vistnes and Nellemann 2008). Studies based on telemetry or aerial surveys of caribou distributions assume that caribou can or have perceived the disturbance at the reported displacement distance, and relate changes in observed habitat use to disturbance and displacement (Vistnes and Nellemann 2008). The underlying assumption from telemetry- or aerial survey-based distributions is that at some point in time the animal was sufficiently close to perceive the disturbance and then moved to a comfortable distance from the disturbance. Distributions based on aerial surveys (radio telemetry and visual surveys) are normally completed during morning to early evening, while caribou may be more likely to approach infrastructure during reduced traffic periods in late evening or overnight (Haskell et al. 2006, Haskell and Ballard 2008).

Such disturbance would most likely affect maternal cow caribou and muskoxen and may result in some displacement from the area of the gravel roads and pads. Displacement would be most pronounced during construction when traffic levels would likely be heaviest; but would continue for the life of the project as long as traffic and human activity continued. Figure 5.10-2 shows caribou calving locations, forage production, and disturbance areas in relation to infrastructure proposed under Alternative B.

Another source of disturbance to caribou may include hazing animals away from the airstrip if animals are gathered there for insect relief. Hazing would be conducted if necessary for safe aircraft operations.

Table 5.10-4 lists the average number of caribou potentially occurring within 2.5 miles of Alternative B proposed infrastructure that could be disturbed and displaced. More caribou would likely occur in the area of proposed Alternative B infrastructure during the post-calving period (Table 5.10-4).

Table 5.10-4: Alternative B—Potential Disturbance to Caribou from Project Construction and Operation

	Potentially Disturbed							
	0 to 0.6 mile	0.6 to 1.2 miles	1.2 to 1.9 miles	1.9 to 2.5 miles	Total 0 to 2.5 miles	Point Thomson Study Area Estimate	Proportion Potentially Disturbed (0.6 miles)	Proportion Potentially Disturbed (2.5 miles)
Calving Locations[a]	1	1	0	0	2	62	2%	3%
Average Number of Caribou During Calving[b]								
Calves	3	2	1	2	8	735[c]	<1%	1 %
Total	9	4	2	6	21	1,233[c]	<1%	2%
Average Number of Caribou Post Calving[d]								
Calves	18	17	5	13	52	693[c]	3%	—
Total	78	203	19	46	346	3,956[c]	2%	—
Photocensus Locations[e]	0	2	1	0	3	95	0%	—

Source: Shideler 1998, 1999; Noel 1998a, b; Noel and Olson 1999a, b, 2001a,b; Noel and King 2000 a, b; Jensen and Noel 2002; Jensen et al. 2003; Noel and Cunningham 2003

—: Not applicable

[a] Location for calves near the time of birth east of the Sagavanirktok River during 1 to 10 June 1992 to 2002; usually one calf associated with each location (Arthur 2002)

[b] Based on average numbers of caribou observed from 11 surveys of the Bullen survey area and 9 surveys of the Badami survey area. Numbers are rounded to the nearest whole number.

[c] Based on combined mean observed densities during systematic surveys between the Sagavanirktok and Canning Rivers of 3.22 caribou per mi^2 and 1.92 caribou calves per mi^2 during calving (1 to 20 June) and 10.33 caribou per mi^2 and 1.81 calves per mi^2 during post-calving (21 June to August) multiplied by 375 mi^2 or the approximate area within 2.5 miles of project components.

[d] Based on average numbers of caribou observed from 30 surveys of the Point Thomson survey area and 27 surveys of the Badami survey area. Numbers are rounded to the nearest whole number.

Traffic is the most common disturbing stimulus associated with roads, and traffic volumes of 15 vehicles per hour or more may deflect caribou movements or delay successful road crossing for several hours (Curatolo and Murphy 1986b, Murphy and Curatolo 1987, Cronin et al. 1994). Studies of interactions between caribou and traffic within the North Slope oil fields have occurred in oil field areas that are closed to hunting and show that caribou, including cows with calves, become tolerant of traffic disturbances during the course of each summer season (Haskell et al. 2006, Haskell and Ballard 2008). However, cows with calves tend to remain farther from roads than cows without calves and caribou tend to be observed closer to roads during time periods with lower traffic volumes. Under Alternative B, allowing access to the developed road system to local hunters and hunting near the roads may lead to an increased avoidance response for caribou and other terrestrial mammals beyond those normally observed in the Prudhoe Bay oil fields where hunting is not allowed. Caribou may distance themselves farther from Alternative B infrastructure and roads as an anti-predator response to interactions with hunters. The road system could also change hunters' access or use of inland areas in the Point Thomson area for caribou or muskoxen harvest.

In general, winter construction of gravel and ice roads with associated vehicle traffic has the potential to disturb hibernating brown bears in dens (Linnell et al. 2000), but no dens have been found within 0.5 miles of proposed gravel or ice roads. Therefore, based on historical den distributions, no brown bear dens would likely be disturbed by winter road construction and use.

Low-level helicopter overflights for routine maintenance and surveillance of pipelines may cause flight responses, especially in maternal caribou, large caribou groups, and brown bears, and would cause the animals to expend extra energy. The noise associated with aircraft take offs and landings could result in the inability of affected animals to hear biologically important sounds such as mating calls, predator alarm calls and approaching predators. This could lead to increased stress levels, decreased reproductive capacity, and decreased survivorship in noisy areas such as airstrips and helipads. Repeated low-level aircraft flights over calving concentration areas at less than 1,000 feet above ground level and over early post-calving concentration areas at less than 500 feet above ground level may reduce calf survival (Wolfe et al. 2000). Landings and takeoffs at the airstrip and helipad during the caribou calving period in late May through late June would also potentially disturb caribou. An estimated 990 fixed-wing aircraft and 990 helicopter round trips would occur in the anticipated flight paths between Deadhorse and the airstrip, potentially reducing productivity in the proportion of caribou that use habitats in this area (Wolfe et al. 2000).

Habitat Fragmentation

Gravel fill may block movements of small mammals such as lemmings and voles during both winter and summer. Blockage may be physical, but would more likely be behavioral because crossing gravel roads and pads during summer would mean that small mammals could increase their predation risk as they move from vegetation concealment cover across the open gravel surface. Small mammals crossing gravel roads during winter would be exposed to decreased air temperatures and higher winds compared to the protected environments of subnivean tunnels, which could also increase their risk of predation.

Gravel roads would potentially block movements of caribou and muskoxen in the study area, which could prevent or delay access between inland and coastal insect-relief habitats. Gravel road berms 4 feet or more in height create a visual barrier that can lead to deflection of caribou movements (Wolfe et al. 2000). As discussed in Chapter 2, all proposed gravel roads associated with the Point Thomson Project would have an average thickness of 7 feet.

The Alternative B export and gathering pipeline heights (minimum of 7 feet) are greater than the minimum 5-foot height that has been recommended to prevent blockage of caribou movements during summer or winter (Cronin et al. 1994, Lawhead et al. 2006).

Caribou have been found to avoid or delay crossing locations where roads and pipelines are located less than 325 feet from high traffic roads (Curatolo and Murphy 1986b, Murphy and Curatolo 1987,Cronin et al. 1994, Lawhead et al. 2006). Areas that may be more susceptible to blockage of caribou movements have been identified based on caribou movement densities and locations where roads and pipelines are separated by less than 500 feet. These locations are characterized in Table 5.10-5 and shown in Figure 5.10-3. Movement numbers are based on telemetry data for 34 caribou during June, July, and August 1983 and for 49 caribou during June, July, and August 1987 to 1990 (see Section 3.10.3.2); they do not indicate a density of caribou, rather the survey indicates the number of individual caribou reported crossing the area during the study period. The area with the highest coincidence of caribou movements combined with pipeline-road separation distances of less than 500 feet occurs near Badami (Table 5.10-5 and Figure 5.10-3).

Table 5.10-5: Alternative B—Potential Road-Pipeline Blockage to Caribou Movements

Location of Road-Pipeline with **Separation ≤ 500 ft**	Feature	Length of Pipeline Segment (ft) ≤ 500 ft	Number of Recorded Caribou Movements[a] (# of crossings per mi^2)
Central Pad	East gathering line	469	2
	West gathering line	1,323	0
	Export pipeline	1,337	0
East Pad	—	—	—
West Pad	Export pipeline	1,662	4
	West gathering line	3,252	4
Airstrip and Adjacent Pipelines	—	—	—
Gravel Mine and Reservoir	—	—	—
Badami Export Pipeline Tie-in Location	Export pipeline	5,954	109

[a] Caribou movement numbers are based on available telemetry data from June, July, and August surveys from 1983 and 1987 to 1990 (WCC and ABR 1983, Griffith 2002)

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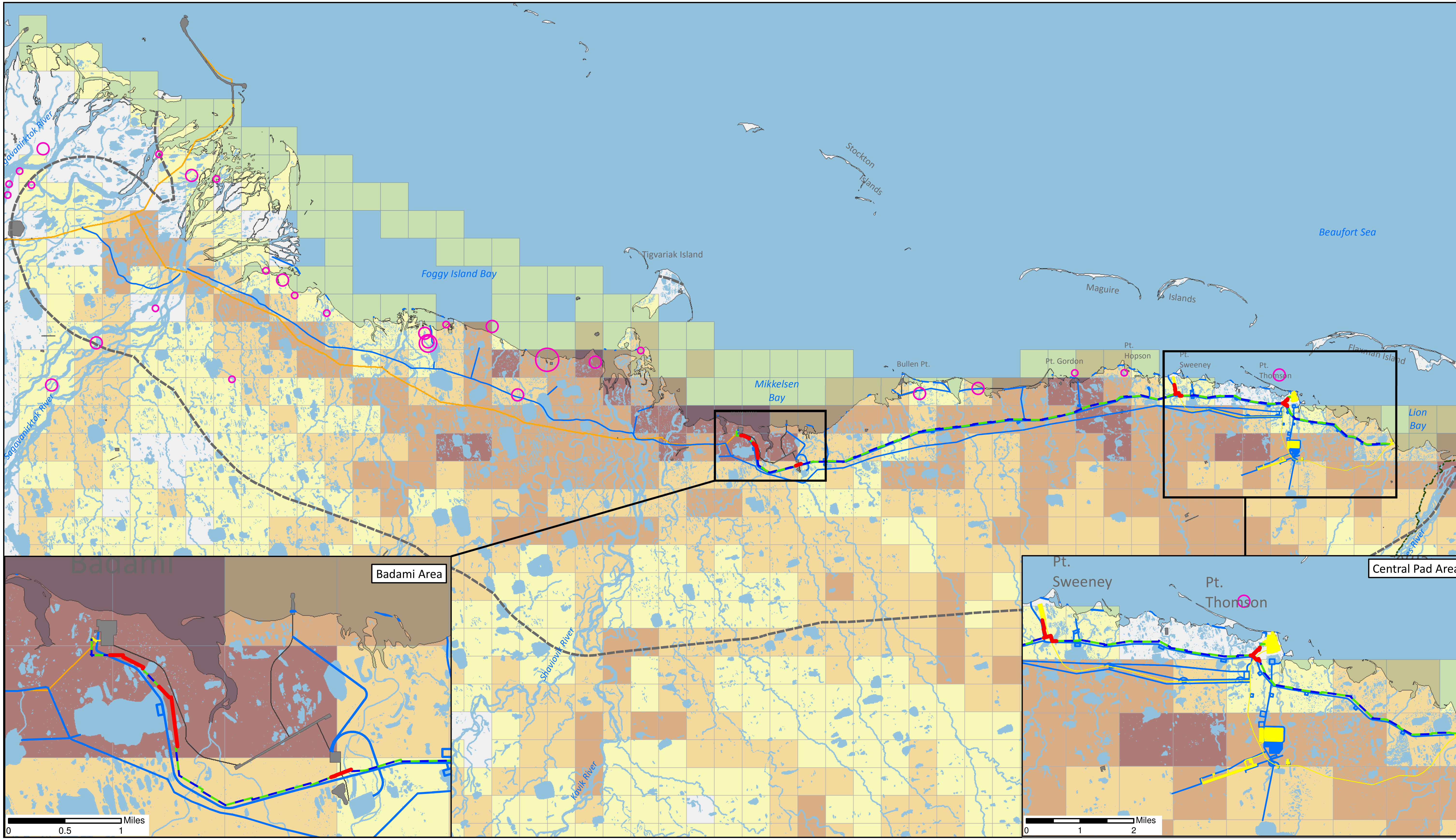

POINT THOMSON PROJECT EIS

Legend

- Stream
- Existing Road
- Existing Pipeline
- Existing Facilities
- Water Body
- Arctic National Wildlife Refuge

Assessment Areas and Data

- 2.5 Mile Project Area around all Project Alternative features
- Proposed Pipelines
- Blockage - Pipeline/Road Separation less than or equal to 500 ft
- Loss - Gravel Mine/Placement Footprint
- Loss - Ice Road Footprint

Density of Caribou Crossings (Crossings per sq. mi.)

- 1 - 5
- 6 - 10
- 11 - 20
- 21 - 40

Caribou Group Size and Location

- 219 - 1000
- 1001 - 5000
- 5001 - 10000
- 10001 - 50000

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

N

0 1 2 Miles

Figure 5.10-3

Alternative B – Caribou Photocensus Groups, Movement Densities, and Potential Blockage Locations near Roads and Pipelines.

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

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Mortality

Tundra ice and gravel road construction would likely result in some small mammal mortality. Some winter-active small mammals (e.g., lemmings, voles, shrews) may be able to avoid being covered by gravel or ice, while those animals in hibernation during construction would be lost if gravel or ice construction were to occur over occupied burrows. Because arctic ground squirrels would be in hibernation during winter gravel and ice road construction, they would not be able to avoid the construction area or destruction.

A few terrestrial mammals would also likely be lost due to collisions with vehicles each year. Terrestrial mammals most likely to collide with vehicles during summer include an abundance of small mammals (e.g., arctic ground squirrels), arctic foxes, and caribou. During winter, vehicle collisions with arctic foxes may occur. Additionally, as the CAH increases and if more caribou remain on the ACP during winter, vehicle collisions with caribou during winter may become more common. Reduced visibility during winter would make avoiding collisions more difficult, and, in addition, the hard surfaces of ice roads are attractive to caribou and muskoxen for travel. Vehicle collision mortality has not been comprehensively monitored in the North Slope oil fields, although caribou mortalities from vehicle collisions have occurred sporadically (Streever et al. 2007). Vehicle collisions with small mammals are unlikely to be recorded.

At times, caribou and muskoxen may attempt to use the airstrip to escape parasitic insects. Planes would have a potential to collide with caribou during landings or takeoff; however, for pilot and passenger safety, caribou would not be allowed to remain on the airstrip and collisions would be unlikely to occur.

Predators, particularly bears and foxes, may be killed to defend human life. Bears may charge humans in a predatory manner or become conditioned to humans and overly aggressive towards humans. Foxes may become conditioned to humans and bite or threaten to bite a human. These animals would be considered nuisance animals and would be destroyed. These types of mortalities have been documented in the Prudhoe Bay oil field (Streever et al. 2006, 2007; Sanzone et al. 2008, 2009). The Applicant has proposed to implement design measures that would minimize the potential for wildlife to become attracted to humans and human development, thus minimizing the potential need to destroy nuisance animals.

Altered Survival or Productivity

Terrestrial mammal displacement from preferred habitats could result in reduced survival and productivity. Caribou displaced from habitats with more nutritious forage, and caribou that expend energy responding to disturbances may not be able to compensate for these energetic losses, which would potentially reduce the individual's survival and reproduction (Murphy and Curatolo 1987, Vistnes and Nellemann 2008). Recent studies of the calf growth and survival for caribou displaced by or exposed to oil and gas infrastructure disturbance during calving, however, did not conclude significant survival or growth effects (Arthur and Del Vecchio 2009).

Access to food waste and use of infrastructure for thermal protection, escape cover, or den sites can benefit arctic foxes, bears, and weasels, potentially increasing their survival and productivity. Staging of construction materials and equipment would create additional crevices and voids that may provide cover for terrestrial mammals. Studies of foxes and brown bears in the Prudhoe Bay oil fields generally conclude that these benefits have been responsible for increased densities and productivity of arctic foxes and bears (Burgess 2000; Shideler and Hechtel 2000, NRC 2003a, USFWS 2003). Operational procedures and controls established to protect terrestrial mammals, as described in the Applicant's Environmental Mitigation Report (appended to the Final DA Permit Application, Appendix A), would minimize factors that commonly attract arctic foxes and bears to oil field infrastructure; e.g., maintaining a clear space under modules and buildings to prevent creation of artificial den sites for foxes and managing food materials and food wastes such that they are unavailable to wildlife.

5.10.3.2 Alternative B: Drilling

Alternative B drilling would affect terrestrial mammals and their habitats through medium-term habitat alteration and disturbance, medium-term potential for vehicle collision and human safety mortality, and medium-term altered survival or productivity.

Habitat Loss and Alteration

Storage areas for drilling equipment would require no additional habitat loss/alteration beyond what is described for construction (Section 5.10.3.1, Alternative B: Construction).

Disturbance

Disturbance from additional traffic on gravel and ice roads and from additional air traffic would occur during drilling. Maximum traffic levels would likely occur when construction and drilling activities occur simultaneously. Activities in support of drilling would occur primarily during February through August. Noise from the drill rig, rig camp, and people walking on or around the production pads may cause some additional disturbance, especially during summer at the East and West Pads; but most disturbances to terrestrial mammals, primarily caribou, muskoxen, and brown bears, would result from vehicle traffic on the roads as described under construction.

Winter mobilization and resupply of the drilling rig over the ice roads would contribute to additional traffic with associated winter disturbance primarily for arctic foxes. Once drilling is completed, summer barge demobilization of the drilling rig would contribute additional coastal traffic disturbance to caribou seeking coastal insect-relief habitats, especially during early to mid-July.

Habitat Fragmentation

No additional habitat fragmentation or blockage of movements would be expected during drilling, although traffic levels on infield roads would be increased when the rig is active on the East and West Pads, potentially impacting current patterns of caribou movements as discussed under construction.

Mortality

Additional vehicle collision, aircraft, and human safety mortality may occur as numbers of personnel, rig camps, and more vehicles are active during drilling. The causes and effects of such collisions and mortality are described under construction.

Altered Survival or Productivity

Drilling camps at the East Pad and West Pad would increase the potential for weasels, arctic foxes, and brown bears to gain access to food waste and artificial cover, as discussed under construction. Storage of drill pipe, materials, and supplies for drilling would create additional crevices and voids that may provide cover for terrestrial mammals similar to that described for construction.

5.10.3.3 Alternative B: Operations

Alternative B operations would affect terrestrial mammals and their habitats through long-term habitat loss and alteration; long-term disturbance; long-term habitat fragmentation; long-term vehicle collision and human safety mortality; and long-term altered survival or productivity.

Habitat Loss and Alteration

Habitat loss and alteration from construction would persist for the life of the project and beyond without restoration. Additionally, wildlife may be attracted to and use areas that provide cover, such as culverts, buildings, and stored materials. Caribou may be attracted to gravel fill locations for brief periods as they seek relief from mosquitoes by moving into the wind and finding cooler environments. During bot and warble fly season, caribou may be attracted to shaded habitats under pipelines and buildings because the flies reflexively move away from shade (Pollard et al. 1996a, Noel et al. 1998). Late-melt snow patches caused by drifting or piling may also provide relief from heat and insects in June.

Disturbance

Ground and air traffic levels would be lower during operations than during construction, but would likely still displace terrestrial mammals from gravel roads and the airstrip. Barge landings with associated people on foot during mid-July to mid-August would likely displace caribou from coastal insect-relief habitats in the vicinity of the Central Pad. The daily fixed-wing and helicopter flights may disturb caribou, especially during calving or when low-level approaches are over large aggregations of caribou. Low-level aerial overflights for pipeline visual inspection would be completed at about weekly intervals to monitor the pipeline for integrity. In some instances, intentional disturbance and hazing caribou away from the airstrip may be necessary for safe aircraft operations.

Habitat Fragmentation

Movements of both small mammals, such as lemmings, shrews, and voles, and large mammals, such as caribou and muskoxen, may be behaviorally blocked by gravel fill and associated traffic.

Large numbers of caribou are likely to move through the Point Thomson area during the summer, with large aggregations during early to mid July. Most caribou have usually moved away from this region by late July or early August on their way to breeding areas and winter ranges. Areas where elevated pipelines and roads are separated by 500 feet or less may delay crossing or deflect caribou from these areas. Based on the available caribou movement data, blocked or altered caribou movements may be more likely to occur near the Badami tie-in to the export pipeline; between the West Pad and the export pipeline junction; junction near the East Pad; and between the mine site reservoir and the Central Pad (Figure 5.10-3).

Mortality

Vehicle collisions would likely be reduced during operations because of reduced personnel and transportation requirements. A few animals would still likely be lost occasionally. In addition to collision mortality, other types of wildlife mortality, such as exposure to flares, entanglement, and trapping and destruction of nuisance animals, could occur during operations, as exemplified in the Prudhoe Bay oil field (Streever et al. 2006, 2007; Sanzone et al. 2008, 2009).

Altered Survival or Productivity

Survival and productivity alterations during operations would be similar to those described in the construction phase.

5.10.3.4 Summary of Effects on Terrestrial Mammals

Infrastructure and activities proposed for Alternative B would result in probable, minor, long term, and limited or local extent effects on arctic foxes, arctic ground squirrels, and other small mammals and their habitats. Impacts to brown bear denning are unlikely, but would be minor, long-term, and limited in extent if they were to occur. Disturbance impacts to caribou (primarily during the calving season [late May to late June]), brown bears (during non-denning periods), and muskoxen would be minor, long term, possible, and limited in extent. The summary of Alternative B impacts by assessment criteria is shown in Table 5.10-6.

Table 5.10-6: Alternative B—Impact Criteria Summary for Terrestrial Mammals

Impact Type and Affected Population		Magnitude	Duration	Potential to Occur	Geographic Extent
Habitat Loss and Alteration	Small Mammals	Minor	Long term	Probable	Limited
	Burrow Habitats	Minor	Long term	Probable	Local
	Den Habitats	Minor	Long term	Probable	Local
	Arctic Ground Squirrel	Minor	Long term	Probable	Local
Disturbance	Arctic Fox Dens/Den Habitat (within 0.5 miles)	Major	Long term	Possible	Limited
	Brown Bear Dens/Den Habitat (within 0.5 miles)	Minor	Long term	Unlikely	Limited
	Calving Caribou (within 2.5 miles)	Minor	Long term	Possible	Limited
	Muskoxen and Brown Bear (within 2.5 miles)	Minor	Long term	Possible	Limited

5.10.4 Alternative C: Inland Pads with Gravel Access Road

Potential long-term Alternative C effects on terrestrial mammals and their habitats from gravel fill and structure placement mirror the types of effects described for Alternative B, but with increased acreages for inland habitat loss and alteration due to the construction of a gravel access road from Point Thomson to the Endicott Spur Road. In addition, the above-ground waterline proposed under Alternative C could cause habitat fragmentation to some species.

Construction of Alternative C would have different levels but similar types of impacts as those described in Alternative B. Long-term loss of habitat due to extraction and placement of gravel for roads, pads, and the airstrip would occur, as shown in Table 5.10-7 and Figure 5.10-4.

Table 5.10-7: Alternative C—Estimated Terrestrial Mammal Habitat Impacts

	Habitat[a]					
	All Habitats (acres)	Forage (tons)	Squirrel Burrow/Fox Den Habitat (acres)	Arctic Fox Dens	Bear Den Habitat (miles)	Brown Bear Dens
Available Habitat within Point Thomson Project Area[b]	245,165	432,369	4,982	32	190.9	3
Habitat Impacts from Gravel Extraction or Placement						
Loss from Gravel Extraction/Placement (footprint)	747	1,344	13	0	<1	0
Alteration by Proximity (within 165 feet of gravel extraction/placement)	2,702	4,855	49	0	2	0
Proportion of Available Habitat Lost and Altered	1%	1%	1%	0%	1%	0%
Habitat/Forage Potentially Disturbed (within 2.5 miles)	184,249	326,826	—	—	—	—
Proportion of Available Habitat/Forage Potentially Disturbed	75%	76%	—	—	—	—
Burrows/Den Habitat and Known Dens Potentially Disturbed (within 0.5 miles)	—	—	338	6	26	1
Proportion of Available Burrow/Den Habitat and Known Dens Potentially Disturbed	—	—	7%	19%	14%	33%
Habitat Impacts from Ice Infrastructure Development						
Loss from Ice Cover (footprint)	762	1,349	12	1	0.4	0
Proportion of Available Habitat Lost	<1%	<1%	<1%	3%	<1%	0%
Burrows/Den Habitat and Known Dens Potentially Disturbed (within 0.5 miles)	—	—	479	9	38	1
Proportion of Available Burrow/Den Habitat and Known Dens Potentially Disturbed	—	—	10%	28%	20%	33%

Source: Shideler 1998, 1999; Perham 2000, 2001; Raynolds et al. 2010

—: Not applicable

[a] Burrow habitat for arctic ground squirrels and arctic foxes as indicated by mapped dry dwarf shrub-lichen tundra (Vc and Vd). Habitat mapping not available for all assessment area extents (range 19 to 100 percent). Brown bear den habitat estimate as indicated by topographic models for suitable polar bear den habitat (Durner et al. 2001, 2006).

[b] Point Thomson Project Area habitat is based on the proportion of mapped habitat types extrapolated to a 375 mi^2 area or the approximate area within 2.5 miles of gravel and ice components for all alternatives.

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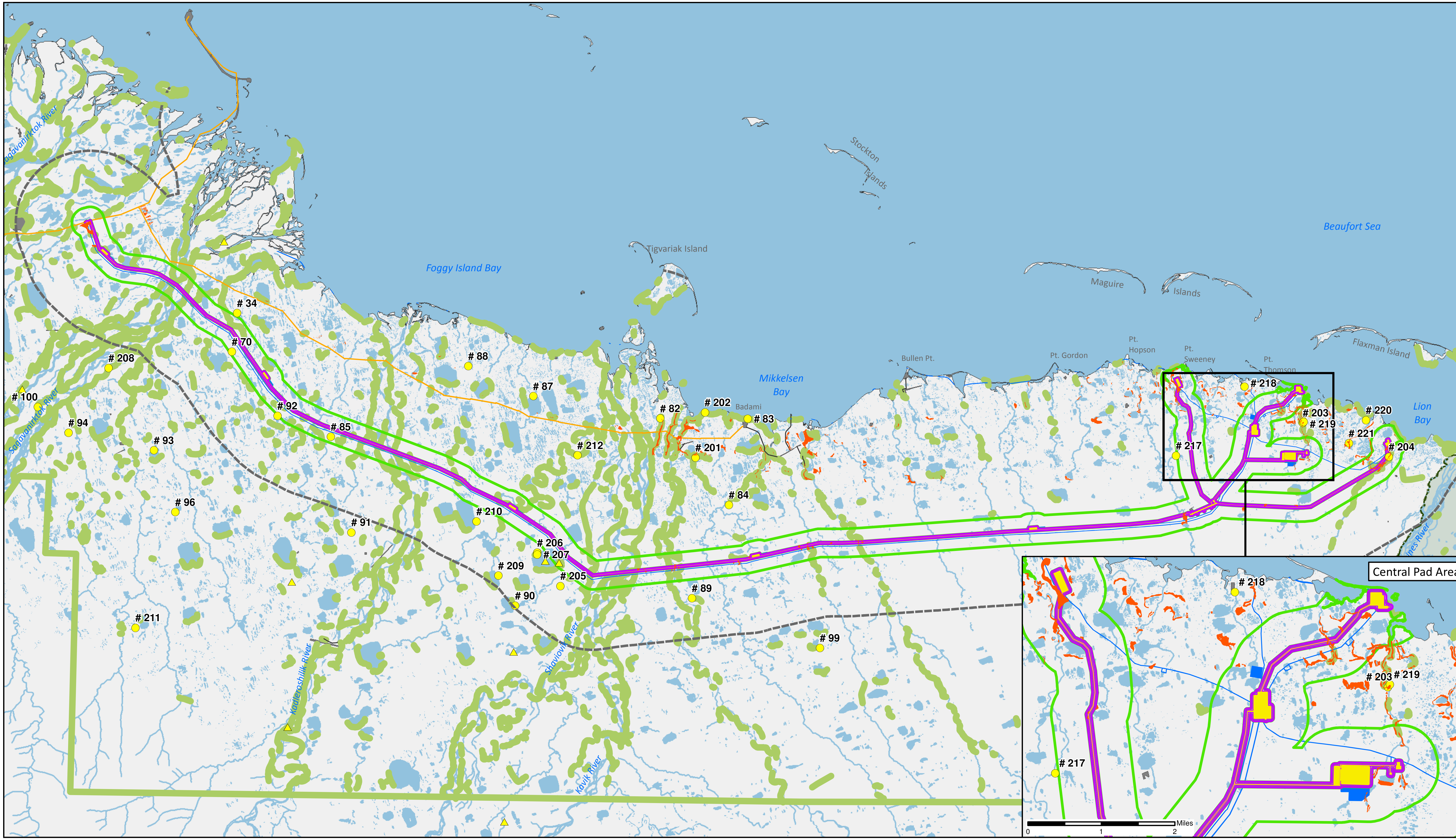

POINT THOMSON PROJECT EIS

Legend

- Stream
- Existing Pipeline
- Existing Road
- Existing Facilities
- Water Body
- Arctic National Wildlife Refuge
- 2.5 Mile Buffer around all Project Alternative features
- Loss - Gravel Mine/Placement Footprint
- Loss - Ice Road Footprint
- Alteration - Within 165 ft of Gravel Mine/Placement
- Disturbance - Within 0.5 mile of Gravel Mine/Placement

Assessment Areas and Data

- Suitable Burrow Habitat (Vc/Vd)
- Polar (and potential Brown) Bear Denning Habitat
- Arctic Fox Den Location (with Den Number)
- Brown Bear Den Location

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

N

0 1 2 Miles

Figure 5.10-4

Alternative C – Areas of Terrestrial Mammal Habitat Loss, Alteration, and Disturbance

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

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Habitat Loss and Alteration

Habitats lost due to gravel fill would have potentially provided forage sufficient to support about 300 caribou or muskoxen for 12 months based on estimated phytobiomass. While the amount of forage loss could support a considerable number of caribou or muskoxen, forage is plentiful in the surrounding areas (Figure 5.10-5) and these animals would likely move to other available areas to forage. In addition, while gravel fill areas are lost as foraging habitat, they may create insect relief habitat for potential use by caribou and muskoxen.

Moderate amounts of burrow or den habitat for arctic foxes would be lost or altered (Table 5.10-8), although no known fox dens would be covered by gravel fill (Figure 5.10-4). Habitat loss and alteration for small mammals is shown in Table 5.10-8.

Table 5.10-8: Alternative C—Potential Small Mammal Habitat Loss and Alteration

Small Mammals	Point Thomson Habitat Estimate[b]	Estimated Area (in acres) of Affected Small Mammal Habitat[a]				Proportion of Point Thomson Habitat Estimate (%)
		Habitat Loss from Gravel Extraction and Placement	Habitat Alteration surrounding Gravel Placement /Extraction/Staging	Habitat Loss from Ice Infrastructure Construction	Total	
Small Herbivores						
Collared Lemming	62,782	201	829	231	1,260	2
Brown Lemming and Root Vole	163,351	664	2,390	663	3,717	2
Small Carnivores						
Barren Ground Shrew	94,779	308	1,183	331	1,821	2
Ermine and Least Weasel	175,244	702	2,474	684	3,860	2
Medium Herbivores						
Arctic Ground Squirrel	104,372	342	1,244	348	1,934	2

Source: Burgess 1984, Babcock 1985, Nature Serve 2009

[a] Small mammal habitat impacts are estimated based on loss and alteration of habitats typically used by the small mammals as defined in Methodology.

[b] Point Thomson Project Area habitat estimate is based on the proportion of mapped habitat types extrapolated to a 375 mi^2 area or the approximate area within 2.5 miles of gravel and ice components for all alternatives.

Brown bear dens have occurred within 0.5 mile of the gravel or ice footprints (Table 5.10-7), though none have occurred within the footprints, and potential brown bear dens would likely occur along the access road and export pipeline route between the Endicott Spur Road and the Central Pad (Figure 5.10-4). Brown bears would lose minor amounts of foraging habitat and could lose minor amounts of den habitat (Table 5.10-7).

The habitat loss and alteration due to ice road construction, snow drifting, dust spray, altered hydrology, and thermokarst and attraction to early vegetation along gravel roads under Alternative C would present similar affects to terrestrial mammals as those described for Alternative B.

Disturbance

As described in Alternative B, ice road construction and maintenance noise has the potential to disturb and displace arctic fox, caribou, and muskoxen, which may occur near the ice road during winter, and traffic on both ice and gravel roads during construction would be greater than other project phases. With the inclusion of the gravel road from Point Thomson to Endicott Spur Road, anticipated traffic levels under Alternative C would likely be more than twice the level for Alternative B. Construction activity associated with the gravel access road could disturb muskoxen historically known to overwinter in the vicinity of the Kavik River near its confluence with the Shaviovik River.

The average numbers of caribou potentially occurring within 2.5 miles of the Alternative C gravel infrastructure that could be disturbed and displaced by traffic and noise associated with that infrastructure are listed in Table 5.10-7. Caribou occur near the Alternative C access road and infrastructure during the calving and post-calving periods; most disturbances to caribou would likely occur during and just after the calving period when caribou are most susceptible to disturbance (Table 5.10-9). Figure 5.10-5 presents caribou calving locations, forage production, and disturbance areas in relation to infrastructure proposed under Alternative C. Large aggregations of caribou are likely to use coastal and riparian insect-relief habitats near the project and would have an increased potential for disturbance (Figure 5.10-6).

Table 5.10-9: Alternative C— Potential Disturbance to Caribou from Project Construction and Operation

	Potentially Disturbed					Point Thomson Study Area Estimate	Proportion Potentially Disturbed (0.6 miles)	Proportion Potentially Disturbed (2.5 miles)
	0 to 0.6 mile	0.6 to 1.2 miles	1.2 to 1.9 miles	1.9 to 2.5 miles	Total 0 to 2.5 miles			
Calving Locations[a]	4	4	3	1	12	62	7%	19%
Average Number of Caribou During Calving[b]								
Calves	65	49	37	52	203	735[c]	9%	28%
Total	169	150	99	148	566	1,233[c]	14%	46%
Average Number of Caribou Post Calving[d]								
Calves	86	80	91	60	316	693[c]	12%	—
Total	475	407	540	311	1732	3,956[c]	12%	—
Photocensus Locations[5]	0	3	1	1	5	95	0%	—

Source: Shideler 1998, 1999; Noel 1998a, b; Noel and Olson 1999a, b, 2001a, b; Noel and King 2000a, b; Jensen and Noel 2002; Jensen, Noel, and Ballard 2003; Noel and Cunningham 2003

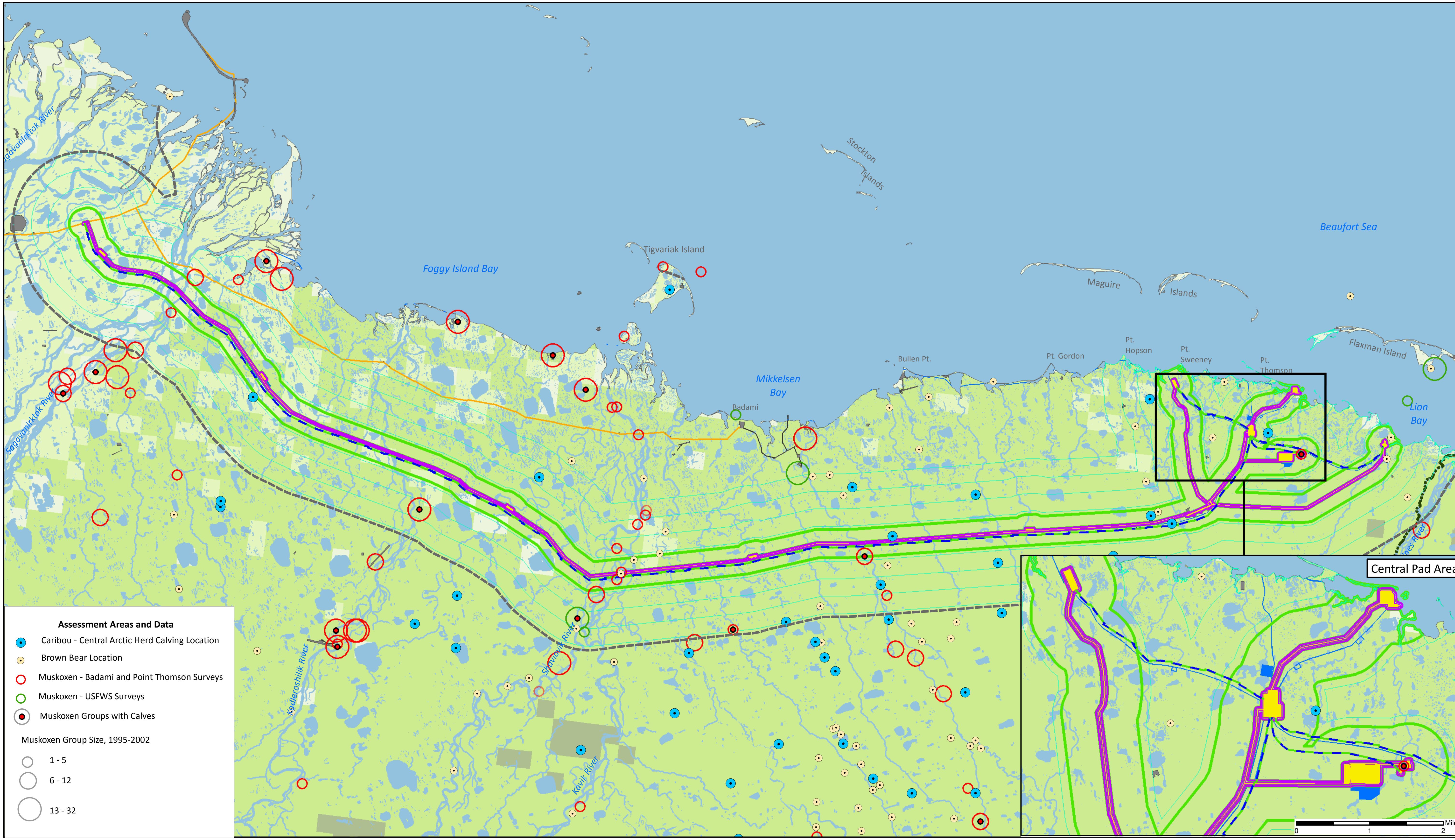
[a] Location for calves near the time of birth east of the Sagavanirktok River during 1 to 10 June 1992 to 2002, note usually one calf associated with each location (Arthur 2002)

[b] Based on average numbers of caribou observed from 11 surveys of the Bullen survey area and 9 surveys of the Badami survey area. Numbers are rounded to the nearest whole number.

[c] Based on combined mean observed densities during systematic surveys between the Sagavanirktok and Canning Rivers of 3.22 caribou per mi^2 and 1.92 caribou calves per mi^2 during calving (1 to 20 June) and 10.33 caribou per mi^2 and 1.81 calves per mi^2 during post-calving (21 June to August) multiplied by 383 mi^2 or the area within 2.5 miles of project components.

[d] Based on average numbers of caribou observed from 30 surveys of the Point Thomson survey area and 27 surveys of the Badami survey area. Numbers are rounded to the nearest whole number.

[e] Photocensus locations for caribou aggregations during July 1983, 1992, 1995, 1997, 2000, 2002, and 2008; note many caribou are associated with each location (range 13—32,031; average 1,89; ADF&G 2003b, 2009c)



POINT THOMSON PROJECT EIS

Legend

- Stream
- Existing Road
- Existing Pipeline
- Existing Facilities
- Water Body
- Arctic National Wildlife Refuge
- Proposed Pipelines
- 2.5 Mile Buffer around all Project Alternative features
- Loss - Gravel Mine/Placement Footprint
- Loss - Ice Road Footprint
- Alteration - Within 165 ft of Gravel Mine/Placement
- Disturbance - Within 0.5 mile of Gravel Mine/Placement
- Disturbance – 0.6-Mile Buffer from Gravel Infrastructure

Phytobiomass (tons/acre)

- <0.03
- 0.27-0.38
- 0.39-0.50
- >0.50

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

N

0 1 2 Miles

Figure 5.10-5

Alternative C – Estimated Forage Production and Terrestrial Mammal Disturbance and Displacement from Gravel Infrastructure

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

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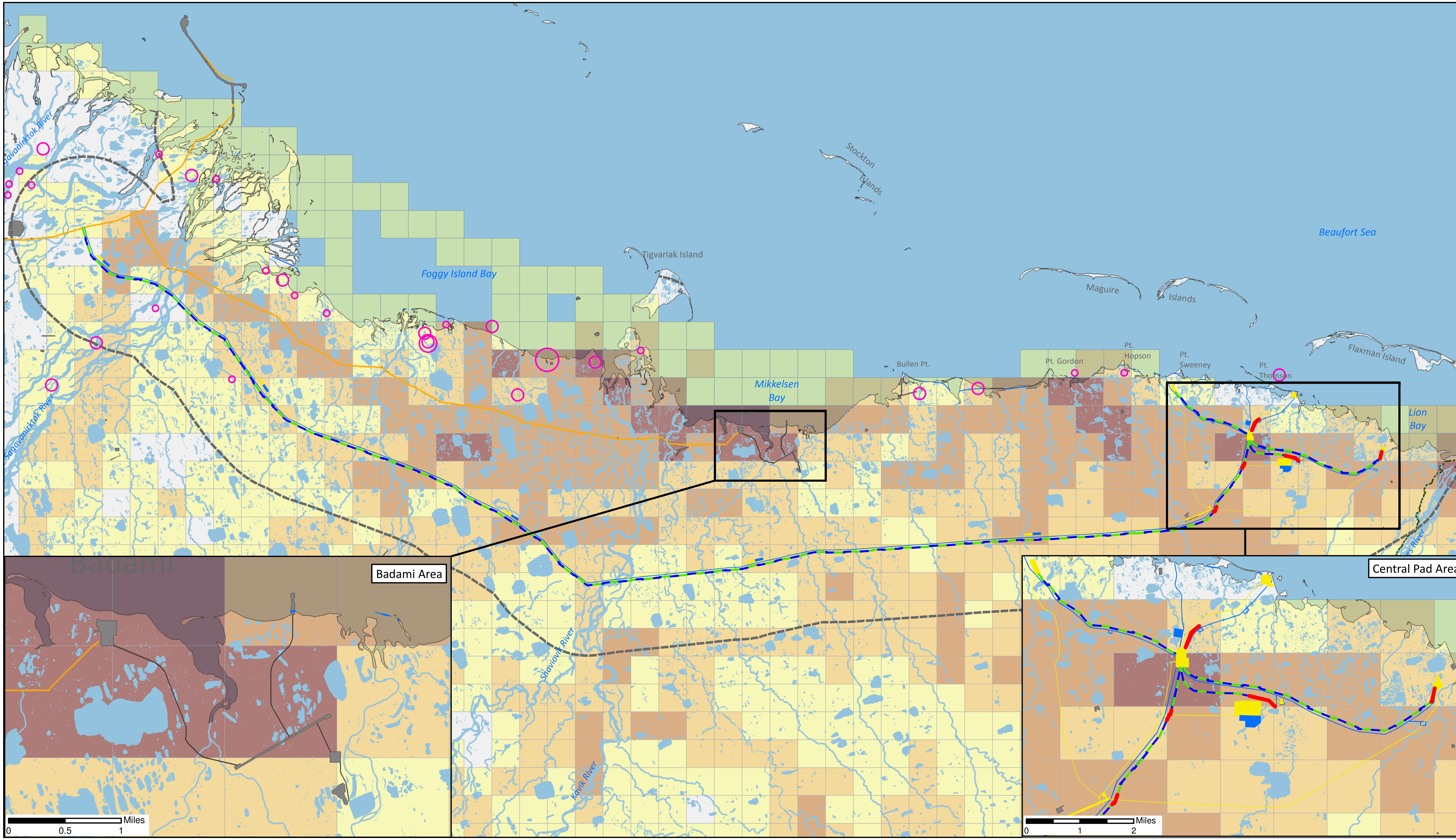

POINT THOMSON PROJECT EIS

Figure 5.10-6

Alternative C – Caribou Photocensus Groups, Movement Densities, and Potential Blockage Locations near Roads and Pipelines.

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

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Hunters may be able to more easily access the Point Thomson area from Deadhorse via the gravel access road. Hunting activity in the area would likely increase the avoidance response for caribou and other terrestrial mammals beyond those normally observed in the Prudhoe Bay oil fields where hunting is not allowed. Caribou may distance themselves further from roads and activity near the proposed Alternative C infrastructure as an antipredator response to interactions with hunters.

Based on historical distributions of brown bear dens, den sites are likely to occur within 0.5 mile of proposed gravel or ice roads and a few hibernating brown bears would likely be disturbed (Table 5.10-7).

Alternative C would have similar air traffic to that described in Alternative B prior to construction of the gravel access road, with similar impacts to terrestrial mammals in the project area. After construction of the gravel access road, air traffic would be expected to be lower for Alternative C than for Alternative B.

Habitat Fragmentation

Habitat fragmentation caused by gravel fill and the design of proposed export, gathering, and water pipelines for Alternative C would have different levels but similar types of effects as those described in Alternative B for fragmentation impacts to small mammals, caribou, and muskoxen.

The 7- to 10-inch diameter temporary and permanent water transport pipelines elevated on 12-inch by 12-inch timber sleepers between the initial water source lake (temporary water pipeline) or the reservoir developed from the gravel mine (permanent water pipeline) and the Central Processing Pad are likely to cause delays or blockage of caribou and muskoxen movements because they are low to the ground (Cronin et al. 1994, Lawhead et al. 2006). While caribou can jump over objects, they are often unwilling to do so, especially if the obstacle is encountered by a large group. Cows and calves could be separated if, while under duress (e.g., mosquito harassment), cows cross and calves do not. A high density of caribou movements occurs in the vicinity of the Central Processing Pad (Figure 5.10-6), indicating a low water pipeline in this area could have a relatively high impact to caribou movements. The effect on caribou movements would be increased if the line is placed parallel to a road: animals agitated by the pipeline could find themselves trapped between the pipeline and the road and susceptible to traffic disturbance or vehicle collision.

The areas with a high coincidence of caribou movement, combined with pipelines crossings near roads occur between the airstrip and the Central Processing Pad and between the mine site and the Central Processing Pad (Table 5.10-10 and Figure 5.10-6).

Table 5.10-10: Alternative C—Potential Road-Pipeline Blockage to Caribou Movements			
Location of Road-Pipeline with **Separation ≤ 500 ft**	Feature	Length of Pipeline Segment (ft) ≤ 500 ft	Number of Recorded Caribou Movements[a] (# of crossings per mi^2)
Central Pad	Gathering pipeline	1,813	12
	Gas injection pipeline	2,555	6
East Pad	East gathering line	1,376	17
West Pad	East gathering line	310	4
Airstrip and Adjacent Pipelines	Export pipeline	2,395	38
Gravel Mine and Reservoir	Water line	2,841	33
Badami Export Pipeline Tie-in Location	—	—	—

[a] Caribou movement numbers are based on available telemetry data from June, July, and August surveys from 1983 and 1987 to 1990 (WCC and ABR 1983, Griffith 2002)

Mortality

Tundra ice and gravel road construction under Alternative C has a greater potential to cause small mammals mortality because the number of ice roads during construction would increase and because the gravel access road would be 44 miles long. Year-round use of the gravel access road could increase the potential for collisions with terrestrial mammals. Muskoxen overwintering in the area may be attracted to the gravel road. Individual animals that become nuisance animals may be destroyed for human safety.

Altered Survival or Productivity

Terrestrial mammal displacement from preferred habitats could result in reduced survival and productivity. Storage of materials and supplies used during construction would create additional crevices and voids that may provide cover for terrestrial mammals similar to that described for Alternative B.

5.10.4.1 Alternative C: Drilling

Alternative C drilling would affect terrestrial mammals and their habitats in manners similar to those described for drilling in Alternative B through habitat alteration, disturbance, vehicle collision and human safety mortality, and altered survival or productivity. Most disturbance to terrestrial mammals, primarily caribou, muskoxen, and brown bears, would result from vehicle traffic on the gravel access road that connects to the Endicott Spur Road. Traffic levels on the gravel access road would cause greater habitat fragmentation than in Alternative B, as well as greater potential for vehicle collision mortality through year-round vehicle access to the site. Also, Alternative C would have traffic between the Central Processing Pad and the Central Well Pad, unlike Alternative B where these facilities are co-located.

Traffic on the gravel access road during winter could also contribute to greater winter disturbance of arctic foxes and denning brown bears compared with Alternative B because it would affect a greater area of den sites. Muskoxen have historically overwintered in areas near the gravel access road in the vicinity of the Kavik River near its confluence with the Shaviovik River; therefore, these animals would also experience greater disturbance in the winter under Alternative C.

Approximately 1,000 to 1,200 helicopter round trips would be made to the facilities during drilling, which could also disturb large mammals.

5.10.4.2 Alternative C: Operations

Alternative C operations would have different levels but similar types of impacts as those described in Alternative B. Large numbers of caribou are likely to calve in the vicinity of the access and infield roads in Alternative C and post-calving aggregations are likely to move through the Point Thomson area during the summer, with large aggregations during late June to mid July. Summer vehicle traffic on the access road from the Endicott Spur Road would likely disturb caribou during calving, resulting in displacement away from the road. Vehicle collision and other mortality would also be increased along the access road, and survival and productivity effects would be similar to those described for construction. The combination of roads and pipelines radiating from the Central Processing Pad, the access road, and the export pipeline would be expected to cause habitat fragmentation for caribou, based on movement patterns shown in Figure 5.10-6.

5.10.4.3 Alternative C: Summary of Effects on Terrestrial Mammals

Infrastructure and activities proposed for Alternative C would result in probable, moderate, long-term, local extent effects on arctic foxes, brown bears, arctic ground squirrels and other small mammals and their habitats, and probable moderate to major, long-term, local extent effects on caribou habitat use during the calving (late May through late June) and parasitic insect seasons (early July through mid-August). The summary of Alternative C impacts by assessment criteria is shown in Table 5.10-11.

Table 5.10-11: Alternative C—Impact Summary for Terrestrial Mammals

Impact Type and Affected Mammals		Magnitude	Duration	Potential to Occur	Geographic Extent
Habitat Loss and Alteration	Small Mammals	Minor	Long term	Probable	Local
	Burrow Habitats	Minor	Long term	Probable	Local
	Den Habitats	Minor	Long term	Possible	Local
	Large Mammals	Minor	Long term	Probable	Local
Disturbance	Arctic Fox Dens/Den Habitat (within 0.5 miles)	Moderate	Long term	Probable	Local
	Brown Bear Dens/Den Habitat (within 0.5 miles)	Moderate	Long term	Possible	Local
	Calving Caribou (within 0.6 miles)	Moderate	Long term	Probable	Local
	Calving Caribou (within 2.5 miles)	Major	Long term	Possible	Local
	Post-calving Caribou (within 0.6 miles)	Moderate	Long term	Probable	Local
	Muskoxen (within 0.6 miles)	Moderate	Long term	Probable	Local

5.10.5 Alternative D: Inland Pads with Seasonal Ice Access Road

Potential long-term Alternative D effects on terrestrial mammals and their habitats from gravel fill and structure placement mirror the types of effects described for Alternative B. The need for an annual ice access road under Alternative D would affect mammal species in different ways, as discussed below.

Construction of Alternative D would have different levels but similar types of impacts as those described in Alternative B. Long-term loss of habitat due to extraction and placement of gravel for roads, pads, and the airstrip would occur, as shown in Table 5.10-12 and Figure 5.10-4.

Table 5.10-12: Alternative D—Estimated Terrestrial Mammal Habitat Impacts

	Habitat[a]					
	All Habitats (acres)	Forage (tons)	Squirrel Burrow/Fox Den Habitat (acres)	Arctic Fox Dens	Bear Den Habitat (miles)	Brown Bear Dens
Available Habitat within Point Thomson Project Area[b]	245,165	432,369	4,982	32	190.9	3
Habitat Impacts from Gravel Extraction or Placement						
Loss from Gravel Extraction/Placement (footprint)	355	644	7	0	0	0
Alteration by Proximity (within 165 feet of gravel extraction/placement)	848	4,551	14	0	<1	0
Proportion of Available Habitat Lost and Altered	1%	1%	<1%	0%	<1%	0%
Habitat/Forage Potentially Disturbed (within 2.5 miles)	47,849	87,397	—	—	—	—
Proportion of Available Habitat/Forage Potentially Disturbed	20%	20%	—	—	—	—
Burrows/Den Habitat and Known Dens Potentially Disturbed (within 0.5 miles)	—	—	262	4	4	0
Proportion of Available Burrow/Den Habitat and Known Dens Potentially Disturbed	—	—	5%	13%	2%	0%
Habitat Impacts from Ice Infrastructure Development						
Loss from Ice Cover (footprint)	519	909	8	1	<1	0
Proportion of Available Habitat Lost	<1%	<1%	<1%	3%	<1%	0%
Burrows/Den Habitat and Known Dens Potentially Disturbed (within 0.5 miles)	—	—	737	10	32	0
Proportion of Available Burrow/Den Habitat and Known Dens Potentially Disturbed	—	—	15%	31%	17%	0%

Source: Shideler 1998, 1999; Perham 2000, 2001; Raynolds et al. 2010

—: Not applicable

[a] Burrow habitat for arctic ground squirrels and arctic foxes as indicated by mapped dry dwarf shrub-lichen tundra (Vc and Vd). Habitat mapping not available for all assessment area extents (range 19 to 100 percent). Brown bear den habitat estimate as indicated by topographic models for suitable polar bear den habitat (Durner et al. 2001, 2006).

[b] Point Thomson Project Area habitat is based on the proportion of mapped habitat types extrapolated to a 375 mi^2 area or the approximate area within 2.5 miles of gravel and ice components for all alternatives.

5.10.5.1 Alternative D: Construction

Construction of Alternative D would have different levels but similar types of impacts as those described in Alternative B, but with the added impacts from an annual ice access road from the Endicott Spur Road to Point Thomson. Exceptions are noted below. Long-term loss of habitat due to extraction and placement of gravel for roads, pads, and the airstrip would occur, as shown in Table 5.10-12 and Figure 5.10-7.

Habitat Loss and Alteration

Gravel fill for infrastructure in Alternative D would cause long-term habitat loss that would potentially have supported approximately 143 caribou or muskoxen annually, based on biomass, and potentially all herbivorous terrestrial mammals, though fill may create some areas of insect relief habitat. While the amount of forage loss could support a considerable number of caribou or muskoxen, forage is plentiful in the surrounding areas (Figure 5.10-8) and these animals would likely move to other areas to forage. No known fox dens would be covered by fill; however, minor amounts of burrow, den, or foraging habitat would be lost to small mammals, including arctic ground squirrels (Table 5.10-12). Although no brown bear dens have been found within 0.5 mile of the gravel or ice footprints, brown bears would lose minor amounts of forage and den habitats.

Alternative D differs in the requirement for construction of an ice access road over multiple years that may lead to minimal additive vegetation damage to tussock tundra, reduced ground cover, increased depth of thaw, and delayed recovery (Yokel et al. 2007), causing loss and alteration of large and small mammal habitat (Table 5.10-13 and Table 5.10-14). Ice roads built on wet tundra over multiple years produce the least amount of vegetation damage (Yokel et al. 2007). The annual on-tundra ice road may be used by muskoxen for travel as this road would provide easy transit between winter habitats used by muskoxen along riparian corridors.

Table 5.10-13: Alternative D—Potential Small Mammal Habitat Loss and Alteration

Small Mammals	Point Thomson Project Area Habitat Estimate[b]	Estimated Area (in acres) of Affected Small Mammal Habitat[a]				Proportion of Point Thomson Habitat Estimate (%)
		Habitat Loss from Gravel Extraction and Placement	Habitat Alteration surrounding Gravel Placement /Extraction/Staging	Habitat Loss from Ice Infrastructure Construction	Total	
Small Herbivores						
Collared Lemming	62,782	73	165	160	398	1
Brown Lemming and Root Vole	163,351	307	785	436	1,528	1
Small Carnivores						
Barren Ground Shrew	94,779	125	304	230	660	1
Ermine and Least Weasel	175,244	335	811	459	728	1
Medium Herbivores						
Arctic Ground Squirrel	104,372	153	329	245	728	1

Source: Burgess 1984, Babcock 1985, Nature Serve 2009

[1] Small mammal habitat impacts are estimated based on loss and alteration of habitats typically used by the small mammals as defined in Methodology.

[2] Point Thomson habitat estimate is based on the proportion of mapped habitat types extrapolated to a 375 mi^2 area or the approximate area within 2.5 miles of gravel and ice components for all alternatives.

Disturbance

As described in Alternative B, ice road construction and maintenance noise has the potential to disturb and displace arctic fox, caribou, and muskoxen that may occur near the ice road during winter, and traffic on both ice and gravel roads would be greater than other project phases.

The average number of caribou potentially disturbed and displaced or attracted by traffic and noise among distance intervals from Alternative D gravel infrastructure are listed in Table 5.10-14. Most caribou were closest to the proposed locations of Alternative D gravel roads and airstrip during the post-calving period and more caribou would likely be disturbed by traffic and activity during this period, although a few caribou were reported near these locations during the calving period (Table 5.10-14). Figure 5.10-8 shows caribou calving locations, forage production, and disturbance areas in relation to infrastructure proposed under Alternative D.

Table 5.10-14: Alternative D—Potential Disturbance to Caribou from Project Construction and Operation

	Potentially Disturbed					Point Thomson Study Area Estimate	Proportion Potentially Disturbed (0.6 miles)	Proportion Potentially Disturbed (2.5 miles)
	0 to 0.6 mile	0.6 to 1.2 miles	1.2 to 1.9 miles	1.9 to 2.5 miles	Total 0 to 2.5 miles			
Calving Locations[a]	1	2	1	0	4	62	2%	7%
Average Number of Caribou During Calving[b]								
Calves	5	4	4	5	18	735[c]	<1%	2 %
Total	13	11	11	13	48	1,233[c]	1 %	4%
Average Number of Caribou Post Calving[d]								
Calves	24	12	6	17	59	693[c]	4%	—
Total	199	85	27	57	368	3,956[c]	5%	—
Photocensus Locations[e]	0	1	2	0	3	95	0%	—

Source: Shideler 1998, 1999; Noel 1998a, b; Noel and Olson 1999a, b, 2001a, b; Noel and King 2000a, b; Jensen and Noel 2002; Jensen, Noel, and Ballard 2003; Noel and Cunningham 2003

[a] Location for calves near the time of birth east of the Sagavanirktok River during 1 to 10 June 1992 to 2002, note usually one calf associated with each location (Arthur 2002)

[b] Based on average numbers of caribou observed from 11 surveys of the Bullen survey area and 9 surveys of the Badami survey area. Numbers are rounded to the nearest whole number.

[c] Based on combined mean observed densities during systematic surveys between the Sagavanirktok and Canning Rivers of 3.22 caribou per mi^2 and 1.92 caribou calves per mi^2 during calving (1 to 20 June) and 10.33 caribou per mi^2 and 1.81 calves per mi^2 during post-calving (21 June to August) multiplied by 383 mi^2 or the area within 2.5 miles of project components.

[d] Based on average numbers of caribou observed from 30 surveys of the Point Thomson survey area and 27 surveys of the Badami survey area. Numbers are rounded to the nearest whole number.

[e] Photocensus locations for caribou aggregations during July 1983, 1992, 1995, 1997, 2000, 2002, and 2008; note many caribou are associated with each location (range 13 – 32,031; average 1,891; ADF&G 2003b, 2009c)

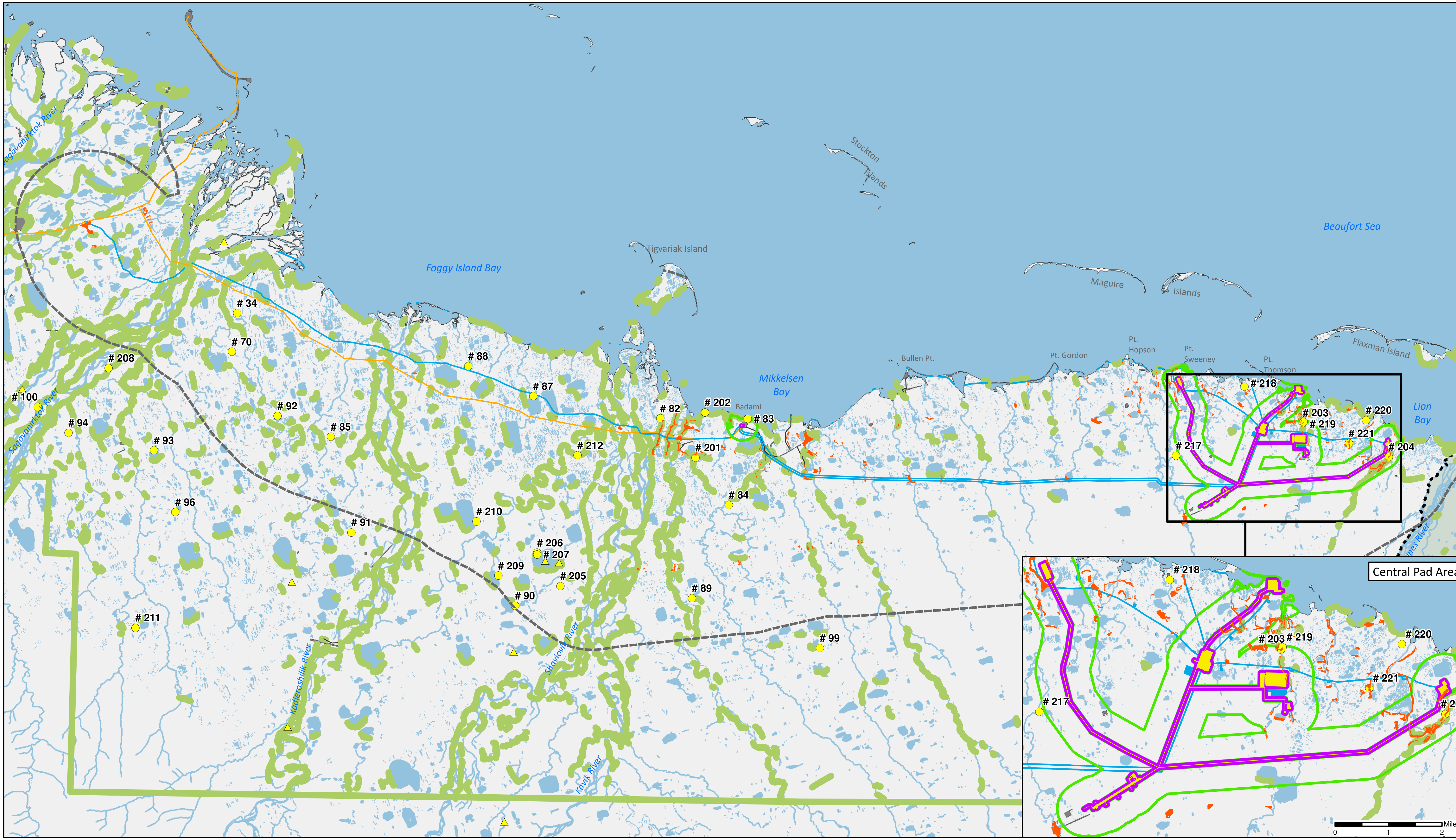

Figure 5.10-7

Alternative D – Areas of Terrestrial Mammal Habitat Loss, Alteration, and Disturbance

POINT THOMSON PROJECT EIS

Legend

- Stream
- Existing Pipeline
- Existing Road
- Water Body
- Arctic National Wildlife Refuge
- Existing Facilities
- 2.5 Mile Buffer around all Project Alternative features
- Loss - Gravel Mine/Placement Footprint
- Loss - Ice Road Footprint
- Alteration - Within 165 ft of Gravel Mine/Placement
- Disturbance - Within 0.5 mile of Gravel Mine/Placement

Assessment Areas and Data

- Suitable Burrow Habitat (Vc/Vd)
- Polar (and potential Brown) Bear Denning Habitat
- Arctic Fox Den Location (with Den Number)
- Brown Bear Den Location

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

N

0 1 2 Miles

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

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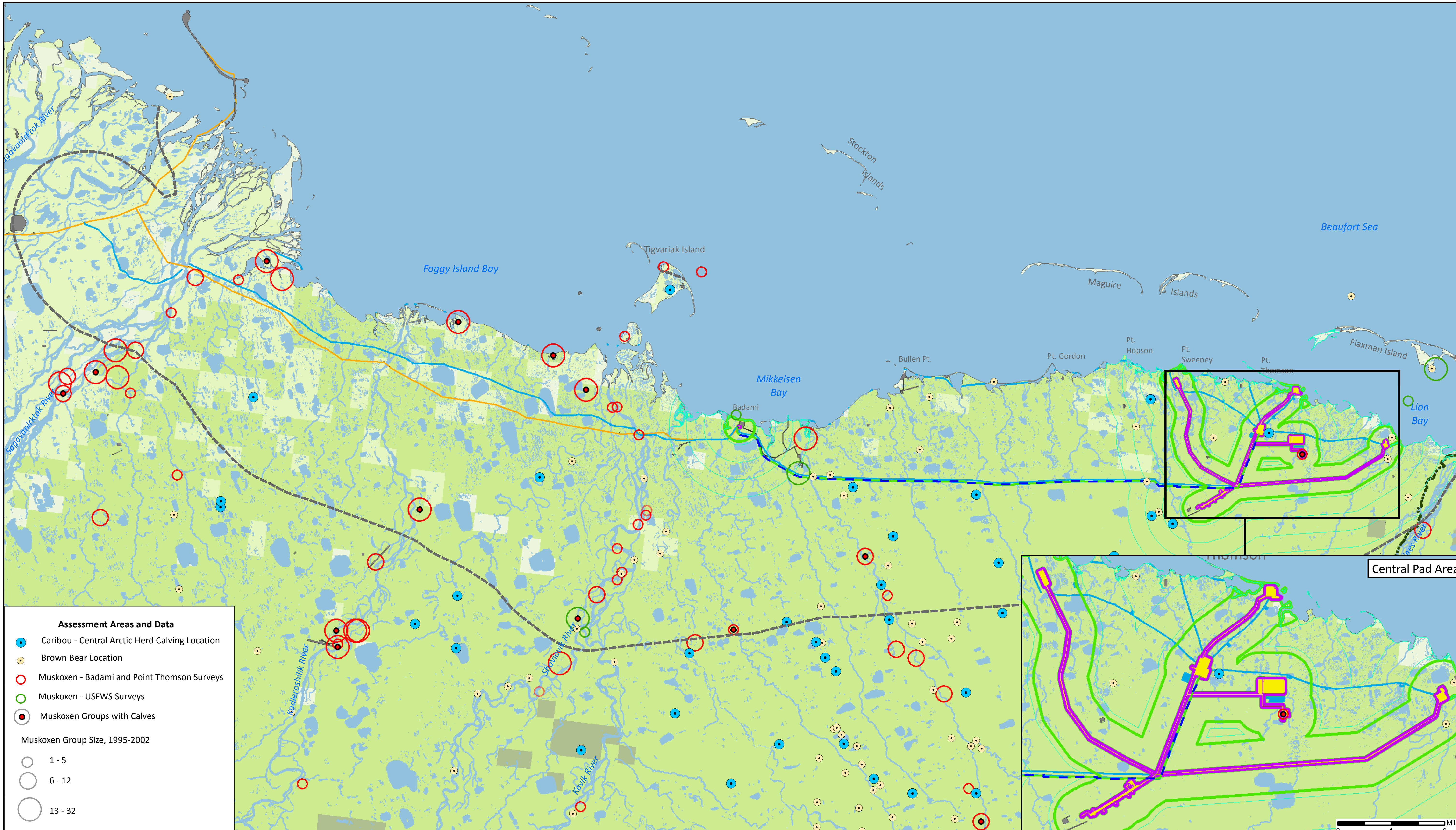

POINT THOMSON PROJECT EIS

Legend

- Stream
- Existing Road
- Existing Pipeline
- Existing Facilities
- Water Body
- Arctic National Wildlife Refuge
- Proposed Pipelines
- 2.5 Mile Buffer around all Project Alternative features
- Loss - Gravel Mine/Placement Footprint
- Loss - Ice Road Footprint
- Alteration - Within 165 ft of Gravel Mine/Placement
- Disturbance - Within 0.5 mile of Gravel Mine/Placement
- Disturbance – 0.6-Mile Buffer from Gravel Infrastructure

Phytobiomass (ton/acre)

- <0.03
- 0.27-0.38
- 0.39-0.50
- >0.50

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

N

0 1 2 Miles

Figure 5.10-8

Alternative D – Estimated Forage Production and Terrestrial Mammal Disturbance and Displacement from Gravel Infrastructure

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

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Access to the ice road system developed under Alternative D to hunters may lead to changes in hunting patterns with the greatest consequence to muskoxen, which may winter in the area. Hunting activity near the infield roads may increase the avoidance response for caribou and other terrestrial mammals beyond those normally observed in the Prudhoe Bay oil fields where hunting is not allowed.

Based on historical distributions of brown bear dens, no dens were located within 0.5 mile of proposed gravel or ice roads and no brown bear dens would likely be disturbed by winter road construction and use (Table 5.10-12). Continued annual construction and use of the ice access road between the Endicott Spur Road and Point Thomson could lead to changes in brown bear den habitat use near the ice road corridor, although most den sites have been located south of the proposed routes.

Alternative D would require similar fixed-wing air traffic as Alternative B during construction, but the use of helicopters would be five times greater (i.e., 5,070 versus 990) for Alternative D. Due to the anticipated increase in helicopter flights, potential impacts to terrestrial mammals in the study area from aircraft disturbance during construction would be higher with Alternative D relative to Alternative B.

Habitat Fragmentation

Alternative D would include a water pipeline from the mine site reservoir to the Central Processing Pad. Because the water pipeline would be buried, it would not block or alter movements of caribou likely to occur in this area.

Caribou may avoid or delay crossing locations where high traffic roads are located near pipelines. The areas with a high coincidence of caribou movement combined with pipelines crossing or near roads occur where the export pipeline crosses the road to the airstrip, and where the export pipeline ties in to existing pipeline in Badami (Table 5.10-15 and Figure 5.10-9).

Table 5.10-15: Alternative D—Potential Road-Pipeline Blockage to Caribou Movements

Location of Road-Pipeline with **Separation ≤ 500 ft**	Feature	Length of Pipeline Segment (ft) ≤ 500 ft	Number of Recorded Caribou Movements[a] (# of crossings per mi²)
Central Pad	—	—	—
East Pad	—	—	—
West Pad	Gathering pipeline	1,233	4
Airstrip and Adjacent Pipelines	Export pipeline	11,478	56
Gravel Mine and Reservoir	—	—	—
Badami Export Pipeline Tie-in Location	Export pipeline	4,954	32

[a] Caribou movement numbers are based on available telemetry data from June, July, and August surveys from 1983 and 1987 to 1990 (WCC and ABR 1983, Griffith 2002).

Mortality

Placement of gravel fill and ice would likely result in mortality of some small mammals, and the potential for caribou or muskoxen strikes on the airstrip would exist, though such strikes would be unlikely because animals would be hazed from the airstrip. During winter collisions of vehicles with arctic foxes, caribou, and muskoxen may occur. Collision mortality with muskoxen on the annual ice access road may be increased as muskoxen are likely to use this road for travel during winter. Individual animals that become nuisance animals may be destroyed for human safety.

Altered Survival or Productivity

Terrestrial mammal displacement from preferred habitats could result in reduced survival and productivity. Storage of materials and supplies used during construction would create additional crevices and voids that may provide cover for terrestrial mammals similar to that described for Alternative B.

5.10.5.2 Alternative D: Drilling

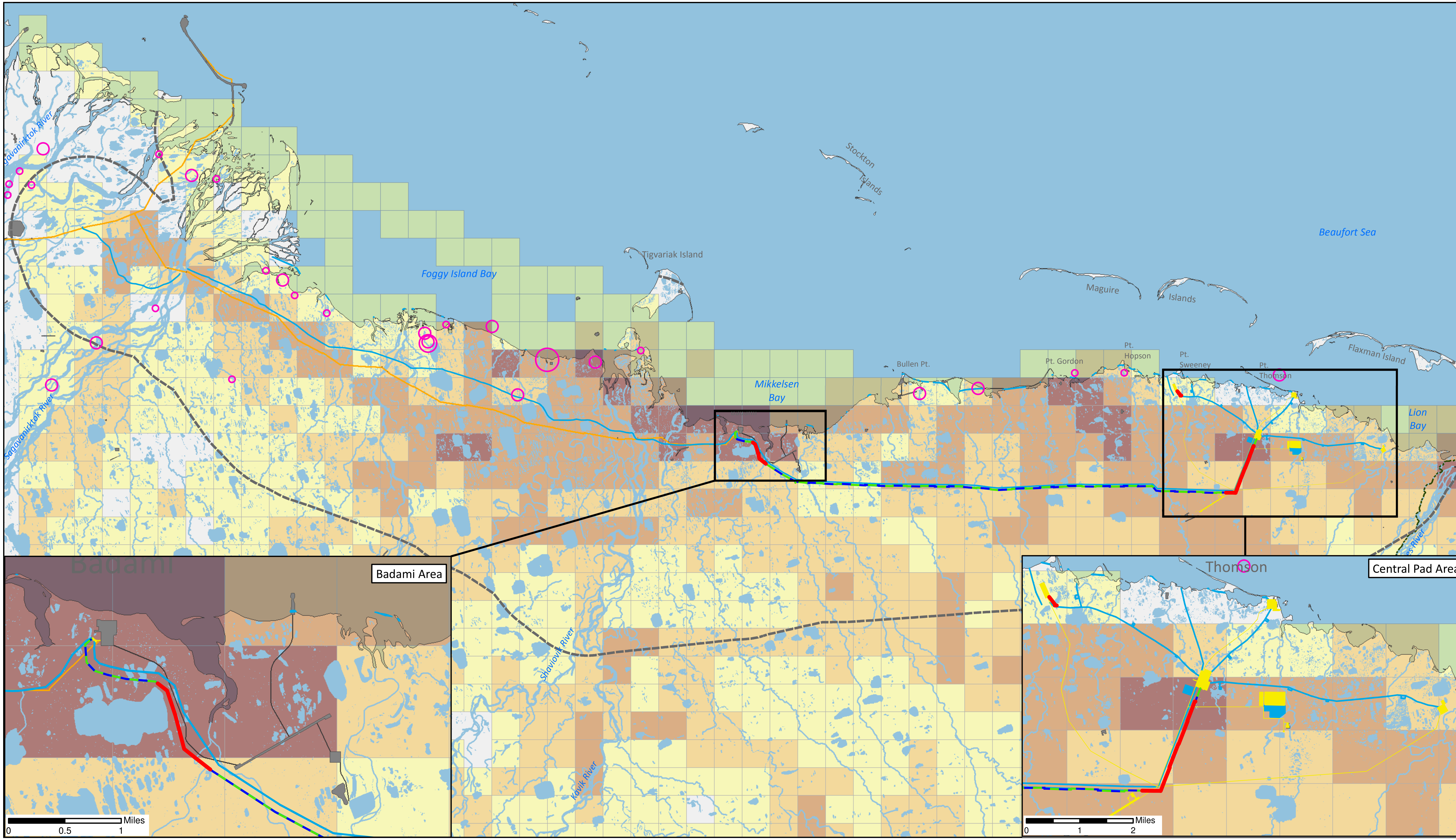
Alternative D drilling would affect terrestrial mammals and their habitats through similar mechanisms as those described in Alternative B, though there would be more potential disturbance of muskoxen from traffic along the ice access road, as muskoxen may overwinter in the vicinity of the Kavik River near its confluence with the Shaviovik River near the proposed tundra ice road location. Also, Alternative D would have traffic between the Central Processing Pad and the Central Well Pad, unlike Alternative B where these facilities are co-located. Compared with Alternative C, Alternative D would require twice as many helicopter round trips (2,000 to 2,400) during drilling, which could disturb large mammals.

5.10.5.3 Alternative D: Operations

Habitat loss, alteration, and disturbance initiated during construction would continue during Alternative D operations. Operation of Alternative D would have different levels but similar types of impacts as those described in Alternative B, less those impacts associated with coastal vessel traffic. Because the ice road routes to Badami in Alternative D are farther south than those proposed in Alternative B, Alternative D operational impacts would also include:

- Additive damage from the annual ice access road to vegetation, especially tussock tundra, which is an important resource for caribou during calving.
- Disturbance to muskoxen and hibernating brown bears from vehicle traffic on the ice access road from the Endicott Spur Road.

A few caribou may calve in the vicinity of the Central Processing Pad and airstrip and post-calving aggregations are likely to move through the Point Thomson area during the summer, with large aggregations during early to mid July. Calving caribou are likely to be displaced some distance from the facilities. Blocked or altered caribou movement may be more likely to occur near areas where roads and pipelines are close to each other (Figure 5.10-9).



Legend

- Stream
- Existing Road
- Existing Pipeline
- Existing Facilities
- Water Body
- Arctic National Wildlife Refuge

Assessment Areas and Data

- 2.5 Mile Project Area around all Project Alternative features
- Proposed Pipelines
- Blockage - Pipeline/Road Separation less than or equal to 500 ft
- Loss - Gravel Mine/Placement Footprint
- Loss - Ice Road Footprint

Density of Caribou Crossings (Crossings per sq. mi.)

- 1 - 5
- 6 - 10
- 11 - 20
- 21 - 40

Caribou Group Size and Location

- 219 - 1000
- 1001 - 5000
- 5001 - 10000
- 10001 - 50000

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

N

0 1 2 Miles

Figure 5.10-9

Alternative D – Caribou Photocensus Groups, Movement Densities, and Potential Blockage Locations near Roads and Pipelines.

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

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5.10.5.4 Alternative D: Summary of Effects on Terrestrial Mammals

Infrastructure and activities proposed for Alternative D would result in probable, minor, long-term, local extent effects on arctic foxes, brown bears, arctic ground squirrels and other small mammals and their habitats; and probable moderate, long-term, local extent, effects on caribou habitat use during the calving (late May through late June) and parasitic insect seasons (early July through mid-August). The summary of Alternative D impacts by assessment criteria is shown in Table 5.10-16.

Table 5.10-16: Alternative D—Impact Summary for Terrestrial Mammals

Impact Type and Affected Mammals		Magnitude	Duration	Potential to Occur	Geographic Extent
Habitat Loss and Alteration	Small Mammals	Minor	Long term	Probable	Local
	Burrow Habitats	Minor	Long term	Probable	Local
	Den Habitats	Minor	Long term	Possible	Local
	Large Mammals	Minor	Long term	Probable	Limited
Disturbance	Arctic Fox Dens/Den Habitat (within 0.5 miles)	Moderate	Long term	Probable	Local
	Brown Bear Dens/Den Habitat (within 0.5 miles)	Moderate	Long term	Possible	Local
	Calving Caribou (within 0.6 miles)	Minor	Long term	Possible	Limited
	Calving Caribou (within 2.5 miles)	Moderate	Long term	Possible	Limited
	Post-calving Caribou (within 0.6 miles)	Moderate	Long term	Probable	Limited
	Muskoxen (within 0.6 miles)	Minor	Long term	Probable	Local

5.10.6 Alternative E: Coastal Pads with Seasonal Ice Roads

Potential long-term Alternative E effects on terrestrial mammals and their habitats would be from frequent helicopter disturbance during the summer and from habitat alteration and disturbance from annual infield ice roads. Long-term loss of habitat due to extraction and placement of gravel for roads, pads, and the airstrip would occur, as shown in Table 5.10-17 and Figure 5.10-4.

5.10.6.1 Alternative E: Construction

Construction of Alternative E would affect terrestrial mammals and their habitats through gravel extraction and placement, and ice road and pad construction with different levels but similar types of impacts as those described in Alternative B. Alternative E would result in medium- to long-term habitat loss and alteration from annual construction of tundra ice roads for long-term project operations and construction and maintenance of ice pads (both summer and winter) over multiple years to support both construction and drilling. Use of aircraft, particularly with the addition of summer season helicopter transport between well pads instead of vehicle travel on gravel roads, would be more frequent with Alternative E relative to Alternative B. Additional unique impacts are described below.

Habitat Loss and Alteration

Arctic foxes, arctic ground squirrels, and other small mammals would lose minor amounts of foraging and burrow or den habitat from gravel infrastructure (Table 5.10-17), although no known fox dens would be covered by gravel fill (Figure 5.10-10). Brown bears could lose minor amounts of both foraging and den habitat (Table 5.10-17), although no brown bear dens have been historically recorded within 0.5 miles of the gravel footprint (Table 5.10-17). Most brown bear dens are likely to exist south of the project area. Lost habitat would potentially provide forage sufficient to support about 79 caribou or muskoxen for 12 months based on estimated phytobiomass. While the amount of forage loss could support a considerable number of caribou or muskoxen, forage is plentiful in the surrounding areas (Figure 5.10-11).

Table 5.10-17: Alternative E—Estimated Terrestrial Mammal Habitat Impacts

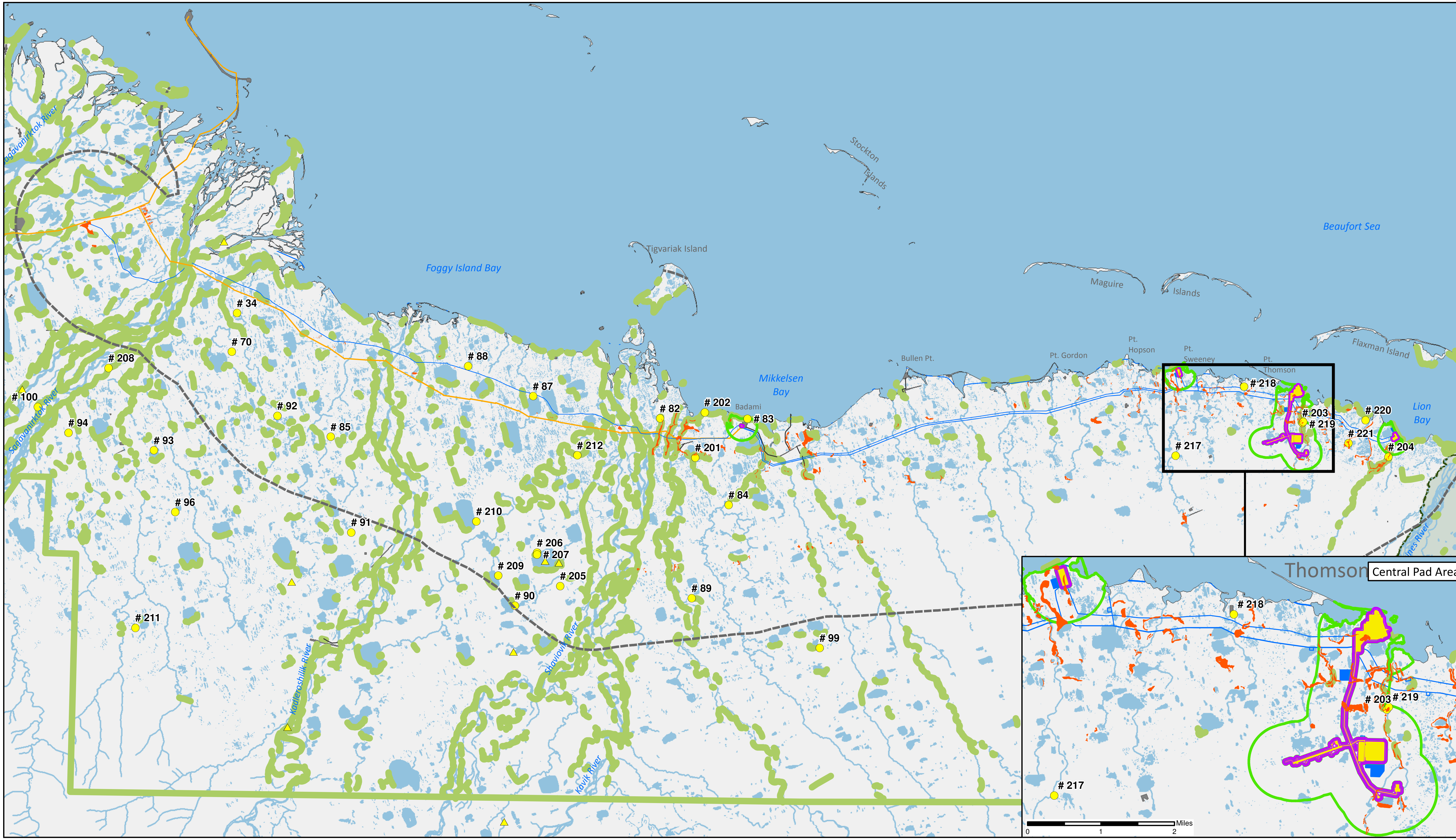
	Habitat[a]					
	All Habitats (acres)	Forage (tons)	Squirrel Burrow/Fox Den Habitat (acres)	Arctic Fox Dens	Bear Den Habitat (miles)	Brown Bear Dens
Available Habitat within Point Thomson Project Area[b]	245,165	432,369	4,982	32	190.9	3
Habitat Impacts from Gravel Extraction or Placement						
Loss from Gravel Extraction/Placement (footprint)	205	354	9	0	0	0
Alteration by Proximity (within 165 feet of gravel extraction/placement)	254	448	10	0	<1	0
Proportion of Available Habitat Lost and Altered	<1%	<1%	<1%	0%	<1%	0%
Habitat/Forage Potentially Disturbed (within 2.5 miles)	33,609	60,636	—	—	—	—
Proportion of Available Habitat/Forage Potentially Disturbed	16%	16%	—	—	—	—
Burrows/Den Habitat and Known Dens Potentially Disturbed (within 0.5 miles)	—	—	174	3	2	0
Proportion of Available Burrow/Den Habitat and Known Dens Potentially Disturbed	—	—	4%	9%	1%	0%
Habitat Impacts from Ice Infrastructure Development						
Loss from Ice Cover (footprint)	487	848	14	1	<1	0
Proportion of Available habitat lost	<1%	<1%	<1%	3%	<1%	0%
Burrows/Den Habitat and Known Dens Potentially Disturbed (within 0.5 miles)	—	—	800	9	33	0
Proportion of Available Burrow/Den Habitat and Known Dens Potentially Disturbed	—	—	16%	28%	17%	0%

Source: Shideler 1998, 1999; Perham 2000, 2001; Raynolds et al. 2010

—: Not applicable

[a] Burrow habitat for arctic ground squirrels and arctic foxes as indicated by mapped dry dwarf shrub-lichen tundra (Vc and Vd). Habitat mapping not available for all assessment area extents (range 19 to 100 percent). Brown bear den habitat estimate as indicated by topographic models for suitable polar bear den habitat (Durner et al. 2001, 2006).

[b] Point Thomson Project Area habitat is based on the proportion of mapped habitat types extrapolated to a 375 mi^2 area or the approximate area within 2.5 miles of gravel and ice components for all alternatives.



POINT THOMSON PROJECT EIS

Legend

- Stream
- Existing Pipeline
- Existing Road
- Existing Facilities
- Water Body
- Arctic National Wildlife Refuge
- 2.5 Mile Buffer around all Project Alternative features
- Loss - Gravel Mine/Placement Footprint
- Loss - Ice Road Footprint
- Alteration - Within 165 ft of Gravel Mine/Placement
- Disturbance - Within 0.5 mile of Gravel Mine/Placement

Assessment Areas and Data

- Suitable Burrow Habitat (Vc/Vd)
- Polar (and potential Brown) Bear Denning Habitat
- Arctic Fox Den Location (with Den Number)
- Brown Bear Den Location

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

N

0 1 2 Miles

Figure 5.10-10

Alternative E – Areas of Terrestrial Mammal Habitat Loss, Alteration, and Disturbance

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

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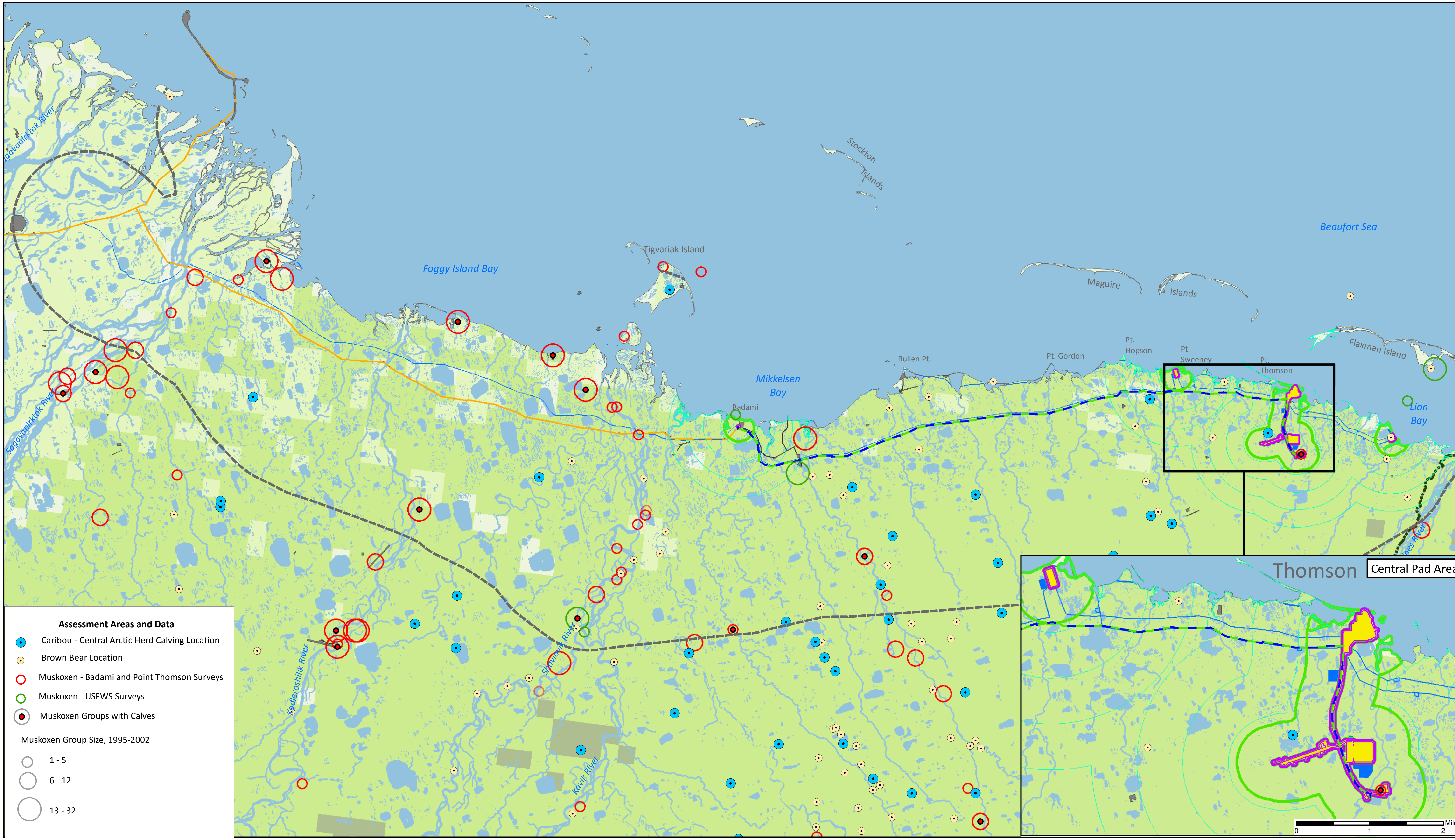

POINT THOMSON PROJECT EIS

Legend

- Stream
- Existing Road
- Existing Pipeline
- Existing Facilities
- Water Body
- Arctic National Wildlife Refuge
- Proposed Pipelines
- 2.5 Mile Buffer around all Project Alternative features
- Loss - Gravel Mine/Placement Footprint
- Loss - Ice Road Footprint
- Alteration - Within 165 ft of Gravel Mine/Placement
- Disturbance - Within 0.5 mile of Gravel Mine/Placement
- Disturbance – 0.6-Mile Buffer from Gravel Infrastructure

Phytobiomass (tons/acre)

- <0.03
- 0.27-0.38
- 0.39-0.50
- >0.50

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

N

0 1 2 Miles

Figure 5.10-11

Alternative E – Estimated Forage Production and Terrestrial Mammal Disturbance and Displacement from Gravel Infrastructure

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

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Habitats near gravel fill would be altered by snow piles and drifts, dust spray, altered hydrology, and thermokarst resulting in reduced forage and habitat suitability for both small and large terrestrial mammals (Table 5.10-17 and Table 5.10-18). Additionally, muskoxen may use the ice access road for travel, as it would provide easy transit between winter habitats along riparian corridors.

Table 5.10-18: Alternative E—Potential Small Mammal Habitat Loss and Alteration

Small Mammals	Point Thomson Project Area Habitat Estimate[2]	Estimated Area (in acres) of Affected Small Mammal Habitat[1]				Proportion of Point Thomson Habitat Estimate (%)
		Habitat Loss from Gravel Extraction and Placement	Habitat Alteration surrounding Gravel Placement /Extraction/Staging	Habitat Loss from Ice Infrastructure Construction	Total	
Small Herbivores						
Collared Lemming	62,782	90	105	174	369	1
Brown Lemming and Root Vole	163,351	154	208	387	750	1
Small Carnivores						
Barren Ground Shrew	94,779	89	137	271	497	1
Ermine and Least Weasel	175,244	191	234	42	845	1
Medium Herbivores						
Arctic Ground Squirrel	104,372	126	161	298	585	1

Source: Burgess 1984, Babcock 1985, Nature Serve 2009

[1] Small mammal habitat impacts are estimated based on loss and alteration of habitats typically used by the small mammals as defined in Methodology.

[2] Point Thomson habitat estimate is based on the proportion of mapped habitat types extrapolated to a 375 mi^2 area or the approximate area within 2.5 miles of gravel and ice components for all alternatives.

Disturbance

Disturbance from ice road construction, maintenance, and traffic could displace and disturb terrestrial mammals as described in Alternative B.

Table 5.10-19 lists the average number of caribou potentially occurring within 2.5 miles of Alternative E proposed infrastructure that could be disturbed and displaced by traffic and noise associated with that infrastructure. More caribou are likely to occur near the Alternative E facilities during the post-calving period.

Figure 5.10-11 shows caribou calving locations, forage production, and disturbance areas in relation to infrastructure proposed under Alternative E.

Table 5.10-19: Alternative E—Caribou Potentially Disturbed by Project Construction and Operation

	Potentially Disturbed					Point Thomson Study Area Estimate	Proportion Potentially Disturbed (0.6 miles)	Proportion Potentially Disturbed (2.5 miles)
	0 to 0.6 mile	0.6 to 1.2 miles	1.2 to 1.9 miles	1.9 to 2.5 miles	Total 0 to 2.5 miles			
Calving Locations[a]	1	1	0	0	2	62	2%	3%
Average Number of Caribou During Calving[b]								
Calves	2	2	1	2	7	735[c]	<1%	<1%
Total	6	4	3	6	19	1,233[c]	<1%	2%
Average Number of Caribou Post Calving[d]								
Calves	15	7	10	17	50	693[c]	2%	—
Total	63	39	77	160	339	3,956[c]	2%	—
Photocensus Locations[e]	0	1	2	0	3	95	0%	—

Source: Shideler 1998, 1999; Noel 1998a, b; Noel and Olson 1999a, b, 2001a, b; Noel and King 2000a, b; Jensen and Noel 2002; Jensen, Noel, and Ballard 2003; Noel and Cunningham 2003

[a] Location for calves near the time of birth east of the Sagavanirktok River during 1 to 10 June 1992 to 2002, note usually one calf associated with each location (Arthur 2002)

[b] Based on average numbers of caribou observed from 11 surveys of the Bullen survey area and 9 surveys of the Badami survey area. Numbers are rounded to the nearest whole number.

[c] Based on combined mean observed densities during systematic surveys between the Sagavanirktok and Canning Rivers of 3.22 caribou per mi^2 and 1.92 caribou calves per mi^2 during calving (1 to 20 June) and 10.33 caribou per mi^2 and 1.81 calves per mi^2 during post-calving (21 June to August) multiplied by 383 mi^2 or the area within 2.5 miles of project components.

[d] Based on average numbers of caribou observed from 30 surveys of the Point Thomson survey area and 27 surveys of the Badami survey area. Numbers are rounded to the nearest whole number.

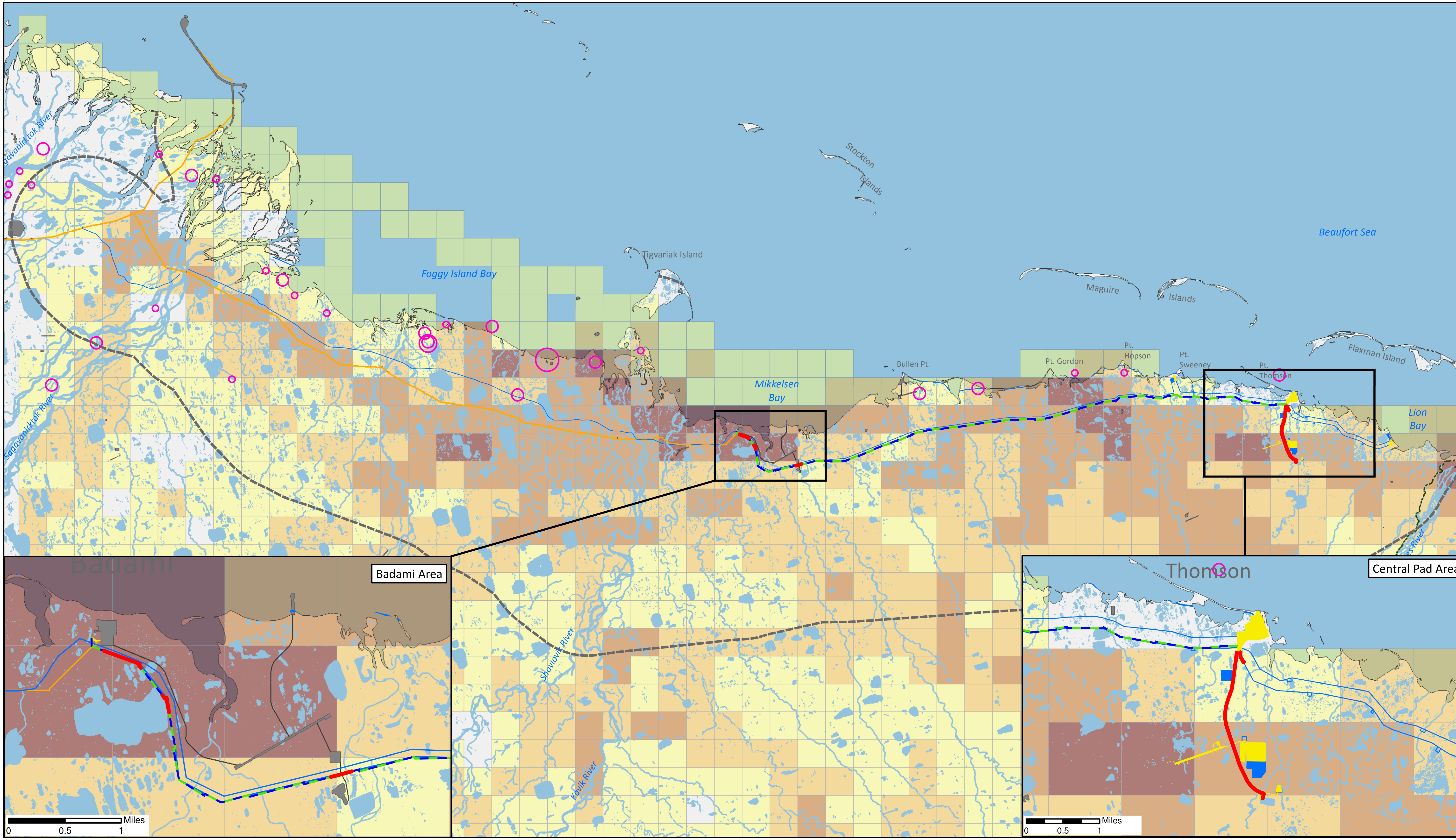
[e] Photocensus locations for caribou aggregations during July 1983, 1992, 1995, 1997, 2000, 2002, and 2008; note many caribou are associated with each location (range 13 – 32,031; average 1,891; ADF&G 2003b, 2009c)

Under Alternative E, winter access to the developed ice road system by hunters and hunting near the roads may lead to changes in hunting patterns with the greatest consequence on muskoxen.

Alternative E would require construction of a helicopter base at the Central Pad and the primary means of transportation between the well pads during construction in summer would be by helicopter. This could cause frequent disturbance to large mammals that may be near the pads or along the flight paths.

Habitat Fragmentation

Caribou may avoid or delay crossing locations where roads and pipelines are located less than 500 feet apart. The areas with pipeline-road separation distances of less than 500 feet and a high coincidence of caribou movement occur where the water pipeline parallels the road between the gravel mine site/water reservoir area and continues north the Central Pad (Figure 5.10-12 and Table 5.10-20). An additional road-pipeline congestion area occurs where the export pipeline approaches Badami.



POINT THOMSON PROJECT EIS

Legend

- Stream
- Existing Road
- Existing Pipeline
- Existing Facilities
- Water Body
- Arctic National Wildlife Refuge

Assessment Areas and Data

- 2.5 Mile Project Area around all Project Alternative features
- Proposed Pipelines
- Blockage - Pipeline/Road Separation less than or equal to 500 ft
- Loss - Gravel Mine/Placement Footprint
- Loss - Ice Road Footprint

Density of Caribou Crossings (Crossings per sq. mi.)

- 1 - 5
- 6 - 10
- 11 - 20
- 21 - 40

Caribou Group Size and Location

- 219 - 1000
- 1001 - 5000
- 5001 - 10000
- 10001 - 50000

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

0 1 2 Miles

Figure 5.10-12

Alternative E – Caribou Photocensus Groups, Movement Densities, and Potential Blockage Locations near Roads and Pipelines.

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

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Table 5.10-20: Alternative E—Potential Road-Pipeline Blockage to Caribou Movements

Location of Road-Pipeline with **Separation ≤ 500** ft	Feature	Length of Pipeline Segment (ft) ≤ 500 ft	Number of Recorded Caribou Movements[a] (# of crossings per mi²)
Central Pad	Gathering pipeline	799	2
	Water line	6,356	16
East Pad	—	—	—
West Pad	—	—	—
Airstrip and Adjacent Pipelines	—	—	—
Gravel Mine and Reservoir	Water line	5,158	21
Badami Export Pipeline Tie-in Location	Export pipeline	3,955	85

[a] Caribou movement numbers are based on available telemetry data from June, July, and August surveys from 1983 and 1987 to 1990 (WCC and ABR 1983, Griffith 2002)

Mortality

Placement of gravel fill and ice would likely result in mortality of some small mammals. Other possible mortality impacts would be similar to those described in Alternative B.

Altered Survival or Productivity

Terrestrial mammal displacement from preferred habitats could result in reduced survival and productivity. Storage of materials and supplies used during construction would create additional crevices and voids that may provide cover for terrestrial mammals similar to that described for Alternative B.

5.10.6.2 Alternative E: Drilling

Alternative E drilling would have different levels but similar types of impacts on terrestrial mammals and their habitats as those described in Alternative B. Alternative E would have the following additional impacts:

- Disturbance to large mammals from additional helicopter traffic between the Central Pad and East and West Pads for personnel and supply transport.
- Disturbance from tundra-safe, low-pressure vehicles, which may be used for transportation between the Central Pad and the East and West Pads during summer.
- Potential for small mammal mortality due to tundra-safe, low-pressure vehicle traffic.

5.10.6.3 Alternative E: Operations

Habitat loss and alteration impacts from gravel fill and extraction initiated in construction would continue through Alternative E operations. Other operations impacts would have different levels but similar types of impacts as described for Alternative B, though the impacts of infield gravel roads between the East and West Pads and Central Pad would not occur. Rather, there would be impacts from annual ice roads between those sites during the winter, and helicopter and tundra-safe, low-pressure vehicle traffic during the summer. Other impacts include:

- Additive vegetation damage from the annual ice access road between the Endicott Spur Road and Point Thomson and from infield ice roads.

- Disturbance of caribou from routine helicopter traffic for well inspections between the airstrip and East and West Pads, and displacement from coastal insect-relief habitats.
- Habitat fragmentation based on available caribou movement data in areas where elevated pipeline routes are fewer than 500 feet from roads and structures (Figure 5.10-12 and Table 5.10-20).

5.10.6.4 Alternative E: Summary of Effects on Terrestrial Mammals

Infrastructure and activities proposed for Alternative E would result in probable, minor, long-term, local extent effects on arctic foxes, brown bears, arctic ground squirrels and other small mammals and their habitats; and probable minor to moderate, long-term, local extent effects on caribou habitat use during the calving (late May through late June) and parasitic insect seasons (early July through mid-August). The summary of Alternative E impacts by assessment criteria is shown in Table 5.10-21.

Table 5.10-21: Alternative E—Impact Summary for Terrestrial Mammals

Impact Type and Affected Mammals		Magnitude	Duration	Potential to Occur	Geographic Extent
Habitat Loss and Alteration	Small Mammals	Minor	Long term	Probable	Local
	Burrow Habitats	Minor	Long term	Probable	Local
	Den Habitats	Minor	Long term	Possible	Local
	Large Mammals	Minor	Long term	Probable	Limited
Disturbance	Arctic Fox Dens/Den Habitat (within 0.5 miles)	Moderate	Long term	Probable	Local
	Brown bear dens/den habitat (within 0.5 miles)	Moderate	Long term	Possible	Local
	Calving Caribou (within 0.6 miles)	Minor	Long term	Possible	Limited
	Calving Caribou (within 2.5 miles)	Moderate	Long term	Possible	Limited
	Post-calving Caribou (within 0.6 miles)	Moderate	Long term	Probable	Limited
	Muskoxen (within 0.6 miles)	Minor	Long term	Probable	Local

5.10.7 Mitigative Measures

This section describes measures to mitigate impacts to terrestrial mammals from the Point Thomson Project. The Applicant has proposed design measures that would be included as part of the project; BMPs and permit requirements would be stipulated by federal, state, and local agencies, and the Corps has considered additional mitigation measures.

5.10.7.1 Applicant's Proposed Design Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on terrestrial mammals:

- Elevating pipelines to provide a minimum clearance of 7 feet from the tundra for unimpeded wildlife movements
- Conducting on-tundra gravel placement activities primarily during the winter to reduce the impact on wildlife (e.g., reducing disturbance to migrating caribou during the summer)

- Constructing infield gravel roads to avoid aircraft and off-road vehicle travel between project locations (not including Alternative E)
- Locating pipelines a half-mile or more away from roads except for short sections at the Central, West, and East Pads and at the Badami export pipeline tie-in, to minimize visual disorientation affecting caribou movement patterns
- Employing operational controls and rigorous training programs, including:
    - Implementing spill prevention and response programs, as detailed in Section 5.24, Spill Risk and Impact Assessment.
    - Employing an onsite Subsistence Representative(s) from Kaktovik or other North Slope communities during periods of active construction and drilling. Use of Subsistence Representatives during long-term operations will be evaluated during the operational planning phase.
    - Prohibiting hunting and fishing by Applicant's employees and contractors while personnel are assigned to, and working in, the Point Thomson area
    - Prohibiting feeding of wildlife
    - Maintaining a clear space under modules and buildings to prevent creation of artificial den sites for foxes
    - Requiring workers to stay on gravel surfaces unless their job duties require them to be on the tundra
    - Requiring strict guidelines for travel on ice roads to avoid tundra damage, including ice road training, establishing speed and weight limits, and installing delineators along both sides of the road.
    - Managing food materials and food wastes such that they are made unavailable to wildlife, including the use of bear-proof dumpsters at project locations
    - Applying dust control measures to roads, pads, and summer mining activities to protect vegetation and terrestrial and aquatic habitats
    - Limiting vehicle speed on project roads and giving right-of-way to wildlife
    - Training in site operations, deterrence and hazing, waste management, and ice road operations for all onsite personnel
    - Using bear monitors to watch for wildlife and take proactive measures to avoid encounters with workers. Identifying specific actions to be taken in the event of an encounter.
    - Coordinating with the USFWS and/or ADF&G on known polar bear and grizzly bear den locations and procedures
- Eliminating the previously proposed aboveground waterline to mitigate agency concerns regarding potential effects on wildlife movement (except for Alternative C)
- Adopting strict management procedures specifically related to the control and containment of waste containers and food
- Implementing a Polar Bear and Wildlife Interaction Plan with detailed measures to avoid adverse encounters with wildlife
- Requiring routine aircraft flights (e.g., transportation of personnel and cargo) to generally fly at a 1,500-foot altitude following a path inland from the coast to avoid disturbance to wildlife, except as required for takeoffs and landings, safety, weather, and operational needs, or as directed by air traffic control

- Minimizing gravel fill by utilizing three existing gravel pads in the area to the greatest extent possible, thereby reducing overall new tundra footprint by more than 20 acres
- Routing the infield gravel roads to minimize overall length and footprint, with consideration for hydrologic impacts and project needs
- Minimizing the size of the gravel pads through optimizing project design and equipment layout

5.10.7.2 BMPs and Permit Requirements

North Slope Area-wide Lease Sale mitigation measures include the following related to terrestrial mammals:

- Before commencement of any activities, lessees shall consult with ADF&G (907-459-7213) to identify the locations of known brown bear den sites that are occupied in the season of proposed activities. Exploration and production activities must not be conducted within one-half mile of occupied brown bear dens, unless alternative mitigation measures are approved by ADF&G. A lessee who encounters an occupied brown bear den not previously identified by ADF&G must report it to the Division of Wildlife Conservation, ADF&G, within 24 hours. Mobile activities shall avoid such discovered occupied dens by one-half mile unless alternative mitigation measures are approved by the Director, with concurrence from ADF&G. Non-mobile facilities will not be required to relocate.
- For projects in proximity to areas frequented by bears, lessees are required to prepare and implement a human-bear interaction plan designed to minimize conflicts between bears and humans. The plan should include measures to minimize attraction of bears to facility sites; organize layout of buildings and work areas to minimize interactions between humans and bears; warn personnel of bears near or on facilities and the proper actions to take; if authorized, deter bears from the drill site; provide contingencies in the event bears do not leave the site; discuss proper storage and disposal of materials that may be toxic to bears; and provide a systematic record of bears on the site and in the immediate area.

5.10.7.3 Corps-considered Mitigation

In addition to the Applicant's proposed design measures and BMPs and permit requirements, the Corps, in consultation with others, is considering the following actions to avoid or minimize impacts to terrestrial mammals:

- Prepare an Air Traffic Plan to be submitted to the Corps and cooperating agencies for review and approval prior to start of construction. Include the following measures to minimize impacts to terrestrial mammals:
    - Route flights to avoid calving areas during the caribou calving period, large post-calving caribou aggregations, and insect-relief habitats.
    - Restrict overflights to more than 1,000 feet during caribou calving and to more than 500 feet in spring and fall.
- Coordinate aircraft and vehicle trips during construction, drilling, and operations to minimize the number of trips.
- Consult with ADF&G to locate and avoid any active brown bear dens prior to winter construction.

5.10.8 Climate Change and Cumulative Impacts

5.10.8.1 Climate Change

Climate change is predicted to result in habitat changes that would affect terrestrial mammal survival, diversity, abundance, and distribution. Likely habitat changes related to climate change include:

- Warmer winter temperature and changing snow structure
- Increased snow depth
- Shorter snow season
- Early winter breakup and flooding
- Increased vegetation productivity
- Increase in shrubs
- Decrease in wet graminoid tundra
- Increase in invertebrates, parasites, and disease organisms

The vulnerability of terrestrial mammals to climate change is influenced by their geographic range and niche breadth. The potential climate change impacts described below would occur to the same level in each of the alternatives, though they may compound the impacts described for each of the action alternatives.

The animals that would be the most susceptible to climate change include the barren-ground shrew, collared lemming, and muskoxen. Those that would be less susceptible to climate change would include the arctic fox, arctic ground squirrel, and singing vole. The brown bear, brown lemming, tundra shrew, and caribou would be moderately susceptible to climate change. The most resilient animals would likely be the least weasel, ermine, red fox, and root vole (Martin et al. 2009).

The small mammals, such as the lemming and ground shrew, would likely suffer from changes in distribution and population if the ground in which they take shelter and the vegetation on which they rely for food changed due to climate change. These animals are very important components in various food webs, and changes in their distribution would likely also affect other species. Additional impacts could be experienced by the barren-ground shrew, which is difficult to study and about which little is known (Martin et al. 2009).

The large herbivores, the muskoxen and caribou, would likely experience changes in abundance and distribution as their food sources changed. While warmer temperatures may increase the amount of vegetation available in the summer, there could be changes in the types of vegetation. Possible increased competition with other vegetation could reduce the amount of lichen available to caribou, and plant lifecycles that currently coincide with migration could change, so that animals are migrating before or after the vegetation is consumable. Longer, warmer summers may lead to an increase in insect harassment, parasites, and disease in both species. An increase in rain-on-snow events and deeper snow in the winter could reduce access to winter forage for both caribou and muskoxen, causing them to expend greater amounts of energy in the search for food (Martin et al. 2009).

Small arctic-adapted predators, such as the arctic fox, could face increased competition with less-specialized species, such as the red fox if the temperatures and seasons of the Arctic begin to resemble those of subarctic regions (Martin et al. 2009). Large predators, such as brown bears, could face competition for scavenged carrion and prey animals if polar bears are able to adapt to ice-free coastal habitats. The brown bear, however, could be impacted less by competition from other species than by a reduction in biodiversity: as plants change, so would the forage that supplies the majority of the bear's diet, and the supplemental prey species upon which the brown bear relies (McMahon 2008)

5.10.8.2 Cumulative Effects

Past, present, and future activities in the cumulative impact study area have the potential to add to the impacts of the proposed project. Section 4.2, Cumulative Impacts, describes the past, present, and reasonably-foreseeable future actions that were considered as part of the cumulative impacts analysis for terrestrial mammals. The features of these industrial and other human developments that can affect terrestrial mammals mirror those discussed above for each of the alternatives and include: habitat alteration from ice pads and roads; disturbance from construction activities (especially during migration and calving); habitat loss, alteration, and disturbance associated with gravel roads and pads; collisions with vehicles; disturbance from operations activities; increased predation from predators attracted to industrial developments; and subsistence and recreational hunting.

The most important reasonably-foreseeable future actions for this analysis are the potential oil and gas developments that are anticipated for the North Slope in the foreseeable future, and especially those developments east of Prudhoe Bay. Included in this list of reasonably-foreseeable future actions is the potential development needed for a natural gas sales line and expansion of the Point Thomson Project to produce natural gas. Compared to nonindustrial human developments and scientific studies, oil and gas development activities have the greatest potential to contribute to habitat loss, disturbance, and mortality effects.

Potential cumulative impact issues relative to terrestrial mammals include incremental habitat loss, alteration, and disturbance; particularly caribou herds that could be displaced from calving areas and insect-relief habitat and muskoxen herds, as they may spend the entire year on the ACP and would be in constant contact with infrastructure. Habitat loss and alteration is discussed in Section 5.8, Vegetation and Wetlands. In addition, Table 5.2-10 (in Section 5.2, Soils and Permafrost) presents the cumulative acreage of oil and gas infrastructure, and thus habitat lost, on the eastern North Slope (east of Foggy Island). In addition, foxes, brown bears, and some other species are often attracted to human development. For bears this may result in negative effects on the population (killing bears in defense of life and property); however, recent wildlife planning efforts are working to minimize the attraction of facilities to bears. Foxes may increase populations adjacent to human facilities which could negatively affect their prey species.

Among alternatives, the incremental contribution to habitat loss and fragmentation would be greater under Alternative C due to the larger area filled and the long-term operation of the gravel Point Thomson-Endicott access road and less under Alternative E due to the smaller gravel footprint and winter-only surface access within the project area. The alteration of approximately 17,770 acres of tundra habitat in the Prudhoe Bay area (NRC 2003a) has not had an apparent adverse cumulative impact on the distribution and abundance of other terrestrial mammals, with the possible exception of arctic foxes that have increased in numbers near the oilfields. Muskoxen have expanded their range westward across the North Slope from an introduced population in the Arctic Refuge (BLM 2004).

Implementation of the proposed project could further displace some calving and maternal caribou from portions of the calving area during spring, and caribou of all ages and sexes from insect-relief habitat during summer. Cumulative impacts on caribou calving distribution would be long-term over the life of the oilfields, but would occur locally within 1.8 to 2.5 miles of roads or other facilities situated within calving areas. Any reduction in the calving and summer habitat used by cows and calves from future onshore leasing represents a functional loss of habitat that may result in long-term effects of the caribou herd's productivity and abundance. However, this potential effect may not be measurable because of the great natural variability in the caribou population productivity (BLM 2004). Cumulative impacts to caribou could be adverse.

Cumulative impacts of oil and gas development on muskoxen are difficult to predict. Muskoxen populations in the study area declined during the 2000s, most likely from natural causes (USFWS 2011c). Also, because their primary distribution is located east of most oil and gas activities, muskoxen on the North Slope have not been subjected to human industrial activities in close proximity. However, NRC (2003a) anticipated that increasing 3-dimensional seismic activities in riparian habitats important to muskoxen could increase disturbance to the species. Cumulative impacts to muskoxen could be adverse.

Past, present, and RFFAs, including the proposed project, are not expected to affect the viability of terrestrial mammal populations. However, some populations may be reduced in number to an extent that could have an adverse cumulative impact on subsistence users (see Section 5.22, Subsistence and Traditional Land-Use Patterns). Cumulatively, non-oil and gas activities and spills would have little impact on terrestrial mammals (see Section 5.24, Spill Risk and Impact Assessment).

Cumulative oil development on the North Slope would likely result in increased abundance of arctic foxes near development areas, which may present a rabies health hazard to humans in the oilfield areas. The attraction of brown bears to human refuse would lead to the loss of bears as the result of interactions with humans and eventual decline in bear abundance near development areas. The cumulative impacts on small mammals from oil and gas development on the North Slope would be local and short-term, within 1 to 2 miles of exploration or development facilities, with no adverse effects on populations.

5.10.9 Alternatives Comparison and Consequences

Impacts from gravel infrastructure under all action alternatives would include the loss of habitat, alteration of the habitat from dust accumulation and hydrologic changes, and disturbance from traffic, noise, and human movements. The gravel access road under Alternative C and the inland location of gravel infrastructure under Alternatives C and D have the greatest potential to impact terrestrial mammals from gravel placement, including the following:

- The proposed location of the gravel access road is near documented caribou calving areas, muskoxen habitat, and brown bear den sites
- Moving infield roads, pads, and the airstrip to the south places the infrastructure closer to caribou calving areas and brown bear den sites
- Separating the processing and camp facilities from the Central Drilling Pad may increase traffic between the two pads which would increase disturbance to caribou and other animal movements in the vicinity of the infield connecting road

Segments of above ground pipelines that are less than 500 feet from gravel roads would impact caribou movements during summer insect relief periods for all action alternatives.

Caribou and muskoxen would be reluctant to cross over the low water pipeline proposed under Alternative C. Some animals may cross and others may not, which could lead to the separation of cows from calves and could increase stress amongst the affected group of caribou or muskoxen. If the low water pipeline is adjacent to a road, animals agitated by the pipeline could find themselves trapped between the pipeline and the road, becoming more susceptible to traffic disturbance and vehicle collision.

For all alternatives, the noise associated with aircraft take offs and landings could result in the inability of affected animals to hear biologically important sounds such as mating calls, predator alarm calls and approaching predators. This could lead to increased stress levels, decreased reproductive capacity, and decreased survivorship in noisy areas such as airstrips and helipads. Alternative E would have the greatest potential noise disturbance to terrestrial mammals because the primary means of summer transportation between the Central Pad and East and West Pads would be by helicopter. Alternative A would have the least amount of helicopter noise impact associated with well monitoring activities.

5.11 MARINE MAMMALS

The key findings of effects for marine mammals are summarized below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

Alternative C: Moderate impacts to polar bears are probable and would last for the life of the project. Impacts would be localized to the study area

Alternatives B, D, and E: Minor impacts to polar bears and ringed seals (Alternatives B and E) are possible and would last for the life of the project. Impacts would be localized to the study area.

Alternative A: Minor impacts to polar bears are possible. Impacts would be temporary and limited to the helicopter flight path used for well monitoring.

Differentiators:

- Alternative C would result in the greatest loss of polar bear critical habitat because of the all-season gravel road; however, all of the alternatives would result in impacts to polar bear critical habitat.
- Barge activities and noise under Alternatives B and E could cause disturbance to whales and seals.
- Annual ice roads under Alternatives D and E have the greatest potential to disturb polar bear dens.

Seven marine mammal species have expected occurrence in the study area. Of them, only the proposed threatened ringed seal and threatened polar bear have a year-round occurrence inshore of the barrier islands, and thus are most likely to be potentially impacted by project activities (see Section 3.11, Marine Mammals; ExxonMobil 2010c). The bowhead and beluga whale, are seasonal and transient, most commonly found offshore of the barrier islands during their spring and fall migrations. The bearded seal is seasonally uncommon, occurs in small numbers, and would be unlikely to occur inshore of the barrier islands. The gray whale and the spotted seal have a less common occurrence in the study area.

Three of the seven species (bowhead, gray, and beluga whales) in the study area occur only in marine waters; three (bearded, ringed, and spotted seals) primarily inhabit marine waters or sea ice; and the last (polar bear) inhabits marine waters, sea ice, and regularly moves onto land. Marine mammal occurrence, habitat usage, and life history characteristics are presented in Section 3.11, Marine Mammals.

All marine mammals in U.S. waters are afforded protection by the MMPA. The MMPA prohibits the “take” of marine mammals, with certain exceptions, in waters under U.S. jurisdiction and by U.S. citizens on the high seas. Under Section 3 of the MMPA, “take” is defined as “harass, hunt, capture, kill, or attempt to harass, hunt, capture or kill any marine mammal.” In the 1994 amendments to the MMPA, two levels of “harassment” were defined. “Harassment” is defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild (Level A); or any act that has the potential to disturb a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns, including, migration, breathing, nursing, breeding, feeding, or sheltering (Level B).

Four of the seven marine mammal species most likely to occur in the study area are afforded additional protection due to their status as listed or proposed for listing under the ESA: the endangered bowhead whale, the threatened polar bear, and the proposed threatened ringed and bearded seals. Critical habitat is designated for the polar bear, some of which occurs within the study area. As noted in Section 3.11, Marine Mammals, the USFWS manages the polar bear, while all other marine mammals with potential to occur in the study area are managed by the NMFS. The bowhead whale and ringed and bearded seals are addressed in the BA that was submitted to the NMFS. The polar bear is included in the BA that was submitted to the USFWS, which also includes the ExxonMobil Polar Bear and Wildlife Interaction Plan (see Appendix M).

MMPA Incidental Take Regulations (ITRs) are currently valid for the oil and gas industry in polar bear habitat. An ITR has been in place for oil and gas activities in the Beaufort Sea since 1993. The current ITR for Beaufort Sea was issued August 3, 2011 (76 FR 47010). The ITRs have been successful in minimizing the effects of industrial activities on polar bears, while monitoring the levels of such interactions. In its Biological Opinion for the ITRs for year-round oil and gas exploration, development, and production activities in the Beaufort Sea and adjacent northern coast of Alaska, the USFWS noted that no lethal take of polar bears was anticipated and that only nonlethal incidental takes were considered (USFWS 2008g).

5.11.1 Methodology

Analyses for marine mammal habitat loss, alteration, and fragmentation were based on types of habitat used by marine mammals, their seasonal distribution and occurrence, and each species’ seasonal movement patterns. More specifically, impacts were based on predicted changes in the acreage or quality of habitats available for breeding, pupping/rearing, denning, feeding, and migrating. For this analysis, the study area includes tundra and coastal regions of the ACP and marine waters from Prudhoe Bay to the Canning River delta, extending 25 miles seaward and up to 20 miles inland. Potential impacts to marine mammals and their habitats from proposed alternative components include:

- Habitat loss due to construction of project components
- Displacement from habitat, most often caused by disturbance from noise and/or human activity
- Impacts to animal movement patterns and land use resulting from project features bisecting available habitat (fragmentation)
- Land/ice vehicle and ocean vessel collision injury or mortality
- Altered survival and/or productivity related to:
    - Changes in predator and prey abundance, distribution, feeding strategies, and predation risks
    - Exposure to garbage, spills, and leaks of toxic materials (discussed in Section 5.24, Spill Risk and Impact Assessment)

Impacts for both habitat loss and alteration were quantitatively evaluated. Potential habitat loss was estimated by using individual project alternative footprints for construction-, drilling-, and operation-related actions. Estimates for acreage of habitat alteration include those areas potentially impacted by project noise and activity, generally adjacent to areas of lost habitat. Other related parameters and quantitative data used to numerically assess impacts included:

- Estimated density of ringed seals in the study area based on current best available data (Moulton et al. 2002, Kelly et al. 2010)
- The density of polar bears based on USGS data from radio-tracking studies
- Estimated overlap of the study area and critical habitat designated for the polar bear (50 CFR Part 17, 75 FR76086-76136).

Impacts from the remaining three project mechanisms—fragmentation, vehicle and vessel collision risk, altered survival/productivity—were evaluated on a qualitative basis, specific to each of the individual alternative's suite of components.

Each of these five impact categories are discussed below, while the impact criteria table (Table 5.11-1) provides an assessment of the intensity levels for impacts to marine mammals. Impact evaluation criteria were developed for marine mammals based on methodology described in Section 4.1, Impact Determination Methodology.

5.11.1.1 Habitat Loss and Alteration

Habitat loss is defined as the medium or long-term destruction or conversion of habitat from construction of a permanent (e.g., gravel road, barge facility, or gravel airstrip) feature or other project action. For marine mammals, permanent habitat loss impacts would result from inland gravel roads, pipelines, and facilities construction and use (polar bear). Estimates of habitat loss for polar bears are based on reductions in the acreage of designated critical habitat from construction of gravel features included in the alternative scenarios.

Habitat alteration is defined as short-term changes in habitats from seasonal construction of ice infrastructure. Seasonal habitat alteration would occur due to winter construction of sea ice features (polar bear and ringed seal). Estimates of habitat alteration for polar bears are based on seasonal reductions in the acreage of designated critical habitat from construction of ice features included in the alternative scenarios. Habitat alteration estimates for ringed seal are limited to the overlap between the footprint(s) of the proposed sea ice roads or airstrips with suitable seal lair habitat (i.e., landfast ice with marine waters greater than 10 feet deep).

5.11.1.2 Behavioral Disturbance and Displacement

The analysis for habitat alteration includes areas of increased noise or human activity that could lead to behavioral disturbance or displacement of individuals (typically an area adjacent to an activity such as aircraft overflights, ice road construction and use, gravel road construction and use, and vessel traffic). For example, estimates of disturbance or displacement for polar bear would be related to proximity of activities to designated critical habitat that could cause a change in behavior (avoidance of an activity or area).

The soundscape of the Beaufort Sea has been extensively studied since the 1970s. Many studies have focused on the impacts of petroleum exploration and production noise sources on protected species, particularly the endangered bowhead whale. For noise analyses, and as noted in Section 3.20.2, acoustic monitoring data collected at Northstar is considered to be the best available data for the region due to the shallow-water nature of both locations. Behavioral monitoring studies conducted at Northstar are also considered to be the best available data for comparison purposes for impact assessment analyses for marine mammals, even though Northstar is a man-made, gravel island offshore of the barrier islands and the Point Thomson study area is closer to shore and inshore of barrier islands.

Behavioral disturbance or displacement was evaluated by using relevant distances from the applicable proposed activities and features. These distances were based on previously established mitigation parameters (in North Slope/Beaufort Sea environmental documents) for marine mammals. The quantitative data (buffers) and rationale used to numerically assess alteration impacts include:

1. Estimated loss in potential ringed seal lair habitat after applying a disturbance/displacement buffer along proposed sea ice roads and/or a sea ice airstrip. Potential disturbance or displacement of ringed seals was considered likely within 330 feet of proposed sea ice features that also overlapped with potentially suitable lair habitat (Harwood et al. 2007). For this EIS, suitable seal lair habitat is defined as marine waters more than approximately 10 feet deep. Water less than 10 feet deep is not typically used by ringed seals as it freezes to the sea bottom during the winter/spring lair-building season (Link et al. 1999).

2. Potential disturbance of cetaceans and pinnipeds was considered possible from aircraft overflights within 1,500 feet of an animal(s). Bowhead, beluga, and gray whales, as well as seals, may be disturbed by small low-flying aircraft (Richardson et al. 1995, Patenaude et al. 2002; Born et al. 1999).
3. Estimated habitat loss and alteration in potential polar bear denning, foraging, and migration habitat was considered after applying a 820-foot buffer around ice and gravel roads, airstrips, pads, pipelines, and other project features. All designated polar bear critical habitat was considered in this analysis. Because little is known regarding polar bear reactions to human activities, this parameter is based on data that reported instances of denning polar bears changing their behavior in response to vehicle activity at distances of 820 feet (USFWS 2008g, h).
4. Estimated disturbance in polar bear critical habitat (due to aircraft disturbance or displacement) after applying a 0.25 mile (1,320 feet) buffer along anticipated flight paths for aircraft traveling from the Deadhorse airport to Point Thomson helipads and airstrips. This buffer distance is based on data indicating that remediation activities on Flaxman Island, approximately 0.25 and 0.5 mile from two active dens, had no observable impact to bears (see USFWS 2008g h).

5.11.1.3 Habitat Fragmentation

Habitat fragmentation was assessed qualitatively. Fragmentation would be caused by a project alternative feature(s) that bisects a habitat, thereby potentially reducing its quality and contiguity, as well as potentially impacting animal movement patterns (e.g., barge route or ice road). Assessment was based on documented species behavior, sensitivity to the feature (e.g., ability or lack thereof to move over or under component), mobility of individual animals, and marine mammal habitat-use patterns.

5.11.1.4 Land/Ice Vehicle and Vessel Collision Injury or Mortality

Potential injury to or mortality of marine mammals due to collisions with land- or ice-based vehicles was qualitatively evaluated. Assessment was based on documented species behavior, sensitivity to the activity, mobility of individual animals, and marine mammal habitat-use patterns relative to the frequency, seasonality, and locations of vessels and ice- and land-based vehicles.

5.11.1.5 Altered Survival and/or Productivity

Potential project impacts on the survival and/or productivity of marine mammals were qualitatively assessed. Examples of potential consequences of project-related activities that could affect survival and productivity include increased stress from disturbance, changes in prey availability, increased risk of death to polar bears attracted to human garbage areas and potentially killed for safety reasons, and toxic spills impacting animal health. The impact assessment was based on results of related available studies, sensitivity of animals, their natural history and habitat-use patterns, and mitigation.

5.11.1.6 Impact Criteria

Impacts are defined by their anticipated level or intensity based on magnitude, duration, potential to occur, and geographic extent. Table 5.11-1 defines the criteria as it is used for assessing impacts to marine mammal populations occurring in the Point Thomson study area and vicinity.

Table 5.11-1: Impact Criteria—Marine Mammals

Impact Category[a]	Intensity Type[a]	Specific Definition for Marine Mammals
Magnitude	Major	Potentially affecting ≥25% of a local marine mammal population, or ≥ 5% of a Beaufort Sea marine mammal population
	Moderate	Potentially affecting ≥5% but < 25% of a local marine mammal population, or ≥1% but < 5% of a Beaufort Sea marine mammal population
	Minor	Potentially affecting < 5% of a local marine mammal population, or < 1% of a Beaufort Sea marine mammal population
Duration	Long term	Lasting ≥ 5 denning seasons or seasonal migrations
	Medium term	Lasting ≥ 2 denning seasons or seasonal migrations but < 5 breeding seasons or seasonal migrations
	Temporary	Lasting < 2 denning seasons or seasonal migrations
Potential to occur	Probable	No avoidance possible
	Possible	Potential to occur (may be able to mitigate)
	Unlikely	May occur, but unlikely to occur
Geographic Extent	Extensive	Impact would extend throughout the study area and beyond[b]
	Local	Impact would occur within the study area[a]
	Limited	Impact would occur within 2.5 miles of project components

[a] Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology.

[b] Study area defined as the ACP and marine waters from Prudhoe Bay to the Canning River delta, extending 25 miles seaward and up to 20 miles inland.

5.11.2 Alternative A: No Action

The No Action Alternative, as described in detail in Chapter 2, involves suspension of hydrocarbon resources production at Point Thomson. The two production wells located on the existing PTU-3 pad were capped and all other equipment and camp structures were demobilized in 2011. Future activities at the site would be limited to wellhead monitoring and inspection until the time that they are closed or brought into production in a future project. Actions related to maintenance could include periodic access of existing pads by helicopter from Deadhorse.

Depending on timing of flights to Point Thomson, monitoring of the capped wells could affect marine mammals and their habitats through long-term but infrequent disturbance. Flights for monitoring purposes would likely occur infrequently (no more than four times per year). Polar bears using the area between Deadhorse and the PTU-3 pad would be the most likely marine mammal disturbed by overflights during well monitoring.

5.11.3 Alternative B: Applicant's Proposed Action

Alternative B could impact marine mammals by placement of structures in the environment and through activities associated with construction, drilling, and operations (e.g., noise and other potential impacts associated with pile driving, vessel traffic). Some of the prominent project features that would be anticipated to impact marine mammals are: gravel roads, pads, and airstrip; seasonal tundra and/or shorefast sea ice roads; barge service pier and sealift facilities; a gravel mine site; infield gathering pipelines and an export pipeline; and an emergency response small-vessel gravel launching ramp. Once these types of physical habitat changes occur, many would continue through drilling and the operational lifespan of the project, although some would decrease in magnitude after construction.

Three phases—construction, drilling, and operations—are proposed for each of Alternatives B, C, D, and E and, for many features, different levels of impact on marine mammals and related habitat would occur as the project proceeds through these phases. While these phases are discussed separately, drilling would begin during construction and extend into operations (see Chapter 2 for proposed sequencing), thus some impacts could be increased during these periods when multiple activities are occurring. These impacts and their severity are discussed by phase for each of the action alternatives.

5.11.3.1 Alternative B: Construction

Construction of Alternative B could impact marine mammals and their habitats by:

- Habitat loss and alteration from construction of three proposed and expanded gravel pads, gravel pit and fill stockpile, gravel airstrip, and barge landing structures. More specifically, polar bear critical habitat could be physically lost or seasonally altered by construction of these project features.
- Seasonal habitat loss and alteration from ice roads that may be constructed during multiple years (polar bears and few ringed seals; Table 5.11-2).
- Disturbance and displacement of polar bears and some ringed seals during winter dredging and pile driving during construction of barge facilities.
- Habitat fragmentation resulting in potential change of movements near the proposed new construction of the barge offloading facility including mooring dolphins and bulkheads (most likely polar bears and some ringed seals).
- Habitat fragmentation resulting in possible change of movements across the new terrestrial tundra gravel airstrip and new or expanded gravel pads (polar bears).
- Minor risk of collision with sealift barges (and to a lesser degree, coastal barges) during the open-water season (bowhead, beluga and gray whales, and ringed, bearded, and possibly spotted seals) and with vehicles on sea ice roads during winter construction periods (possibly polar bears and ringed seals).
- Possible change of movements during the open-water season from temporary barge bridges that would be used at the sealift facility (possibly bowhead, beluga and gray whales, and ringed, bearded, and possibly spotted seals). Over the construction period (3 years), up to 170 coastal barges and 10 sealift barges would dock at Point Thomson facilities during the summer barge seasons (Appendix D, RFI 55).
- Possible disturbance of polar bears and some ringed seals during round trip flights to transport crew and equipment during construction; helicopters would be used while the gravel airstrip was under construction, with fixed-wing aircraft used after the airstrip was operational (up to approximately 990 round trip flights each of helicopter and fixed-wing aircraft).

Habitat Loss and Alteration

As described in the bulleted list above, construction of Alternative B would result in loss of terrestrial tundra habitat primarily due to placement and extraction of gravel for roads, pads, and an airstrip (see Table 5.11-2). These losses would primarily impact polar bear critical habitat and are not expected to impact ringed seals and their preferred sea ice habitat. The one exception may be shoreline habitat that would be lost or altered during construction of the new coastal barge service pier and adjacent sealift barge facility. However, this area would be less than 3 acres (for both structures) and located in shallow water, therefore it would have little to no impact to ringed seal preferred habitat and is a very small percentage of total polar bear critical habitat.

Seasonal (winter) ice roads would also alter ice conditions along the footprint from approximately December through March or early April when polar bears are active or denning in the area. The ice road may be built on tundra or sea ice. During years in which a sea ice road is built, there is also the potential for impact to a small numbers of ringed seals that occur in the area.

Table 5.11-2: Alternative B—Polar Bear Habitat Loss and Alteration; Polar Bear Disturbance and Displacement

Structures/Roads	Area (acres)
Habitat Loss: Designated polar bear critical habitat from construction of gravel project features	390
Habitat Alteration: Designated polar bear critical habitat from construction of seasonal project ice features	985
Disturbance and Displacement: Area around permanent project features (820-foot buffer)	3,226
Disturbance and Displacement: Area around seasonal ice project features (820-foot buffer)	26,563
Disturbance and Displacement: Flight path from Deadhorse (1,320-foot buffer)	17,312

As proposed, none of the Alternative B sea ice road footprint would effect suitable ringed seal lair habitat as ice roads require grounded ice (shorefast ice that freezes to the seafloor due to shallow depths of under 10 feet deep) for stability, and ringed seals do not use grounded ice areas. For the short term, polar bears may lose a minor amount of potentially suitable den habitat, yet this temporary loss would only affect a small number of polar bears based on previously identified den sites in the study area (Table 5.11-2).The total estimated acreage of polar bear critical habitat that would be seasonally altered by ice roads or potentially disturbed by human-caused activities along these same footprints under Alternative B is anticipated to be low (Table 5.11-2). Less than one percent of the 200,541 square miles of polar bear critical habitat could be physically lost or seasonally altered by construction of Alternative B project features. In addition, MMPA and ESA regulatory requirements, such as avoiding construction within 1 mile of known polar bear den sites (as required by USFWS; 75 FR 29925), would minimize impacts to individual polar bears.

Behavioral Disturbance and Displacement

Construction activities under Alternative B that have the greatest potential to disturb marine mammals (e.g., bowhead and beluga whales, ringed seals, and polar bears) are vehicle and aircraft overflight traffic, construction activities at the barge offloading facilities, barge traffic, ice road, and pipeline construction. Project activities would disturb marine mammals if they cause a change in behavior or stress in the animals. Some project activities could cause animals to avoid an area or be completely displaced from an area. Table 5.11-2 shows the area of potential disturbance to polar bears from Alternative B infrastructure and overflights.

Terrestrial Vehicles and Aircraft

Vehicle traffic between Deadhorse and Point Thomson would occur during winter on the sea or tundra ice road. Infield vehicle traffic and air traffic would occur year round.

During winter ice road construction and use, female polar bears would be denning in the project area, while adult males, nondenning females, and immature polar bears would be foraging or may take shelter during storms. For most of the year, polar bears do not appear to be very sensitive to noise or other human disturbances (Amstrup 1993, Richardson et al. 1995). However, pregnant females and those with newborn cubs in maternity dens, both on land and on sea ice, may be more sensitive to noise and vehicular traffic (Amstrup and Gardner 1994). Available data do not provide documentation of any incidental collisions of polar bears with such vehicles. In general, bears that have not been previously food-conditioned to human presence would be expected to avoid close interactions with moving vehicles given their mobility and the noise of the vehicles. Therefore, disturbance impacts from ice roads to polar bears would be minor and temporary.

Aircraft produce noises that are well within the frequency range of marine mammal hearing and also create visual signals from the aircraft itself and its shadow (Richardson et al. 1995; Section 5.20, Noise). While design measures would be implemented to minimize disturbance to marine mammals (i.e., flying at higher altitudes and avoiding direct overflights of animals; See Section 5.11.7), weather and/or operational needs may require changes in altitude and/or flight paths, thereby, affecting marine mammals. Airborne or waterborne noise from aircraft is the most apparent reason for response by marine mammals. A number of factors influence the levels and durations of sounds received by marine mammals below the water surface from an overflying helicopter or fixed-wing aircraft. These include the type of aircraft and its engine size, aircraft proximity and orientation (i.e., heading toward or away), current sea state (e.g., level of water turbulence), water depth, and the depth of the animal below the water surface. In addition, sound levels heard under water decrease with increasing altitude of the aircraft. Generally, helicopters are noisier than fixed-wing aircraft of comparable size.

Behavioral reactions of marine mammals to overflying aircraft are influenced by factors, including the behavioral state of the animal(s), group size, habitat type, and the flight pattern (Richardson et al. 1995). Marine mammal responses are discussed below by taxonomic groups (pinniped, cetacean, and polar bear).

Pinnipeds from areas subjected to strong, naturally-occurring noises, such as crashing icebergs, were reported to be more tolerant of aircraft disturbance and habituated sooner than did seals from more quiet environments. However, pinnipeds hauled out for pupping or molting are often more sensitive to aircraft disturbance (Richardson et al. 1995). Previous studies have shown only minor responses by hauled out ringed seals to survey-plane flights performed at 300 feet (Richardson et al. 1995, Born et al. 1999), although helicopters appear to elicit more of a response than fixed-wing aircraft (Kelly et al. 1986, Blackwell et al. 2004a). There are few observations of the reactions of pinnipeds in the water to aircraft. Overflights at low altitudes may cause some animals to alter their behavior (i.e., dive or enter water if hauled out), but are very unlikely to have long-lasting or biologically important effects (Richardson et al. 1995).

Toothed whales show variable reactions to aircraft, probably related to past experience and behavior at the time of previous overflights (Richardson et al. 1995). Observed reactions of beluga whales to aircraft in the Beaufort Sea are also variable (Richardson et al 1995; Patenaude et al. 2002). Some beluga whales showed no reaction to airplanes or helicopters at 330 to 670 feet altitude, while others dove abruptly or swam away in response to overflights at altitudes of up to 1,500 feet (Patenaude et al. 2002). Beluga whales did respond more frequently to the helicopters than to the fixed-wing aircraft (Patenaude et al. 2002).

Reported baleen whale responses to overflying aircraft indicate that responses are variable and likely related to behavior state (e.g., feeding, migrating, or socializing), group size and composition, individual experience, and water depth, among other factors (Richardson et al. 1995). Bowhead whales reacted to aircraft overflights at altitudes of 500 to 1,000 feet by diving, changing dive patterns, or leaving the area (Richardson et al 1985; Patenaude et al. 2002). Reported gray whale reactions to aircraft also varied and seemed related to ongoing whale behavior and aircraft altitude (Moore and Clark 2002). Gray whales sometimes react to aircraft overflights at altitudes less than 1,300 feet (Ljungblad et al. 1983, SRA 1991, Clarke et al. 1989). Reactions by gray whale mother/calf pairs to a turboprop aircraft in the Chukchi Sea included abrupt turns, dives, a mother covering the calf with her body, or the calf swimming under the mother (Ljungblad et al. 1983). It should be noted that some of the before-mentioned responses to aircraft and helicopters involved repeated overflights or circling over the whales. Bowhead whale responses to single straight-line overflights are generally brief and probably of no lasting import if they are not repeated frequently (e.g., Patenaude et al. 2002).

Polar bears on the ground or ice are most likely to see and hear overflying aircraft, as the noise is audible for much greater distances in air than in water. Potential exposure levels of various industry noise sources (including aircraft) on denning polar bears is of concern due to possible den abandonment. Pregnant females or females with young might die if a disturbance caused abandonment of a den in mid-winter. However, they were more likely to be displaced by disturbance in the early part of a denning season (early winter), before the birth of cubs, therefore there will be less impacts associated with den abandonment (Amstrup 1993, Linnell et al. 2000). Polar bears might also be exposed to noise disturbance when they are in the water. They typically swim with their heads above the water surface (USFWS 2008g) and would hear (and possibly see) the aircraft, while also being exposed to underwater noise when diving below the surface while hunting.

Behavioral reactions of polar bears to aircraft depend on distance and type of aircraft (USFWS 2008g). Reactions can range from no noticeable response to nearby operating aircraft (including examples of denning females) to running away when seeing an aircraft or hearing a noise (Amstrup 1993, USFWS 2008g). Amstrup (2003) noted that polar bears appear very tolerant of aerial (and ground) traffic very near maternal dens in winter and spring. Studies at Flaxman Island of industrial noise and vibration in artificial polar bear dens intended to mimic natural dens have also provided data for noise detection by denning polar bears. The artificial dens were found to be very good at reducing noise exposure, decreasing low frequency noise (50 Hz) by 25 dB and high-frequency noise (1000 Hz) by up to 45 dB (MacGillivray 2002, 2009). Blix and Lentfer (1992) observed that a helicopter would need to take off within a distance of 10 ft to produce noticeable noise levels (above ambient levels) inside of dens. However, MacGillivrary et al. (2009) suggested that helicopters may be detectable in dens at much greater distances than suggested by Blix and Lentfer (1992). The Flaxman Island studies also concluded that a denning polar bear is unlikely to feel vibrations unless the source is very close (MacGillivray 2002, 2009).

In summary, as noted by USFWS (2008g), behavioral reactions of nondenning polar bears to aircraft should be limited to short-term changes in behavior, resulting in no long-term impact on individuals and no impact on the general polar bear population. In contrast, denning bears may abandon or depart their dens early in response to repeated noise such as that produced by extensive aircraft overflights. Repeated den abandonment, resulting in lower cub survivorship, may have negative impacts to the SBS polar bear population. However, few dens have been recorded within the project area and design measures, including conducting FLIR surveys to identify dens and maintaining a 1 mile buffer around known dens, will reduce the risk of den abandonment. The USFWS (2008g, 2011b) notes that routine and occasional aircraft traffic should have little to no effect on polar bears;

however, the report also states that extensive or repeated overflights of fixed-wing aircraft or helicopters could disturb polar bears.

Barge Facility Construction

Construction of the proposed barge offloading facilities would impact marine mammals and their coastal habitat (e.g., sediment disturbance and increased presence of humans) via dredging and pile driving, and would produce underwater noise audible to species anticipated to occur in the area. Dredging and screeding is scheduled to occur in the winter as part of construction of both the coastal barge pier and adjacent sealift facility. None of the identified Beaufort Sea whale species are expected to be in the study area during these winter months (see Section 3.11, Marine Mammals). Bowhead and beluga whale occur commonly offshore of the barrier islands only during the spring and fall migrations. Polar bears (denning females and mobile nondenning individuals) and an occasional ringed seal are the only marine mammals expected in the study area during the winter.

Maintenance of the barge facilities during the construction phase may require minimal summer dredging and/or screeding. Maintenance screeding would move up to 800 cubic yards of seafloor material during regular operations. During these open water months, bowhead and beluga whales and the occasional ringed seal may be within the vicinity of the project area. Noise disturbance associated with dredging and/or screeding activities is expected to be minor and limited only to periods when dredging/screeding occurs. Sediment resuspension during dredging would be of minor to no impact as activities would occur during winter in nearshore areas where ice is grounded; thus, turbidity is not expected to be an issue at that time. The proposed disposal site for dredged material would not likely affect marine mammals. This project would not be likely to contribute substantially to seasonal marine turbidity associated with break-up (see Section 5.7, Water Quality).

Dredging does produce broadband and continuous sound, primarily at low frequencies (below 1 kHz) with source sound pressure levels (SPL) of 160 to louder than 180 dB re 1 µPa at 1 m (Greene et al. 1987, Richardson et al. 1995). Research has found that dredging noise travels over a long distance in water, keeping in mind that most dredging-related research has been conducted during summer months. For example, in shallow waters of the Canadian Beaufort Sea, the overall noise (20- to 1000-Hz band) from most drilling and dredging operations would be at levels below the median ambient noise (SPL of 99 dB) at ranges of over 18 miles, based on data collected at that time (Greene et al. 1987). Looking at these relatively high SPLs, dredging noise has the potential to impact marine mammals by inducing adverse behavioral reactions and by causing physiological damage. Previous studies indicate that dredging can trigger avoidance reactions in some marine mammals (e.g., Richardson et al. 1995). Yet, Blackwell et al. (2004b) commented on the apparent tolerance by ringed seals to dredging noise at the Northstar facility, approximately 37 miles northwest of the study area.

Another source of marine noise, pile-driving, would occur in coastal sea ice over shallow depths of less than approximately 7 feet MHW in Lion Bay during winter using vibratory and/or impact pile-driving techniques. Pile-driving to construct the coastal barge service pier and adjacent sealift facility, and install associated dolphins and piles, is likely to be one of the noisiest underwater/in-ice on-site activities of this project. Pile driving in or near water is known to produce strong underwater noise levels (e.g., Greene and Moore 1995, Blackwell et al. 2004a). The level of received sound at any specific distance from pile-driving depends on the water (or ice) depth in which the piles are driven, the density or resistance of the substrate, bottom topography and composition (e.g., mud, sand, rock), the physical properties and dimensions of the pile being driven, and the type of pile-driver that is used (Richardson et al. 1995, Greene 1999, Blackwell et al. 2004a).

Possible impacts to marine mammals exposed to loud pile-driving noise could include disruption of normal activities, and in some cases, temporary or longer displacement from areas important for feeding and/or reproduction. Short-term changes in activity budgets that reduce feeding time could reduce energy acquisition.

The energetic consequences of one or more disturbance-induced periods of interrupted feeding have not been evaluated quantitatively. Energetic consequences would depend on the availability of suitable food.

While unlikely, winter dredging and pile-driving noise under Alternative B could impact a small number of ringed seals. However, these activities would occur in shallow coastal areas where the sea would be frozen and sea ice grounded, therefore occurring in areas already unsuitable for ringed seals. Large blocks of ice would be cut and removed from the sealift construction footprint to allow dredging. Because the water would be frozen, disturbance of bottom sediments resulting in turbidity would be minimal.

In addition, a small number of nearby foraging polar bears could be temporarily disturbed and displaced from a limited geographic area by winter construction of the barging facilities via in-air noise and increases in local human activity. Potential disturbance effects of general construction activities at the barge facilities on polar bears would be similar to those described above under terrestrial vehicles and aircraft.

Barging

Coastal and sealift barging operations are proposed for the open-water season. The route for coastal barges would be inshore of the barrier islands, while sealift barges would transit further offshore. Figure 3.17-4 shows the approximate routes of coastal and sealift barges. Water disturbance caused by ships towing or pushing objects can create strong underwater sound at frequencies audible to cetaceans and pinnipeds underwater (see Section 5.20, Noise; Austin and Hannay 2010). However, barging would occur in areas and periods of relatively low marine mammal densities. For example, during July, most bowhead and beluga whales are foraging east or northeast of the study area, and ringed seals tend to occur farther offshore, near the pack ice edge. In addition, the Applicant would comply with the Conflict Avoidance Agreement which includes protocols for avoiding and minimizing interactions between project barges and subsistence whaling activities. Thus, possible disturbance effects would be limited to a minor number of individuals in a limited area, most likely ringed seals and possibly small numbers of bowhead and beluga whales during the fall migration.

Responses of marine mammals to vessels, such as the barges, are variable based on taxonomic group and related to a number of factors including sound characteristics of the vessel, its movement pattern and the activity of the animal. While studies of the effects of vessels on pinnipeds are limited, the industry monitoring program in the Chukchi and Beaufort seas has recorded some observable seal reactions to vessels. Yet, most seals display no discernible reaction to vessel operations in either the Chukchi or Beaufort seas (AOGA and API 2011). Most cetaceans avoid close interactions with vessels though some may approach them (Richardson et al. 1995). Typical responses to vessels involve short-term behavioral changes including changes in respiration rates, dive times, and movement patterns. Numerous studies around the world have documented whale avoidance of vessels (see Richardson et al. 1995 for a detailed review of the pre-1995 literature). However, whales that are actively engaged in behaviors such as feeding may be less likely to respond to approaching vessels (Laist et al. 2001). In the Beaufort Sea, most bowheads begin to swim away when vessels approach rapidly and directly (as reported by Richardson and Malme 1993), with avoidance behavior usually initiating when a rapidly approaching vessel is 0.62 to 2.5 miles away (Koski and Johnson 1987; Richardson and Malme 1993). Bowheads are often more tolerant of vessels moving slowly, such as barges, or in directions other than toward the whales (Richardson and Malme 1993). After some disturbance incidents, at least some bowheads return to their original locations (Richardson and Malme 1993; Richardson et al. 1995).

There is little documented information on polar bear responses to vessel traffic. Available data indicate that polar bear responses to vessels tend to be variable and include approaching, ignoring, and avoiding the vessel. The USFWS (2008g) reported that polar bears often run in response to sources of noise and sight of vessels. During the open-water season, most polar bears remain offshore in the pack ice and are not typically present in the area of proposed barge traffic. Barges and vessels associated with industry activities travel in open-water and avoid large ice floes. If there was any encounter between a vessel and a bear, it would most likely result in short-term behavioral disturbance (USFWS 2008g).

Habitat Fragmentation

Minor habitat fragmentation effects could occur during construction of the sea ice road during winter. Movement of nondenning polar bears along the coastline during winter and across tundra habitats year round could be altered because of the construction of gravel and ice infrastructure, aboveground pipelines, barge facilities and buildings on pads. Construction activities and the unfamiliar structures could induce individuals to avoid or move around these areas throughout the year to a greater extent than under existing conditions. However, polar bears would likely habituate to the new structures given their apparent tolerance to human-related activities and ability to habituate to it (USFWS 2008g, f). As stated previously, ice roads will be constructed in areas that are not suitable ringed seal habitat. Therefore, habitat fragmentation due to ice roads would only occur for the few individuals that may enter the project area, resulting in a negligible impact to the ringed seal population.

Vehicle and Vessel Collision Injury or Mortality

It would be highly unlikely that ice/gravel road vehicle or barge collision injury or mortality would occur to marine mammals, including polar bears, under Alternative B. However, the chance of collisions of bowhead and beluga whales with barges would be higher during construction than operations, because up to ten times more barges would travel to and from Point Thomson during the construction period than during subsequent drilling and operations.

Vessels

Wherever vessels and marine mammals share the same waters, the risk exists for a ship-marine mammal collision resulting in injury or mortality to the individual(s). The probability of collision differs between species (due to differences in hearing sensitivities, swimming speeds, and maneuverability), varies within species based on behavioral state of individual animals (i.e., feeding, resting, socializing) before a vessel moves into an area, and depends on the vessel (based on its type, speed, and maneuverability).

A direct relationship exists between the number and speed of ships, and the severity of vessel/whale collisions (Jensen and Silber 2004). Approximately 1 percent of the bowhead whale population shows scars from collisions with vessel propellers, yet it is unlikely that these scars were produced by barges (George et al. 1994). Barges tend to be slow moving (<10 knots) and Laist et al. (2001) determined that serious injuries to whales rarely occur in incidents involving vessels traveling at speeds of less than 10 knots. Barges are not capable of making fast changes in speed or direction, however the Applicant has committed to including marine mammal observers on barges in arctic and subarctic waters to spot marine mammals and direct the vessel captain to make speed and course corrections to avoid collisions with animals (see Section 4.4, Avoidance, Minimization, and Mitigation and Section 5.11.7, Mitigative Measures). In addition, the proposed barge route would follow the route chosen in coordination with a Conflict Avoidance Agreement between the Applicant and the Alaska Eskimo Whaling Commission to avoid whale migration and typical subsistence whale hunting areas (see Section 5.22, Subsistence and Traditional Land-Use Patterns).

Due to their small size, relative to vessels, and their high maneuverability, it is highly unlikely for a pinniped to be struck by a vessel. In general, during the open-water season in the study area and vicinity, ringed seals tend to be found in the water in small groups (one or two animals). Therefore, potential for vessel interactions with large seal aggregations would be extremely rare. Similar to pinnipeds, large polar bear aggregations in the water are rare and polar bears are maneuverable enough to avoid collisions with vessels, especially slow moving barges. A vessel strike would be highly unlikely to occur for polar bears.

The Applicant conducted barging operations during its 2009-2011 drilling program. Marine mammal observers were aboard all barges and recorded marine mammal sightings. The Applicant submitted reports to the NSB for each year of the drilling program (ExxonMobil 2009d, 2010e). During the reporting period from November 1, 2008 to October 30, 2009 barge operations reported polar bear observations at West Dock and at Cross Island and whale observations at a distance; no seal observations were reported. During the reporting period from November 1, 2009 to October 28, 2010, the Applicant conducted 28 round trip barge transits between West Dock and Point Thomson between July 25 to August 24 and September 22 to October 1 (barging activities were suspended during the whaling season). During barging MMOs observed approximately 50 seals and no whales, walrus, and polar bears. Of the seals recorded, one was noted as "escape diving." Behaviors noted for the other observations did not indicate disturbance from barge activities.

Vehicles

Ice road vehicle collision injury or mortality would be highly unlikely to impact marine mammals, as a result of Alternative B construction activities. The species with minimum potential for vehicular traffic collisions are ringed seals and polar bears. While monitoring studies for the Northstar and Liberty projects suggested minor effects on ringed seals from ice road construction (Richardson and Williams 2000, Harris et al. 2001), ice roads for this project would be preferentially located in areas where the ice is grounded, thus unsuitable for ringed seals that prefer shorefast ice with underlying unfrozen water access (see Section 3.11, Marine Mammals). While unlikely, it is possible for a few ringed seals to enter the project area but, studies have shown that individuals, including breeding females, observed in proximity to offshore industrial activities did not react noticeably to either construction or drilling-related noise, or the presence of vehicles on ice roads (Blackwell et al. 2004a, Moulton et al. 2005, Harwood et al. 2007). Additionally, most ice road construction equipment would be relatively slow moving thereby reducing the risk of collision. Reduced driving speeds would also decrease the occurrence of a polar bear collision with construction vehicles.

Altered Survival or Productivity

While there is a low probability of directly affecting cetaceans or pinnipeds, changes in prey abundance and/or distribution may indirectly affect foraging whales and seals. Fish and invertebrates would most likely be affected by the construction of the barging facilities and the presence of the barge bridge. However, the barge bridge is only a temporary structure (2 to 4 weeks) and studies suggest that the barge facilities are not anticipated to have any affect on fish presence within the project area (See Section 5.12, Fish, Essential Fish Habitat, and Invertebrates). Therefore, there would be no population level affects to cetacean or pinniped survival or productivity.

The species most likely to have altered survival or productivity because of the proposed project is the polar bear. Construction activities under Alternative B would increase the level of human-polar bear interactions. Polar bear productivity could be affected if noise from construction activities (such as extensive overflights) causes maternal bears to abandon their dens. If den abandonment occurs after the cubs are born, there is an increased risk of cub mortality which, after several years, may have negative population level effects. However, there have been few dens identified within the project area, and therefore, the potential for large-scale den abandonment is minimal. Human activities, particularly at the Central Pad, could increase the potential for polar bears to become food conditioned which could lead to the need to kill polar bears to defend human life. To minimize this potential, the Applicant has committed to storing food, garbage, sewage, and other waste in bear-resistant containers; prohibiting personnel from feeding wildlife; and using bear monitors at construction sites so that bears and humans can be kept apart (see Section 4.4, Avoidance, Minimization, and Mitigation and Section 5.11.7, Mitigative Measures).

Depending on the circumstances, bears may be repelled from or attracted to sounds, smells, or sights associated with onshore industrial activities. ExxonMobil's Polar Bear and Wildlife Interaction Plan describes procedures that the company's employees and contractors would follow to protect personnel, bears, and other wildlife. The Polar Bear and Wildlife interaction Plan for the Point Thomson Project (see Appendix M, Biological Assessment of the Polar Bear, Spectacled Eider, Steller's Eider, and Yellow-billed Loon [Appendix A of the BA]) stipulates monitoring and reporting of bear sightings and encounters by using trained observers, as well as by training personnel in non-lethal means of protection (deterrence and hazing). Although camps and other activity areas have the potential to attract polar bears, experience demonstrates that these risks can be mitigated effectively by following the interaction plan (e.g., with detection systems using bear monitors, motion/infrared sensors, and adequate lighting; safety gates, fences, and cages for workers, as well as skirting of elevated buildings; careful waste handling and snow management; chain-of-command procedures to coordinate responses to sightings; and employee education and training programs). All project operations must be conducted to minimize the attractiveness of the construction sites to polar bears and to prevent their access to food, garbage, or other potentially edible or harmful materials. Trained bear monitors would be present on site and all polar bear sightings would be reported immediately.

The USFWS also issued voluntary deterrence guidelines (75 FR 61631) that include: (1) passive measures intended to prevent polar bears from gaining access to property or people (fencing, gates, skirting, exclusion cages, bear-proof garbage containers), and (2) preventive measures intended to discourage bears from interactions with property or people (acoustic devices for auditory disturbance, vehicle, or boat deterrence).

5.11.3.2 Alternative B: Drilling

Drilling would start towards the end of construction and would continue into the beginning of the operations phase at the Point Thomson project site.

Habitat Loss and Alteration

No additional permanent loss of habitat acreage is anticipated from the drilling phase of Alternative B. Seasonal habitat loss and alteration would increase during the drilling phase due to increased land transport to and from Point Thomson via sea ice or tundra ice roads for the mobilization, resupply, and demobilization of the drilling rig and related equipment.

Behavioral Disturbance and Displacement

Disturbance from coastal barge activity and land transport on ice roads would continue into the drilling phase. Although sealift barging activities are anticipated to end at the completion of the construction phase, coastal barging would continue to be used during drilling. Impacts from drilling activities would be similar to those discussed under construction (Section 5.11.3.1). Disturbance from ice road use would increase during the drilling phase and is expected and have the same types of impacts for the same species as discussed under construction (Section 5.11.3.1).

As part of Alternative B, there would be a potential for additional disturbance from noise produced by the drilling rig. This noise would be expected to spread both in-air and underwater, even though the drilling rig would be located on land (see Section 5.20, Noise). Sound transmission loss rates (i.e., attenuation) and received levels of drilling sound from the source are affected by a number of variables, including bottom substrate, composition of the material being drilled through, drill bit depth, water depth, frozen *vs*. unfrozen water, drilling characteristics, etc. (Richardson et al. 1995, Blackwell et al. 2004b). Acoustic monitoring and recording studies have been conducted for a number of years at various onshore and island oil and gas production facilities in the Beaufort Sea (Richardson et al. 1995; Greene 1997; Blackwell et al. 2004a, b). Blackwell et al. (2004b) recorded drilling (when the drill bit was boring through the ground) and production sounds (pumping of crude oil while injecting gas into the formations) at the Northstar facility located on an artificial gravel island inshore of the barrier islands near Prudhoe Bay, roughly 60 miles west of the Point Thomson area. Underwater (below the ice), in-air, and ice-borne vibration sounds produced during drilling and oil-production activities were recorded on five winter days when the island was surrounded by shorefast ice 4.5 to 8.2 feet thick. The highest underwater broadband (10-10,000 Hz, but mainly 700-1400 Hz frequencies) levels were associated with drilling sounds (maximum SPL = 124 dB re:1 µPa at 1 km). Conversely, broadband levels in air and ice mediums did not increase during drilling relative to levels measured during other industrial activities at the Northstar facility. Furthermore, broadband levels during production did not increase for any of the sensors. In-air sounds dropped below ambient noise levels about 3 to 6 miles from Northstar, while underwater sounds dropped below ambient levels 1 to 6 miles from the Northstar facility; both measures were affected by wind, but not drilling sounds. Therefore, it is possible that winter drilling and production noise may travel through ice and water below the ice for at least several miles before dropping below ambient levels.

Human-related noise and activity disturbance associated with year-round drilling and drilling equipment mobilization and removal activities could cause medium-term disturbance of a minor number of marine mammals in a limited area near these activities. Underwater noise may cause temporary disturbance to cetaceans and pinnipeds similar to effects mentioned for construction (Section 5.11.3.1). In-air noise may be of concern for polar bears, especially while denning. However, based on current data, no polar bear dens have been found within 1 mile of the proposed drilling activities and studies have shown that dens provide adequate sound insulation (MacGillivray et al. 2002). Therefore, noise from drilling would not be expected to negatively affect denning polar bears.

Habitat Fragmentation

No additional potential for habitat fragmentation or blockage of movements would be expected in association with drilling under Alternative B beyond what was previously described under construction (Section 5.11.3.1). However, traffic levels on in-field roads would be increased when the rig is active on the East and West Pads.

Vehicle and Vessel Collision Injury or Mortality

Mobilization, resupply, and demobilization of the drilling rig by using the ice or gravel roads would contribute additional road traffic, yet it is unlikely that a collision with polar bears or ringed seals would occur. A substantial decrease in marine vessel traffic following the completion of the construction phase would reduce risk for collision with marine mammals, particularly cetaceans, in water.

Altered Survival or Productivity

Drilling camps located at the East and West Pads would increase the potential for human-polar bear interactions and for polar bears to become food conditioned. Design measures would be implemented to reduce human-polar bear interactions (see Sections 5.11.3.1, Construction, and 5.11.7, Mitigative Measures). The potential for altered survival or productivity of marine mammals from an oil spill is discussed under Section 5.24, Spill Risk and Impact Assessment.

5.11.3.3 Alternative B: Operations

Alternative B operations would affect marine mammals and their habitats through human activity and habitat fragmentation in the study area over the life of the project.

Habitat Loss and Alteration

No additional habitat loss or alteration is anticipated from the Operations phase of Alternative B. Land transport and vessel traffic levels would drop after completion of the drilling phase, but could still temporarily displace or disturb a minor number of marine mammals within the study area. Seasonal habitat alteration from land transportation on ice roads during winter (ice road construction and use) would be reduced during operations because ice roads would be constructed occasionally (about every 5 years). Coastal barge activities with associated people on foot during late-July to late-September could either disturb or possibly attract ringed seals as well as polar bears to the Central Pad. Fixed-wing aircraft overflights would increase and remain at an estimated level of 545 flights per year, but the more intrusive helicopter activity would drop to less than five trips per year. Types of impacts and species most likely to be affected remain similar to those discussed above under Sections 5.11.3.1, Construction, and 5.11.3.2, Drilling.

Behavioral Disturbance and Displacement

Disturbance to marine mammals from coastal barge activity would continue during operations, but the number of coastal barges per season would be reduced from the construction and drilling phases. Behavioral disturbance associated with land transport on seasonal ice roads would be decreased during operations because roads would not be built each year.

The primary noise that may disturb marine mammals during operations would be generated by the central processing facility. This noise would be a relatively constant noise located near the coast. The noise would not likely affect denning polar bears because dens would provide adequate sound insulation (MacGillivray et al. 2002). Noise from the central processing facility would not likely affect whales because of the barrier islands, wave activity, and the noise would likely bounce off the water surface and not enter the water surface where whales would most likely occur. Seals that swim near the Point Thomson facilities would hear the central processing facilities but would likely acclimate to the noise, similar to the acclimation documented at the Northstar facility (Blackwell 2004b).

Polar bears may be attracted to activities and smells at the Central Pad. By following the project's Polar Bear and Wildlife Interaction Plan and USFWS voluntary deterrence guidelines, negative affects on polar bears would be minimized.

Habitat Fragmentation

The potential for habitat fragmentation under Alternative B operations would be minor and limited; less than that described for construction and drilling phases due to less traffic on gravel roads and the elimination of all ice roads.

Vehicle and Vessel Collision Injury or Mortality

The potential for collisions with vehicles and marine vessels would likely be reduced during operations as compared to both construction and drilling due to a substantial reduction in personnel and traffic.

Altered Survival or Productivity

Impacts would be similar to those described under Section 5.11.3.1, Construction.

5.11.3.4 Alternative B: Summary of Impacts on Marine Mammals

Infrastructure and activities proposed for Alternative B could result in minor, temporary to long term habitat loss and disturbance effects on marine mammals and their habitats, most likely on polar bears and ringed seals.

The NMFS has previously concluded that oil and gas exploration, development, and production are not a threat to ringed and bearded seals (75 FR 77476, 75 FR 77496). The documented impacts to seals from such activities are limited to short-term, localized, temporary effects that have no apparent long-term effects on individuals and no detectable effect on seal populations (75 FR 77476, 75 FR 77496). Permanent loss of marine mammal habitat would be unlikely to occur. Direct collisions of ice-road vehicles or barges with marine mammals also would be unlikely to occur. Effects would be primarily linked to temporary disturbance events. However, the sources of disturbance would persist as long as drilling and operations continue. Individuals may become habituated to this ongoing activity, or may already be habituated given existing and past similar activities. A minor portion of marine mammal populations (primarily ringed seals and polar bears, and possibly bowhead and beluga whales and bearded seals) could be temporarily disturbed by year-round aircraft overflights and open-water, summer-fall barge use. The latter effects would be limited in geographical and temporal extent to close passes by the barge or aircraft. Overall impacts to each species discussed are summarized in Table 5.11-3 below.

Table 5.11-3: Alternative B—Summary of Potential Impacts to Species

Species	Potential Alternative B Impacts	Additional Comments
Bearded Seal	Aircraft and barge noise could cause temporary limited disturbance of a minor number of individuals during summer.	Occurs in smaller numbers than ringed seal in study area, only in summer, and primarily offshore beyond barrier islands. Prefers unstable broken sea ice.
Beluga Whale	Unlikely to impact. Barge noise/activity disturbance possible but unlikely during summer when species could occur in project area. Possible disturbance by aircraft operations.	Unlikely to be impacted by any of the activities because migration is seaward and offshore of barrier islands.
Bowhead Whale	Temporary localized barge/noise disturbance possible to minor number of individuals during the fall migration. Possible disturbance by aircraft operations.	Applicant a signatory to the Conflict Avoidance Agreement which will stipulate barge use during fall whaling season.
Gray Whale	Unlikely to impact. Barge noise/activity disturbance possible but unlikely during summer when species could occur in project area. Possible disturbance by aircraft operations.	Unlikely to be impacted by any project activities; species occurs typically in small numbers seaward and west of barrier islands.
Polar Bear	Designated polar bear critical habitat would be physically lost and seasonally altered by construction of project features over long-term. Potential disturbance from barging, aircraft overflights, ice-road and barge lift construction and pile driving, and vehicle and equipment use primarily during construction, but to lesser degree during drilling and operations. Vehicle-bear collisions unlikely.	—

Table 5.11-3: Alternative B—Summary of Potential Impacts to Species		
Species	Potential Alternative B Impacts	Additional Comments
Ringed Seal	Construction could temporarily alter potentially useable winter ice habitat. Localized habitat fragmentation effects unlikely during winter construction of shorefast ice road. Potential disturbance from barging, aircraft overflights, ice road, and barge lift construction and pile driving, and vehicle and equipment use primarily during construction, but to lesser degree during drilling and operations. Drilling and human disturbance on or around the production pads may cause some temporary, limited minor disturbance of individuals close to shore, especially during summer at the East and West Pads. Vehicle-seal collisions unlikely.	—
Spotted Seal	Unlikely to impact; occurs in small numbers mostly offshore only in summer when no construction occurs. Temporary localized barge/aircraft noise disturbance possible to minor number of individuals.	Occurs in smaller numbers than ringed and bearded seals in study area, only present in project area in summer.

Using the impact methodology described in Section 5.11.1, Methodology, impacts to marine mammals are summarized as shown below in Table 5.11-4.

Table 5.11-4: Alternative B—Impact Criteria Summary for Marine Mammals

Impact Type and Affected Population		Magnitude	Duration	Potential to Occur	Geographic Extent
Cetaceans	Habitat Loss	Minor	Temporary	Unlikely	Limited
	Behavioral Disturbance and Displacement	Minor	Temporary	Possible	Local
	Habitat Fragmentations	Minor	Temporary	Unlikely	Limited
	Land/Ice Vehicle and Vessel Collision Injury or Mortality	Minor	Temporary	Possible	Limited
	Altered Survival and Productivity	Minor	Temporary	Unlikely	Limited
Pinnipeds	Habitat Loss	Minor	Medium term	Possible	Limited
	Behavioral Disturbance and Displacement	Minor	Medium term	Possible	Limited
	Habitat Fragmentations	Minor	Medium term	Unlikely	Limited
	Land/Ice Vehicle and Vessel Collision Injury or Mortality	Minor	Temporary	Unlikely	Limited
	Altered Survival and Productivity	Minor	Medium term	Possible	Limited
Polar Bear	Habitat Loss (Gravel Placement)	Minor	Long term	Possible	Local
	Habitat Alteration (Ice Roads)	Minor	Medium term	Possible	Local
	Disturbance and Displacement (Overflights)	Minor	Long term	Possible	Local
	Disturbance and Displacement (Permanent Facilities)	Minor	Long term	Possible	Limited
	Disturbance and Displacement (Ice Roads)	Minor	Medium term	Possible	Local
	Habitat Fragmentations	Minor	Long term	Unlikely	Limited
	Land/Ice Vehicle and Vessel Collision Injury or Mortality	Minor	Temporary	Unlikely	Limited
	Altered Survival and Productivity	Minor	Long term	Unlikely	Limited

5.11.4 Alternative C: Inland Pads with Gravel Access Road

The intent of Alternative C is to minimize impacts to coastal and marine environments by moving most gravel infrastructure inland to the extent practicable and eliminating barging. Alternative C also would include construction of an all-season gravel road between Endicott Spur Road and Point Thomson. Sea and/or tundra ice roads would be used until the all-season gravel road was completed.

5.11.4.1 Alternative C: Construction, Drilling, and Operations

Construction and drilling would overlap in time, resulting in combined impacts for a portion of the schedule. Operations would begin during drilling and would extend for the life of the project. The impacts to marine mammals from operations would be similar or reduced from those of construction and drilling.

Alternative C would potentially affect marine mammals and their habitats as described for Alternative B with the following exceptions:

- No barges would be used under Alternative C and no barge facilities would be constructed. Thus, no loss of coastal habitat, dredging and screeding, deposition of dredge materials, or coastal pile-driving would occur.
- New gravel pads and related roads would be located farther inland (up to one-half mile) and processing facilities would be separated from drilling activities and moved inland. An inland all-season gravel road would be constructed between Endicott Spur Road and Point Thomson for use during operations, substantially increasing the gravel footprint over existing conditions.
- Seasonal ice roads will be built and used during construction of the gravel road and would be used to transport modules and drilling rigs to Point Thomson.
- Land transport (due to lack of barge capabilities) would more than double from Alternative B during construction (up to 10,370 trips over 3 years), increase during the drilling phase (6,850 to 8,200 round trips), and would continue throughout the operations phase with an estimated 370 trips per year.
- Fixed-wing air transport would increase by about 5 percent (1,040, 540, and 45 trips during construction, drilling, and operations, respectively) and helicopter round trips would increase substantially (6,200 and 1,200 trips during construction and drilling, respectively). However, helicopter trips would be reduced during operations, to about five trips per year.

Habitat Loss and Alteration

Alternative C would result in medium and long-term loss of terrestrial tundra habitat due to extraction of gravel and placement for roads, pads, and an airstrip. Nearly double the amount of polar bear critical habitat would be lost due to construction of gravel structures as compared to Alternative B. However, in proportion to the amount of total available habitat, this loss accounts for only a minor amount of potentially suitable polar bear denning habitat. If built, seasonal habitat alteration would occur along shorefast sea ice roads as described for Alternative B. Table 5.11-5 presents habitat loss and alteration for polar bears under Alternative C.

Table 5.11-5: Alternative C—Polar Bear Habitat Loss and Alteration; Polar Bear Disturbance and Displacement

Structures/Roads	Area (acres)
Habitat Loss: Designated polar bear critical habitat from construction of gravel project features	743
Habitat Alteration: Designated polar bear critical habitat from construction of seasonal project ice features	1,139
Disturbance and Displacement: Area around permanent project features (820-foot buffer)	14,062
Disturbance and Displacement: Area around seasonal ice project features (820-foot buffer)	15,643
Disturbance and Displacement: Flight path from Deadhorse (1,320-foot buffer)	17,312

Behavioral Disturbance and Displacement

Sources and effects of disturbance under Alternative C would be similar to Alternative B except there would be no barges operating under Alternative C. Thus, there would be no potential disturbance to marine mammals due to barge facility construction (including pile-driving, dredging and screeding, and dredge material deposition) and barge operations. This would considerably reduce construction noise levels near the coastline that could potentially disturb ringed seals, cetaceans and polar bears that occur along the coast and on the barrier islands in the study area. The potential occurrence for disturbance to pinnipeds would be further reduced from construction of primary gravel features being moved farther inland as compared to Alternative B. However, increased gravel road construction would result in more long-term loss of critical habitat for polar bears and increased vehicular traffic may increase potential collisions with bears.

Drilling activities may disturb a small number of seals and polar bears in the short-term at the inland coastal pads, aircraft operations, vehicles on ice and gravel roads, and associated noise as described for Alternative B. Maximum traffic levels, and thus potential disturbance, would likely occur when construction and drilling activities occur simultaneously. Noise from the drilling rig, rig camp, and people walking on or around the production pads may cause minimal disturbance primarily for polar bears, most likely during summer at the East Pad and West Pad locations.

Noise disturbance during operations associated with the central processing facility would be shifted inland approximately 2 miles. Seals that swim near the Central Well Pad would likely not hear noise associated with the central processing facility. Polar bear and polar bear den impacts from noise and activity at the Central Processing Pad would be the same as Alternative B.

Habitat Fragmentation

The potential for habitat fragmentation caused by ice road construction and operations under Alternative C would be similar to that anticipated under Alternative B for pinnipeds, but would be increased for polar bears due to the increase in gravel road construction and use.

Impacts caused by the new infield facilities would be similar to those under Alternative B. In addition to impacts caused by infield construction, the construction of a 44 mile gravel road to Endicott Spur Road may cause minor habitat fragmentation for polar bears. This could induce individuals to behaviorally avoid this area throughout the year to a greater extent than under existing conditions. However, polar bears would likely habituate to these new facilities and road, given their apparent preponderance to tolerate human-related activities.

Habitats lost, altered, disturbed, and fragmented by gravel deposition during construction would generally continue during operations, although with reductions in project workforce and ground and air traffic, the potential for these effects would lessen.

Vehicle and Vessel Collision Injury or Mortality

Under Alternative C, the risk of barge collision with marine mammals would be eliminated as the project alternative does not include the use of barges.

There would be an increased number of vehicles operating on ice and gravel roads under this alternative to compensate for the loss of barge access. This could increase the likelihood of vehicle-polar bear collisions.

Altered Survival or Productivity

Impacts would be similar to those discussed under Alternative B. Altered survival and productivity related to oil spills is discussed in Section 5.24, Spill Risk and Impact Assessment.

5.11.4.2 Alternative C: Summary of Impacts on Marine Mammals

Infrastructure and activities proposed for Alternative C could result in minor, temporary to long term habitat loss and disturbance effects on marine mammals and their habitats, most likely on polar bears. The general sources of disturbance would persist as long as drilling and operations persisted, although individuals may become habituated to ongoing activity and presence of facilities. Overall impact to each species discussed is summarized in Table 5.11-6.

Table 5.11-6: Alternative C—Summary of Possible Impacts by Species

Species	Potential Alternative C Impacts	Additional Comments
Bearded Seal	Aircraft noise could cause temporary limited disturbance of a minor number of individuals during summer.	Occurs in smaller numbers than ringed seal in study area, only in summer, and primarily offshore beyond barrier islands. Prefers unstable broken ice.
Beluga Whale	Possible disturbance of a few individuals by aircraft operations.	Unlikely to be impacted by any of the activities because migration outside and offshore of barrier islands.
Bowhead Whale	Possible disturbance of a few individuals by aircraft operations.	—
Gray Whale	Possible disturbance of a few individuals by aircraft operations.	Unlikely to be impacted by any of the activities; species occurs typically in small numbers seaward and west of barrier islands.
Polar Bear	Designated polar bear critical habitat would be physically lost and seasonally altered by construction of project features. Potential disturbance from aircraft overflights, and road construction, and vehicle and equipment use primarily during construction, but to lesser degree during drilling and operations. Vehicle-bear collisions unlikely.	—
Ringed Seal	Possible construction disturbance from project components remaining (e.g., Central Well Pad) along coastline. Possible disturbance of a few individuals by aircraft operations.	—
Spotted Seal	Possible disturbance of a few individuals by aircraft operations.	Occurs in smaller numbers than ringed and bearded seals in study area, only present in project area during summer.

Using the impact methodology described in Section 5.11.1, Methodology, impacts to marine mammals are summarized as shown in Table 5.11-7.

Table 5.11-7: Alternative C—Impact Criteria Summary for Marine Mammals

Impact Type and Affected Population		Magnitude	Duration	Potential to Occur	Geographic Extent
Cetaceans	Habitat Loss	Minor	Temporary	Unlikely	Limited
	Disturbance and Displacement	Minor	Temporary	Unlikely	Limited
	Habitat Fragmentations	Minor	Temporary	Unlikely	Limited
	Land/Ice Vehicle and Vessel Collision Injury or Mortality	Minor	Temporary	Unlikely	Limited
	Altered Survival and Productivity	Minor	Temporary	Unlikely	Limited
Pinnipeds	Habitat Loss	Minor	Medium term	Possible	Limited
	Disturbance and Displacement	Minor	Medium term	Possible	Limited
	Habitat Fragmentations	Minor	Medium term	Unlikely	Limited
	Land/Ice Vehicle and Vessel Collision Injury or Mortality	Minor	Temporary	Unlikely	Limited
	Altered Survival and Productivity	Minor	Medium term	Possible	Limited
Polar Bear	Habitat Loss (Gravel Placement)	Moderate	Long term	Probable	Local
	Habitat Alteration (Ice Roads)	Minor	Medium term	Probable	Local
	Disturbance and Displacement (Overflights)	Minor	Long term	Possible	Local
	Disturbance and Displacement (Permanent Facilities)	Minor	Long term	Probable	Local
	Disturbance and Displacement (Ice Roads)	Minor	Medium term	Probable	Local
	Habitat Fragmentations	Minor	Long term	Possible	Local
	Land/Ice Vehicle and Vessel Collision Injury or Mortality	Minor	Temporary	Unlikely	Limited
	Altered Survival and Productivity	Minor	Long term	Unlikely	Limited

5.11.5 Alternative D: Inland Pads with Seasonal Ice Access Road

From the standpoint of marine mammal impacts, Alternative D would be similar to Alternative C with the following exceptions:

- The all-season gravel road would not be constructed. Instead, seasonal tundra or sea ice roads would be constructed between Point Thomson and the Endicott Spur Road during construction, drilling, and operations.
- A tundra ice airstrip would be built seasonally during construction until completion of the gravel airstrip.

5.11.5.1 Alternative D: Construction, Drilling, and Operations

Construction and drilling would overlap in time, resulting in combined impacts for a portion of the schedule. Operations would begin during drilling and would extend for the life of the project. The impacts to marine mammals from operations would be similar or reduced from those of construction and drilling. Alternative D would potentially affect marine mammals and their habitats as described for Alternative C, although at a reduced scale due to the removal of the all-season gravel road.

Habitat Loss and Alteration

Long-term habitat loss under Alternative D would be reduced from that anticipated for Alternative C. A tundra or sea ice road from Endicott Spur Road to Point Thomson would be built annually as needed for the life of the project. In addition, a tundra ice airstrip will be built for use during construction until completion of the gravel airstrip. This construction could result in minor, temporary habitat alteration in the limited areas occupied by the ice road and airstrip during winter-spring. Most of this acreage would probably be unsuitable to ringed seals because ice roads require grounded ice for stability, and ringed seals do not use grounded ice areas. A minor amount of potentially suitable polar bear denning habitat would also be altered each season for ice structures. Table 5.11-8 presents habitat loss and alteration for polar bears under Alternative D.

Table 5.11-8: Alternative D—Polar Bear Habitat Loss and Alteration; Polar Bear Disturbance and Displacement

Structures/Roads	Area (acres)
Habitat Loss: Designated polar bear critical habitat from construction of gravel project features	354
Habitat Alteration: Designated polar bear critical habitat from construction of seasonal project ice features	896
Disturbance and Displacement: Area around permanent project features (820-foot buffer)	4,503
Disturbance and Displacement: Area around seasonal ice project features (820-foot buffer)	21,610
Disturbance and Displacement: Flight path from Deadhorse (1,320-foot buffer)	17,312

Behavioral Disturbance and Displacement

Disturbance impacts under Alternative D would be similar to Alternative C, except that vehicular travel would be confined to winter ice road use rather than a year-round gravel road. The location of annual ice roads — tundra or landfast sea ice—could vary the level of risk for marine mammals, as higher occurrence of species would be anticipated along the shoreline sea ice. The construction of approximately 50 miles of ice roads annually for the life of the project would increase the likelihood of disturbing polar bears during denning compared to Alternatives B and C, which would have annual ice roads only through drilling.

As with Alternative C, there would be no barge traffic under Alternative D to cause disturbance. Disturbance due to aircraft would be slightly higher, with helicopter round trips slightly decreasing during construction, but doubling to over 2,000 trips during the drilling phase (Chapter 2, Alternatives Descriptions).

Noise disturbance during operations associated with the central processing facility would be the same as Alternative C.

Habitat Fragmentation

Due to the removal of the 44-mile gravel all-season road, long-term impacts would be less than those under Alternative C. Where ice roads are constructed, impacts would be similar in mechanism and scale as described under Alternative C.

Vehicle and Vessel Collision Injury or Mortality

Impacts would be similar to those described under Alternative C, with the exception of there being no potential for year-round over-land vehicular collisions.

Altered Survival or Productivity

Impacts would be similar to those described under Alternative B.

5.11.5.2 Alternative D: Summary of Impacts on Marine Mammals

Infrastructure and activities proposed for Alternative D could result in minor, temporary to long term habitat loss and disturbance effects on marine mammals and their habitats, most likely on polar bears. Ice road and aircraft disturbance would continue through the life of the project, although as described in Alternative B, individuals may become habituated to ongoing activity and presence of facilities. Overall impacts to each species discussed are summarized in Table 5.11-9.

Table 5.11-9: Alternative D—Summary of Possible Impacts by Species

Species	Potential Alternative D Impacts	Additional Comments
Bearded Seal	Possible disturbance of a few individuals by aircraft operations	Occurs in smaller numbers than ringed seal in study area, only in summer, and primarily offshore seaward of barrier islands. Prefers unstable broken ice.
Beluga Whale	Possible disturbance of a few individuals by aircraft operations	Unlikely to be impacted by any of the activities because migration seaward and offshore of barrier islands
Bowhead Whale	Possible disturbance of a few individuals by aircraft operations	—
Gray Whale	Possible disturbance of a few individuals by aircraft operations	Unlikely to be impacted by any of the project activities; species typically occurs in small numbers seaward and west of barrier islands
Polar bear	Polar bear critical habitat would be physically lost or seasonally altered by construction of project features. Potential disturbance from aircraft overflights, road construction, and vehicle and equipment use. Annual ice roads increase potential for disturbing denning polar bears. Vehicle-bear collisions unlikely.	—
Ringed Seal	Possible construction disturbance. Drilling and human disturbance on or around production pads may cause some temporary, limited minor disturbance from remaining construction that occurs close to shore, especially during summer at the East Pad and West Pad locations. Potential disturbance from aircraft overflights, road construction, and vehicle and equipment use. Vehicle-seal collisions unlikely.	—
Spotted Seal	Possible disturbance of a few individuals by aircraft operations	Occurs in smaller numbers than ringed and bearded seals in study area, only present in project area in summer.

Using the impact methodology described in Section 5.11.1, Methodology, impacts to marine mammals are summarized in Table 5.11-10.

Table 5.11-10: Alternative D—Impact Criteria Summary for Marine Mammals

Impact Type and Affected Population		Magnitude	Duration	Potential to Occur	Geographic Extent
Cetaceans	Habitat Loss	Minor	Temporary	Unlikely	Limited
	Disturbance and Displacement	Minor	Temporary	Unlikely	Limited
	Habitat Fragmentations	Minor	Temporary	Unlikely	Limited
	Land/Ice Vehicle and Vessel Collision Injury or Mortality	Minor	Temporary	Unlikely	Limited
	Altered Survival and Productivity	Minor	Temporary	Unlikely	Limited
Pinnipeds	Habitat Loss	Minor	Medium term	Possible	Limited
	Disturbance and Displacement	Minor	Medium term	Possible	Limited
	Habitat Fragmentations	Minor	Medium term	Unlikely	Limited
	Land/Ice Vehicle and Vessel Collision Injury or Mortality	Minor	Temporary	Unlikely	Limited
	Altered Survival and Productivity	Minor	Medium term	Possible	Limited
Polar Bear	Habitat Loss (Gravel Placement)	Minor	Long term	Possible	Local
	Habitat Alteration (Ice Roads)		Long term	Possible	Local
	Disturbance and Displacement (Overflights)	Minor	Long term	Possible	Local
	Disturbance and Displacement (Permanent Facilities)	Minor	Long term	Possible	Local
	Disturbance and Displacement (Ice Roads)	Minor	Long term	Possible	Local
	Habitat Fragmentations	Minor	Long term	Unlikely	Local
	Land/Ice Vehicle and Vessel Collision Injury or Mortality	Minor	Temporary	Unlikely	Limited
	Altered Survival and Productivity	Minor	Long term	Unlikely	Limited

5.11.6 Alternative E: Coastal Pads with Seasonal Ice Roads and Airstrip

Alternative E would have reduced gravel footprints for roads and pads. Pads would be located on the coastline with seasonal ice roads for connection between East, West, and Central Pads. A sea ice airstrip would be used during construction of a gravel airstrip, and small helipads would be constructed at the East and West Pads for transportation between pads when ice roads were not available. Year-round gravel road construction would be limited to the connection between the Central Pad and gravel airstrip, gravel mine, and water source for use during operations. Barge offloading facilities would be constructed and coastal and sealift barges used to supply Point Thomson as described under Alternative B.

5.11.6.1 Alternative E: Construction, Drilling, and Operations

Construction and drilling would overlap during a portion of the schedule and for that period, would result in combined impacts. Operations would begin during drilling and would extend for the life of the project. The impacts to marine mammals from operations would be similar or reduced from those of construction and drilling. It is anticipated that the long-term impact to polar bears for Alternative E would be somewhat reduced compared to Alternative B due to a smaller footprint and, as a result, less critical habitat loss. However, impacts to pinnipeds and cetaceans would be similar to Alternative B given the use of barges and the construction and maintenance of barge facilities.

Habitat Loss and Alteration

The overall project gravel footprint would be reduced under Alternative E, and possible effects from construction, drilling and operations would be slightly less than Alternative B. Coastal barging access would continue with the use of the new coastal barge service pier and adjacent sealift barge facility, as described for Alternative B. The reduced number of infield gravel roads from Alternative B would slightly reduce the acreage of polar bear critical habitat lost. Seasonal habitat alteration due to ice road construction and use would be similar to Alternative D, but reduced compared to Alternatives B and C. Table 5.11-11 presents habitat loss and alteration for polar bears under Alternative E.

Table 5.11-11: Alternative E—Polar Bear Habitat Loss and Alteration; Polar Bear Disturbance and Displacement

Structures/Roads	Area (acres)
Habitat Loss: Designated polar bear critical habitat from construction of gravel project features	205
Habitat Alteration: Designated polar bear critical habitat from construction of seasonal project ice features	901
Disturbance and Displacement: Area around permanent project features (820-foot buffer)	1,502
Disturbance and Displacement: Area around seasonal ice project features (820-foot buffer)	21,966
Disturbance and Displacement: Flight path from Deadhorse (1,320-foot buffer)	17,312

Behavioral Disturbance and Displacement

Under Alternative E, potential disturbance and displacement associated with barge facility construction and barging would be the same as Alternative B. Disturbance from central processing facility noise and activities at the Central Pad also would be the same as Alternative B.

The lack of permanent gravel roads to the East and West pads would increase the potential for disturbance and displacement associated with annual ice road construction and use and the need for helicopter traffic between the pads during seasons when ice roads would be unavailable. Annual ice road construction and use could affect denning polar bears and helicopter noise could affect polar bears and seals.

Habitat Fragmentation

The types of habitat fragmentation impacts under Alternative E would be reduced compared to other alternatives because of the reduced acreage of proposed gravel roads. Alternative E also differs from Alternative B in that a sea ice airstrip would be built during construction. However, most of this acreage would probably be unsuitable for ringed seals because the airstrip would likely require grounded ice for stability, and ringed seals do not use grounded ice areas. A minor amount of potentially suitable polar bear denning habitat would be lost, but these impacts would be minor given the small acreage utilized by the airstrip (see Table 5.11-11).

Vehicle and Vessel Collision Injury or Mortality

The types of collision impacts under Alternative E would be similar to those under Alternative B; however, the possibility of marine mammal-vehicle collisions would be reduced under Alternative E due to reduced acreage of proposed year-round roads.

Altered Survival or Productivity

The types of altered survival or productivity impacts under Alternative E would be similar to those under Alternative B; however, the potential for such impacts would be reduced under Alternative E due to reduced acreage of proposed year-round gravel roads.

5.11.6.2 Alternative E: Summary of Impacts on Marine Mammals

Infrastructure and activities proposed for Alternative E could result in minor, temporary to long term habitat loss and disturbance effects on marine mammals and their habitats, most likely on polar bears and ringed seals. Ice road, barging, and aircraft disturbance would continue through the life of the project, although as discussed previously, individuals may become habituated to ongoing activity and presence of long-term facilities. Overall impacts to each species discussed are summarized in Table 5.11-12.

Table 5.11-12: Alternative E—Summary of Possible Impacts by Species		
Species	Alternative E	Comments
Bearded Seal	Aircraft and barge noise could cause temporary limited disturbance of a minor number of individuals during summer.	Occurs in smaller numbers than ringed seal in study area, only in summer, and primarily seaward of barrier islands. Prefers unstable broken ice.
Beluga Whale	Unlikely to impact. Barge/aircraft noise/ activity disturbance possible, but unlikely.	Unlikely to be impacted by any of the activities, because seasonal migration occurs seaward and offshore of barrier islands.
Bowhead Whale	Similar to Alternative B with temporary localized barge/aircraft noise disturbance possible to minor number of individuals during the fall migration.	Applicant a signatory to the Conflict Avoidance Agreement which will stipulate barge use during fall whaling season.
Gray Whale	Unlikely to impact. Barge/aircraft noise/ activity disturbance possible, but unlikely.	Unlikely to be impacted by any of the activities since species typically occurs in small numbers seaward and west of barrier islands.
Polar Bear	Minor amount of polar bear critical habitat would be physically lost or seasonally altered by construction of project features. Potential disturbance from barging, aircraft overflights, ice road, and barge lift construction and pile driving, and vehicle and equipment use primarily during construction, but to a lesser degree during drilling and operations. Vehicle-bear collisions unlikely.	—
Ringed Seal	Construction could temporarily alter potentially useable winter ice habitat. Localized habitat fragmentation effects unlikely during winter construction of shorefast ice road and sea ice airstrip. Drilling and human disturbance on or around the production pads may cause some temporary, limited minor disturbance of individuals close to shore, especially during summer at the East and West Pads. Potential disturbance from barging, aircraft overflights, ice road, and barge lift construction and pile driving, and vehicle and equipment use primarily during construction, but to a lesser degree during drilling and operations.	—
Spotted Seal	Temporary localized summer barge/aircraft noise disturbance possible to minor number of individuals.	Occurs in smaller numbers than ringed and bearded seals in study area, only present in project area during summer.

Using the impact methodology described in Section 5.11.1, Methodology, impacts to marine mammals are summarized as shown in Table 5.11-13.

Table 5.11-13: Alternative E—Impact Summary for Marine Mammals

	Impact Type and Affected Population	Magnitude	Duration	Potential to Occur	Geographic Extent
Cetaceans	Habitat Loss	Minor	Temporary	Unlikely	Limited
	Disturbance and Displacement	Minor	Temporary	Unlikely	Limited
	Habitat Fragmentations	Minor	Temporary	Unlikely	Limited
	Land/Ice Vehicle and Vessel Collision Injury or Mortality	Minor	Temporary	Unlikely	Limited
	Altered Survival and Productivity	Minor	Temporary	Unlikely	Limited
Pinnipeds	Habitat Loss	Minor	Medium term	Possible	Limited
	Disturbance and Displacement	Minor	Medium term	Possible	Limited
	Habitat Fragmentations	Minor	Medium term	Unlikely	Limited
	Land/Ice Vehicle and Vessel Collision Injury or Mortality	Minor	Temporary	Unlikely	Limited
	Altered Survival and Productivity	Minor	Medium term	Possible	Limited
Polar Bear	Habitat Loss (Gravel Placement)	Minor	Long term	Possible	Limited
	Habitat Alteration (Ice Roads)	Minor	Long term	Possible	Limited
	Disturbance and Displacement (Overflights)	Minor	Long term	Possible	Limited
	Disturbance and Displacement (Permanent Facilities)	Minor	Long term	Possible	Limited
	Disturbance and Displacement (Ice roads)	Minor	Long term	Possible	Limited
	Habitat Fragmentations	Minor	Long term	Unlikely	Limited
	Land/Ice Vehicle and Vessel Collision Injury or Mortality	Minor	Temporary	Unlikely	Limited
	Altered Survival and Productivity	Minor	Long term	Unlikely	Limited

5.11.7 Mitigative Measures

This section describes measures to mitigate impacts to marine mammals from the Point Thomson Project. The Applicant has proposed design measures that would be included as part of the project; BMPs and permit requirements would be stipulated by federal, state, and local agencies, and the Corps has considered additional mitigation measures.

5.11.7.1 Applicant's Proposed Design Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on marine mammals.

Whales and Seals

- Minimizing offshore infrastructure.
- Installing mooring dolphins and the service pier (Alternatives B and E only) in winter and in less than 8 feet of water, minimizing interactions with ringed seals which are usually farther offshore in floating landfast ice areas.

- Using Marine Mammal Observers (MMOs) on barges, vessels, and convoys. If a marine mammal is observed within one mile of a barge, the MMO will alert the vessel captain who will make any necessary speed and course alterations to avoid a collision (Alternatives B and E only).
- Planning sealift barging (passing outside the barrier islands) to be completed prior to the main fall bowhead whale migration and subsistence whaling (Alternatives B and E only).
- Routing coastal barging inside barrier islands, minimizing marine vessel traffic offshore of the islands where bearded seals may occur and where bowhead and beluga whales commonly occur during spring and fall migrations (Alternatives B and E only).
- Constructing the service pier to reduce the number of coastal barging trips (Alternatives B and E only).
- Implementing applicable protective measures of the Conflict Avoidance Agreement with the AEWC (see Section 5.22, Subsistence and Traditional Land-Use Patterns).
- Constructing ice roads onshore or on the sea ice over shallow waters (grounded ice), avoiding seal habitat.
- Dredging the barge landing area through the ice during the winter preceding an open water sealift; this will minimize disturbance to marine mammals. Maintenance dredging and screeding, if needed in the summer, is expected to be minor (Alternatives B and E only).

Polar Bears

- Implementing and building on the successful experience of procedures developed during the 2008 through 2011 drilling program; including, but not limited to:
  - Obtaining LOAs from the USFWS for Incidental and Intentional Take by Harassment of polar bears.
  - Updating and implementing the project's Polar Bear and Wildlife Interaction Plan with detailed measures to avoid adverse encounters with wildlife.
  - Conducting FLIR surveys for potential maternal polar bear dens along ice road routes.
  - Implementing procedures and communications protocols for wildlife encounters.
  - Closing and rerouting an ice road if an active polar bear den is discovered within 1 mile of the ice road route, or taking other action in consultation with the USFWS.
  - Conducting ice road closure drills to practice the ice road closure protocols.
  - Watching for polar bears by using bear monitors and deterring polar bears from project activities, as necessary, following USFWS-approved deterrent methods.
  - Employing operational controls (e.g., road and air traffic restrictions).
  - Ensuring project workers attend appropriate training programs, such as Arctic Pass, which cover polar bear and wildlife awareness.
  - Communicating with the workforce on polar bear issues through Environmental Bulletins, posters, safety meeting discussions, etc.
  - Developing project design and operational features to avoid or discourage wildlife encounters and to protect wildlife and human safety (e.g., building walkways and doors, lighting, snow management, and traffic control).

- Implementing the design measures outlined for Terrestrial Mammals(see Section 5.10) also applicable to polar bears, including:
  - Coordinating with USFWS and ADF&G on known polar bear and grizzly bear den locations and procedures.
  - Proper handling and disposal of any animal carcasses encountered.
  - Constructing infield gravel roads to avoid aircraft and off-road vehicle travel between project locations.
  - Implementing spill prevention and response programs, as detailed in Section 5.24, Spill Risk and Impact Assessment.
  - Prohibiting hunting and fishing by Applicant's employees and contractors while personnel are assigned to, and working in, the Point Thomson area.
  - Prohibiting feeding wildlife.
  - Requiring workers to stay on gravel surfaces unless their job duties require them to be on the tundra.
  - Managing food materials and food wastes such that they are unavailable to wildlife, including the use of bear-proof dumpsters at project locations.
  - Applying dust control measures to roads, pads, and summer mining activities to protect vegetation and terrestrial and aquatic habitats.
  - Limiting speed on project roads and giving right-of-way to wildlife.
  - Training in site operations, deterrence and hazing, waste management, and ice road operations.
  - Adopting strict management procedures specifically relating to the control and containment of waste containers and food.
  - Requiring routine aircraft flights (e.g., transportation of personnel and cargo) to generally fly at a 1,500-foot altitude following a path inland from the coast to avoid disturbance to wildlife, except as required for takeoffs and landings, safety, weather, and operational needs, or as directed by air traffic control.
  - Minimizing gravel fill by utilizing three existing gravel pads in the area to the greatest extent possible, thereby reducing overall new tundra footprint by more than 20 acres.
  - Minimizing the size of the gravel pads through optimizing project design and equipment layout.

5.11.7.2 BMPs and Permit Requirements

North Slope Area-wide Lease Sale mitigation measures include the following related to marine mammals:

- Before commencement of any activities, lessees shall consult with the USFWS (907-786-3800) to identify the locations of known polar bear den sites. Operations must avoid known polar bear dens by 1 mile. A lessee who encounters an occupied polar bear den not previously identified by USFWS must report it to the USFWS within 24 hours and subsequently avoid the new den by 1 mile. If a polar bear should den within an existing development, off-site activities shall be restricted to minimize disturbance.

Federal laws pertaining to marine mammals include the MMPA and ESA. The MMPA prohibits the take of marine mammals and the ESA prohibits take of species listed as threatened or endangered. MMPA and ESA consultation with the NMFS and USFWS will result in requirements or authorizations relative to protected species that occur in the Point Thomson Project area.

5.11.7.3 Corps-considered Mitigation

The Corps is not considering additional mitigation measures for marine mammals.

5.11.8 Climate Change and Cumulative Impacts

5.11.8.1 Climate Change

Various studies and data indicate that arctic marine mammals are being affected by relatively recent changes in climate in the Beaufort Sea. Predicted climate changes are expected to result in long-term, habitat-related effects on arctic marine mammals. Some of these species are predicted to have greater ability than others to adapt to major climate shifts and ecosystem disturbances (Harington 2008, Moore and Huntington 2008, Moline et al. 2008, O'Corry-Crowe 2008, AOGA and API 2011). Potential associated effects that could affect marine mammal survivorship, abundance, and distribution include:

- Reduced sea ice (shorter ice season, warmer winter temperature, changing snow structure)
- Loss of habitat
- Alterations in prey availability
- Increased human activity causing disturbance/displacement

Moore and Huntington (2008) predicted susceptibility of arctic marine mammals to climate change based on their dependency on ice. Ice-obligate and ice-associated species are adapted to sea ice-dominated ecosystems and would be expected to be the least able to adapt to habitat changes induced by climate changes (Moore and Huntington 2008).

The polar bear, bearded seal, and ringed seal are considered ice-obligate species (i.e., rely on sea ice platforms) and would be considered most susceptible to adverse habitat changes induced by climate change. The bearded and ringed seals use the ice as a platform to hunt, rest, and breed, and a reduction in that habitat could reduce survivorship (Moore and Huntington 2008). Polar bears also use the ice for hunting and resting platforms, and the USFWS noted in its designation of polar bear critical habitat that the timing of ice formation and breakup will impact seal distributions and abundance, and, consequently, the ability of polar bears to hunt seals (75 FR 76086-76136). Additionally, some polar bears den on sea ice, and a recent thinning of arctic sea ice has been linked to a declining number of bears able to den there (Fischbach et al. 2007). Decreased sea ice extent may also impact the reproductive success of onshore denning polar bears because they require a stable substrate for denning and dens would become vulnerable to erosion from storm surges. The USFWS also noted that it anticipates that polar bear use of the Beaufort Sea coast will increase during the open-water season (June through October) due to changing ice conditions (75 FR 76086-76136).

Ice-associated species evaluated in the Final EIS include the beluga and bowhead whales and spotted seals. The reliance of ice-associated whales on sea ice-mediated ecosystems is unclear, and the potential effect of reduced sea ice on these whale species could be either beneficial or detrimental. Belugas are capable of surviving up to hundreds of kilometers from sea ice, and sometimes select open water habitats for at least part of the year. The bowhead whale may benefit from a reduction of sea ice that could enhance feeding opportunities on prey both produced in and transported by water to their summer and autumn habitats. These changes could result, however, in a migration alteration for both species, the impacts of which are currently unclear. The gray whale, a seasonally migrant species, would likely benefit from some aspects of climate change, such as reduced sea ice, which might increase access to the biologically-productive Beaufort Sea. It could have a metabolic advantage over its standard migration, whereby the energetic costs of thermoregulation in cold water were offset by remaining in northern seas to take advantage of spring forage rather than undertaking the 33,000-mile round trip migration (Moore and Huntington 2008). Spotted seals are considered an ice-associated species and would likely experience a detrimental impact on birthing rates on ice and juvenile survival if sea ice continues to decline.

Climate change impacts to marine mammal species also have the potential to impact project alternatives. A decrease in sea ice denning habitat for polar bears could lead to an increase in onshore denning, which could in turn impact the routes of ice access roads during construction of the action alternatives. Alternative D, which would rely on an annual resupply ice road, would experience the longest-term impact from a shift in polar bear denning patterns, though Alternatives B and E ice road route selection could also be impacted should they require a tundra ice road for operational resupply.

5.11.8.2 Cumulative Impacts

Past, present, and future activities in the project area have the potential to add to the impacts of the proposed project on marine mammals. Past and current actions in the study area that could have affected marine mammals include military operations, oil and gas exploration, restart of the Badami Development, scientific research, and remediation activities. Relevant future actions in the study area include planned exploration activities in the Beaufort Sea OCS lease areas. Additionally, a Gas Treatment Plant is proposed in Prudhoe Bay as part of the Alaska Pipeline Project. The plant would be the largest gas plant in the world and would include large scale sealift activities during construction, including dredging.

Potential cumulative impacts of concern for marine mammals include offshore seismic exploration and drilling in the Beaufort Sea, outside of the barrier islands; vessel traffic; and predicted changes in climate conditions. Increased vessel traffic increases underwater noise and the potential for vessel-marine mammal strikes. Noise can cause marine mammals to leave an area (change in behavior, increased energetic demand, and potentially moving to areas with lower quality habitat) and/or affect the ability for animals to communicate and locate prey. Additionally, increased seismic survey activity increases underwater noise, which can affect prey species and marine mammals. Observations and studies of responses of marine mammals to noise are difficult to interpret (Richardson et al. 1995). Although noise can cause pronounced behavioral reactions and displacement of some species, it has not been possible to predict the type and magnitude of responses to the variety of disturbances caused by oil and gas operations, or, most important, to evaluate the potential effects on populations. Onshore infrastructure can also affect marine mammals through the need for sea ice roads that cross seal habitat. When seals haul out on sea ice roads, they are susceptible to vehicle strikes. Ice and gravel infrastructure can affect polar bear habitat and maternal polar bear denning.

Seals, whales, and polar bears could all be potentially disturbed by the aforementioned impacts associated with noise, increases in collision risk, and habitat modifications that could result from the accumulation of past, present, and RFFAs. With respect to onshore development, construction, drilling, and operations expose some seals and polar bears to increased noise and disturbance associated with vessel and air traffic. The magnitude of effects on marine mammals from disturbance is unknown, but long-term effects on any species are unlikely. These activities likely have caused no more than a temporary and localized effect on a small percentage of the populations (Moulton et al. 2002, 2005). Additionally, there is an increased risk of death to polar bears if attracted to human garbage and killed for safety purposes.

The proposed project could contribute to an incremental increase in habitat loss and alteration; noise/disturbance from air, vessel, and vehicle traffic; and mortality associated with construction, vessel strikes, and human safety. Placement of gravel fill would contribute to the incremental loss and alteration of potential polar bear denning habitat on the North Slope. Because the marine waters of the Beaufort Sea have seen only limited and sporadic industrial activity, however, it is likely that there have been no serious effects or accumulation of effects on seals or polar bears (NRC 2003a). As a result, adverse cumulative effects to marine mammals are not anticipated.

Past, present, and RFFAs, including proposed project, are not expected to affect the viability of marine mammal populations. However, some populations may be reduced in number to an extent that could have an adverse cumulative impact on subsistence users (see Section 5.22, Subsistence and Traditional Land-Use Patterns). Cumulatively, non-oil and gas activities and spills would have little impact on marine mammals (see Section 5.24, Spill Risk and Impact Assessment).

5.11.9 Alternatives Comparison and Consequences

All of the proposed action alternatives have the potential to affect marine mammals and their habitat. The species most likely to be affected by the project would be polar bears and the habitats most likely affected would be polar bear denning critical habitat. The primary impacts and differentiators among the alternatives include the following:

- Construction of project infrastructure (i.e., gravel roads, airstrip, and pads and ice roads) would have long-term impacts to polar bears by incrementally decreasing available denning critical habitat.
  - All action alternatives would impact polar bear critical habitat to some extent because all proposed infrastructure under all alternatives would be located within polar bear denning critical habitat. The amount of available denning habitat impacted would be small.
  - Alternative C would have the greatest potential to affect polar bears and polar bear critical habitat. The all-season gravel road under Alternative C would result in the most habitat loss by having the largest gravel footprint within the critical habitat.
  - The need for annual ice roads under Alternatives D and E would increase the potential for disturbance by increasing possible encounters with polar bear dens during ice road construction. However, this disturbance would be seasonal and would not result in long-term impacts to critical habitat.
- Barging activities would impact marine mammals through vessel noise, the potential for collisions, and docking facility construction-related noise. These impacts would occur under Alternatives B and E.
  - Whales and seals could be disturbed by the presence of and noise generated by sea lift and coastal barges. However, the disturbance would likely affect individual animals and would be a short duration disturbance.
  - Collisions with marine mammals are possible, but not likely to occur.
  - Noise generated from pile driving and dredging and screeding would mostly occur during winter when whales would not be in the area and seals would be far enough away that noise impacts would be minor.

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5.12 FISH, ESSENTIAL FISH HABITAT, AND INVERTEBRATES

The key findings of effects for fish, EFH, and invertebrates are summarized below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

Alternative C: Moderate impacts to diadromous fish and fish habitat are probable and would last beyond the life of the project. Impacts would extend across the study area.

Alternatives B, D, and E: Moderate impacts to diadromous fish and fish habitat are probable and would last beyond the life of the project. Impacts would be localized to the eastern portion of the project area.

Alternative A: No impacts.

Differentiators:

- Bridges and culverts at stream crossings for the gravel access road under Alternative C would impact fish habitat and fish movements for resident and anadromous fish, including EFH.
- Alternative E would have the least impacts from bridges and culverts.
- Alternatives D and E would have long term impacts to overwintering fish and fish habitat because of the need for annual water withdrawals for ice road construction and maintenance.

Primary concerns for fish, invertebrates, and habitat under each alternative would be maintenance of adequate winter habitat, suitable feeding and spawning habitats, and passage to and from these areas. Key project components or activities that could impact fish, invertebrates, and habitat include water withdrawal, alteration of flow patterns and fish passage through placement of fill, bridges, and culverts, spills or releases of contaminants, and alteration of water quality (especially during winter when habitat available to fish is rare). Areas of special consideration include maintenance of access to crucial habitats such as the Sagavanirktok River, Canning/Staines River, Kavik/Shaviovik Rivers, and anadromous streams within the study area. Impacts of and mitigation for spills are addressed in Section 5.24, Spill Risk and Impact Assessment.

5.12.1 Methodology

Potential impacts to fisheries and invertebrate resources from proposed construction and operations for each alternative were analyzed based on current and potential:

- Marine and freshwater fish habitat use.
- Marine and freshwater invertebrate habitat use.
- Marine and freshwater fish habitat requirements.
- Marine and freshwater invertebrate habitat requirements.
- Seasonal movement patterns of fish.
- Proposed crossing sites or footprints.
- Potential stream blockage.
- Stream contributions to important subsistence, commercial, and recreational fisheries.

Analysis of potential habitat was based on the review of reported fish presence and habitat use data (Johnson and Blanche 2011), and fish habitat data collected at or near proposed stream crossings (Winters and Morris 2004). Definitions for common life histories of North Slope fish can be found in Section 3.12, Fish, Essential Fish Habitat, and Invertebrates. Streams were determined to be fish-bearing if sampling documented presence of fish (Winters and Morris 2004). Streams were considered anadromous if they were cataloged by ADF&G (Johnson and Blanche 2011) or if they were connected to cataloged anadromous water.

Impact evaluation criteria were developed for fish and invertebrates based on methodology described in Section 4.1, Impact Determination Methodology. These criteria are presented in Table 5.12-1. Impact analyses are based on these criteria.

Table 5.12-1: Impact Criteria—Fish, Fish Habitat, and Invertebrates

Impact Category/ Intensity Type[a]	Specific Definition for Fish and Invertebrates	Specific Definition for Fish Habitat
Magnitude		
Major	Would impact: • Normal movements of fish populations, *or* • Survival or reproductive success, resulting in population-level[b] impacts, *or* • The distribution of fish or invertebrate populations.	Would impact > 25% of a water body (stream length or lake area) in the project area used as fish habitat (including spawning and overwintering).
Moderate	Impact would be measureable but would not affect normal fish/invertebrate movement, *or* Would have the potential to impact individual fish/invertebrate survival or reproductive success, but population-level effects not expected.	Would impact: • A limited area of spawning or overwintering habitat, *or* • Spawning or overwintering habitat outside of spawning or overwintering activity periods, *or* • 5 to 25% of a water body within the project area used as fish habitat.
Minor	An impact that cannot be measured or detected.	Would impact less than 5% of a water body in the project area that provides fish habitat.

Table 5.12-1: Impact Criteria—Fish, Fish Habitat, and Invertebrates		
Impact Category/ Intensity Type[a]	Specific Definition for Fish and Invertebrates	Specific Definition for Fish Habitat
Duration		
Long Term	Impact would last longer than two life cycles of an affected species.	Impact would extend beyond the life of the project; restoration not possible.
Medium Term	Impact would last longer than 2 years but less than two life cycles of affected species.	Impact would last for life of project; restoration possible.
Temporary	Impact would last 2 years (24 months) or less.	Impact would last through project construction, restoration possible or not needed.
Potential to Occur		
Probable	Unavoidable.	Unavoidable.
Possible	Potential to occur (can avoid or mitigate).	Potential to occur (can avoid or mitigate).
Unlikely	May occur, but not likely to occur.	May occur, but not likely to occur.
Geographic Extent		
Extensive	Impact would extend throughout the study area[c] and beyond.	Impact would extend throughout the study area and beyond.
Local	Impact would occur within the project area[c].	Impact would occur within project area.
Limited	Impact would be confined to a specific feature within the project footprint.	Impact would be confined to a specific feature within the project footprint.

[a] Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology.

[b] Population level defined as the majority of individuals of a species that occur within the study area.

[c] Study area is defined as the area between the Canning/Staines River and the Sagavanirktok River and extending offshore approximately 5 miles; project area is defined as the area within and adjacent to proposed Point Thomson facilities.

5.12.2 Alternative A: No Action

Under the No Action Alternative, the Applicant would suspend project engineering and planning activities for the evaluation of the Thomson Sand and other hydrocarbon resources at Point Thomson. It is believed that there would be insufficient space on the existing Central Pad for processing facilities and related support infrastructure to make a viable project. The two existing wells have been capped, and only ongoing monitoring activities would take place (see Section 2.4.1, Alternative A: No Action).

Because development of the field would not take place, no impacts to fish, essential fish habitat, or invertebrates would occur under this alternative.

5.12.3 Alternative B: Applicant's Proposed Action

Under Alternative B, project components with potential to impact fish, invertebrates, and habitat would include ice roads, pads, and airstrip to support construction activities; gravel pads, infield road system, and airstrip; a gravel mine site that would fill with water over time; barging facilities; and export and infield pipelines. The location of proposed infrastructure and the proximity to fish streams and currently permitted water withdrawal sources is shown in Figure 5.6-1 and Figure 5.6-2.

5.12.3.1 Alternative B: Construction

Ice Infrastructure

Seasonal ice roads that would be used to support construction would include a heavy-duty sea or tundra ice road from Endicott Spur Road to Point Thomson for transportation of materials and supplies, a tundra ice road from Badami to Point Thomson to support VSM and export pipeline construction, a tundra ice road from Badami to Point Thomson for supplemental materials and equipment transport and infield ice roads to support construction of roads, pads, and gathering pipelines (see Table 2.4-1). The number of stream crossings for each ice component is given in Table 5.6-3.

The sea ice road would cross streams in the braided delta of the Sagavanirktok River and near the outlets of the Kadleroshilik, Shaviovik, and No Name rivers and numerous other small streams (Table 5.6-3). The sea ice road would be constructed adjacent to the shoreline where sea ice freezes to the seafloor naturally. Both sea and tundra ice roads would cross streams that provide fish and invertebrate habitat. Impacts to fish and invertebrates from ice roads could include the following:

- Ice could impede fish movements within streams and at the mouths of streams during breakup; however, this would be unlikely because permit stipulations require ice roads to be slotted at stream crossings before breakup (ADF&G 2011c).
- The sea ice road could physically preclude fish use of nearshore marine habitat or trap fish in nearshore habitats with unsuitable salinity during the winter months; however, (as noted above) ice roads would be slotted at stream crossings and outlets before breakup to allow streams to flow as the snow pack melts, allowing for fish passage.
- Overwintering habitat could be impacted by freezedown (due to compaction) of deepwater pools harboring overwintering fish; however, common permit stipulations for stream crossings for tundra ice require avoidance of deep water pools where overwintering fish may be present (ADF&G 2011c).
- Thickened ice at stream crossings (where not slotted at nonanadromous stream crossings) and along the coast would melt more slowly than the surrounding ice, which could affect resident fish, invertebrates, and their habitat.
- If the hydrology of receiving waters was altered by the ice road, more sensitive invertebrate taxa could be affected.

Ice pads would be used for temporary construction camps, bridge and export pipeline construction, and for stockpiling of gravel and overburden excavated from the gravel mine. Ice pad extensions would support construction activities on the Central Pad. Impacts from ice pads on fish, invertebrates, and their habitat would be similar to impacts from ice roads, except that there would be no stream crossings.

Gravel Infrastructure

Under Alternative B, construction of gravel project components could affect freshwater fish and invertebrates and their habitat. Roads would cross streams via bridges and culverts; the number of stream crossings for each component is shown in (Table 5.6-3). Existing gravel pads would be improved and expanded at the Central and East Pads and a new gravel pad would be constructed for the West Pad. Other gravel pads would include a small water source pad, a gravel mine stockpile pad, the C-1 storage pad, and an auxiliary pad at Badami. Under Alternative B, a gravel airstrip would be constructed and located south of the Central Pad. Construction activities would occur during winter.

Fish would not likely be directly affected by gravel construction activities because tundra streams in the area are shallow, freeze solid during winter when construction activities would occur, and do not provide overwintering fish habitat. Habitat could be affected if bridges or culverts restrict flow at the crossing site of fish streams, if gravel fill impinges on fish bearing streams, if construction activities result in increased sedimentation of fish streams or lakes, or if gravel infrastructure affects overall drainage patterns of the area around a fish stream (see Section 5.6, Hydrology, for an analysis of drainage patterns). Any of these impacts could result in displacement of fish from functional habitat or affect fish passage. In addition, increased sedimentation during construction could affect fish, invertebrates, and their habitats; increased turbidity could decrease DO concentrations and potentially negatively impact fish. Impacts to water quality are discussed in detail in Section 5.7, Water Quality. The potential impacts of the changes in drainage patterns on fish and invertebrates are discussed under Drilling and Operations below.

Under Alternative B, four streams (18b, 22a, 22b, 24b) would be crossed with bridges (Appendix T, Point Thomson Hydrology and Hydraulics Report). Of these, only stream 24 is classified as anadromous for Dolly Varden (known as arctic char and Dolly Varden char) rearing downstream of the crossing (Johnson and Blanche 2011). Impacts from pile driving during bridge construction are discussed under Pile Driving/Blasting, below.

Streams not crossed by bridges would be crossed with culverts; construction could affect freshwater fish and invertebrate habitat. Culverts would be designed for a 50-year flood event (Section 2.4.2.3 Access and Transportation). Streams 18A and 24A are documented to provide fish habitat and, based on consultation with ADF&G, "hybrid culvert batteries" would be installed in these streams. The hybrid culvert battery would consist of structural line pipe culverts with a single corrugated multiplate culvert buried beneath the thalweg of the stream (see the ExxonMobil Environmental Mitigation Report, appended to the Appendix A, the Final DA Permit Application). Proper sizing and placement of culverts during construction would be important for maintaining fish habitat in the future (see discussion under Drilling and Operations below).

When completed, vehicular traffic would use gravel roads and pads year-round for travel and maintenance. Potential impacts to fish, invertebrates, and habitat would include runoff from road and pad surfaces contaminated by spills, leaks, and contamination (see Section 5.24, Spill Risk and Impact Assessment) and dust fallout from gravel roads (see Sections 5.2, Soils and Permafrost; 5.6, Hydrology; 5.7, Water Quality; and 5.8, Vegetation and Wetlands).

Gravel Mining

The proposed gravel mine site and adjacent permanent gravel stockpile pad and temporary overburden stockpile area contain several small ponds that provide habitat for invertebrates. Gravel mining activities would result in the permanent (mine site and gravel stockpile pad) or temporary (ice pad overburden storage) loss of the ponds within the footprint.

After completion of gravel mining, the gravel mine site would be rehabilitated and allowed to fill naturally with sheet flow water to become a reservoir (HDR 2011l). As the mine site is filling with water, the site could be colonized by fish. Fish colonization would occur during spring thaw when the area is covered with sheet flow. Fish that colonize the mine site would be trapped in the mine site until it is filled with water. Once the mine site is filled with water, fish would be able to migrate in and out of the reservoir during spring flood events, but fish remaining in the reservoir when sheet flow subsides would be confined to the reservoir until the following spring flood. The most likely fish species to colonize the mine site at this location is ninespine stickleback. Dolly Varden has not been captured upstream from the mine location so it is unlikely that Dolly Varden would colonize the reservoir naturally.

Barge Offloading Facilities

Construction of facilities to support barge offloading facilities could affect marine habitat, fish, and invertebrates. Bulkhead and service pier construction would occur during winter when the site would be frozen and when fish would not be present. By late winter, bottom-fast ice occurs in the nearshore zone to a depth of approximately 7 feet (Section 5.5, Physical Oceanography and Coastal Processes). Potential impacts from pile driving activities during bulkhead, service pier, and mooring dolphin construction are discussed below under Pile Driving/Blasting.

Dredging and screeding of the nearshore environment during winter could cause mortality to marine invertebrates inhabiting or overwintering in the affected substrate. Screeding during the summer to level barge landing areas could cause additional mortality, and could temporarily reduce fish prey availability and affect fish habitat use because of substrate disturbance. The impact area would be limited to the direct area of dredging and screeding.

Dredged material would be disposed on coastal uplands, as shown on Figure 2.4-2. This area is a gravel beach adjacent to a salt marsh. Deposition of the dredged material could cause

- increased sedimentation from runoff from the dredged material into either the salt marsh or the nearshore marine environment
- transportation of windblown dried sediments to adjacent areas
- movement of the dredged material by ice forced onshore or storm-driven waves

Deposition of the material in the nearshore zone is unlikely to impact fish because dredged materials would be similar to native substrate adjacent to the disposal site. Invertebrates could be impacted by deposition of materials if they become buried in the event that a large amount of sediment is deposited by ice or waves at once into the nearshore zone. Deposition of material in the adjacent salt marsh could impact fish habitat through physical burial of salt marsh ponds and through changes in water quality (see Section 5.7, Water Quality). Access to the salt marsh ponds is limited to the mouth of Stream 22 at high water. The most likely fish to be found in the ponds is the ninespine stickleback; marine species are possible but unlikely because the salt marsh ponds do not provide preferred habitat.

Barge Bridge

Modules for the processing facility would be transported to the Central Pad by sealift barges and would be offloaded by forming a temporary (approximately 2 to 4 weeks) bridge system with the barges at the bulkhead (Section 2.4.3.3, Access and Transportation). Barges would take on ballast water and ground to the substrate; at the time of departure the barges would release ballast water, refloat, and move away. While in place, the full length of the barge bridge would be the length of three 400-foot sealift barges, or approximately 1,200 feet from the shore (HDR 2010a).

Structures placed perpendicular to shore have potential to affect surface currents and upwellings in marine waters (Fechhelm 1999); however, because the barge bridge would extend only 1,200 feet from shore for a temporary period, and because there would be gaps between the barges through which fish could swim, it would be unlikely to have an effect. Upwellings of cold, marine water in the nearshore zone that could impede passage of salinity-sensitive species (e.g., least cisco) due to the barge bridge also would be unlikely because Lion Bay receives freshwater input from the Staines River. Fish passed through breaches in the Endicott Causeway, which receives constant freshwater input from the nearby Sagavanirktok River (Fechhelm et al. 2009).

Coastal migrating diadromous fish tend to move through shallow nearshore waters because decreased salinities in this zone promote the invasion of their preferred prey (Gallaway and Fechhelm 2000; Section 3.12). Though gaps would exist between barges, the barge bridge could potentially be a barrier to fish movements along shore because the gaps would be shaded and could present a perceived barrier to fish migration, as has been observed with salmonids at Puget Sound dock structures (e.g., Nightingale and Simenstad 2001). If fish migrated around the total length of the barge structure from shore (approximately 1,200 feet) this distance would still be less than half the distance between shore and a breach in West Dock (4,000 feet) effectively used by adult humpback whitefish (Fechhelm 1999), indicating that fish migration along shore would not likely be inhibited by the barges, even if fish did not pass between them. Thus, while it would be possible for the barge bridge to impede fish passage it would not be likely because of the short overall length of the barge bridge and the gaps between barges.

The release of ballast water from the sealift barges could have potential to introduce invasive invertebrate species, such as freshwater mussels or Chinese mitten crabs into the nearshore freshwater environment, because these barges would not originate from the North Slope. For most potential invasive species the extremely harsh environment of the study area would likely not allow the substantial proliferation of invasive invertebrates. However, Chinese mitten crabs have been documented in the White Sea near Arkhangelsk, Russia, which is at a similar latitude to the Point Thomson Project (Petterson 2010). The Chinese mitten crab is a native to East Asia that occurs in both fresh and saltwater environments. The species can have negative ecological and economical impacts and is listed as injurious wildlife under the Lacey Act (Smithsonian Environmental Research Center 2012).

Emergency Response Boat Launch

Construction of the emergency response boat launch would not likely affect fish because construction activities would occur in winter and fish would be physically excluded from nearshore and freshwater construction areas because these waters would be frozen to the substrate (see Barge Offloading Facilities above). Marine invertebrates living in nearshore substrates could be affected, depending on whether the invertebrates present burrow deep into the substrates for survival. The number of invertebrates that could be detrimentally affected is relatively low and would not have an overall influence on the population in the study area.

Pipeline/VSM Crossings

Construction of export and infield pipelines would require stream crossings (see Table 5.6-3). VSMs would avoid streams and other water bodies to the extent possible by adjusting the spacing (Section 2.4.2.2, Pipelines), which would avoid impacts to freshwater fish habitat. Impacts to fish, invertebrates, and habitat from pipeline and VSM construction would not be likely.

Pile Driving/Blasting

Pile driving would be used to install the mooring dolphins, service pier pilings, bulkhead sheet piles, and bridge sheet piles. Blasting would be used to excavate the gravel mine. Noise from pile driving and blasting has been documented to cause hearing loss, mask biologically important sounds, increase stress levels, impact immune systems, and kill fish, larvae, and eggs (Popper and Hastings 2009). Impacts to larger fish can include startling by waves. Impacts to smaller fish can include injury or death due to internal swim bladder rupture or a stun response to waves which makes them more susceptible to predation (ADF&G 2011c). During winter, when pile driving and blasting would occur, most fish would be physically excluded from nearshore and freshwater impact areas because these waters would be frozen to the substrate. By late winter, bottom-fast ice occurs in the nearshore zone to a depth of approximately 7 feet (Section 5.5, Physical Oceanography and Coastal Processes), and fresh water freezes to a depth of 6 feet (water depths exceeding 6 feet are rare within the study area; Section 3.12, Fish, Essential Fish Habitat, and Invertebrates). However, if fish were present, ADF&G permit stipulations would limit impacts to fish because blasting in anadromous streams is limited to no more than 2.7 psi and a peak particle velocity of no more than 0.5 inches per second, unless the water body, including the substrate, is frozen (ADF&G 2011c). Invertebrates, if present, would likely be in a dormant state.

Vessel Traffic

During the open water season, vessel traffic at Point Thomson would include coastal barges docking at the service pier, sealift barges accessing the bulkhead via barge bridge, and marine based spill response drills from the emergency response boat launch.

Noise and prop wash from barges and tugs could disturb fish and planktonic invertebrates. Substrate-dwelling invertebrates could be directly affected by sediment resuspension from docked barges. Most effects of vessel traffic would be limited to the immediate area surrounding the service pier and bulkhead/barge bridge but effects in the barge transit corridor would affect a more extensive area (a long but narrow path within the barrier islands corridor). Barges would likely take a slightly different route on each trip, reducing repeated effects to fish and invertebrates remaining in discrete areas. All species of fish in the affected area could be disturbed by prop wash or noise and repeated disturbances could decrease survival or reproductive success of fish. Continuous noise from boating could mask biologically important sounds, cause hearing loss, increase stress levels, and/or impact immune systems of fish (Popper & Hastings 2009). Impacts to fish would be greater from coastal barge traffic than sea lift barge traffic because coastal barging would continue throughout the open water season for all construction years, whereas sea lift barging would occur for a short, concentrated period during the open water season for one or two years.

At the emergency response boat launch, a minimum of two deployment drills would occur each open water season (Appendix D, RFI 84). The vessels involved in the drills would include two work boats and a skimming vessel (launched at West Dock or the Central Pad; Appendix D, RFI 84). Impacts would be limited to these events. Impacts associated with actual spill response are discussed in Section 5.24, Spill Risk and Impact Assessment.

Water Withdrawal

Under Alternative B, water needed for ice roads, pads, maintenance, camp use, and dust suppression would be supplied from currently-permitted water sources between the Endicott Spur and East Pad (lakes, offshore sites, and man-made material site reservoirs as shown in Figure 5.6-1 and Figure 5.6-2. The C-1 reservoir would be the water source for camp use, gravel construction activities, dust suppression, and other year-round uses at permanent Point Thomson facilities (HDR 2010c). The remaining water sources would be used for ice infrastructure construction and other winter uses. Potential impacts to fish, invertebrates, and habitat from water withdrawal are summarized below.

- Water quality changes, such as decreased DO concentration, could affect the ability of lakes to support overwintering fish. Openings in the ice would be maintained to pump water, which would allow oxygen exchange at the lake surface, minimizing the rate of oxygen depletion (Section 5.7, Water Quality).
- Fish and invertebrates could be killed or injured through mechanical stress, entrainment in withdrawn waters, impingement on intake structures, or becoming frozen to ice road surfaces on discharge (NRC 2003a). However, impacts from impingement and entrainment would be reduced by using screens on water pumps to prevent fish from entering the pump, and by restricting flow to keep fish from being suctioned to

the screen (HDR 2011k). Small fish that are not excluded by required screen mesh sizes on water pumps could be impacted.

- Annual withdrawal of high volumes of water from lakes and reservoirs that provide winter fish habitat may impact the ability of the water bodies to support overwintering fish. Temporary water use permits regulate the amount of water that can be extracted from water sources and require monitoring during summer months to ensure that lakes are not drawn down too far and that they recharge each year. If a water body does not recharge sufficiently in one year it would not be permitted for use until recharge occurred. Therefore, impacts to fish habitat from insufficient recharge are unlikely to occur (HDR 2011k).

Water Distribution

Water would be trucked from the C-1 reservoir to the Central Pad or to areas where needed during construction. Water transport would result in no direct impacts to fish, invertebrates, or fish habitat. Impacts from water withdrawal are discussed above.

Tundra Travel

Tundra-safe, low pressure vehicles would be used when allowed to support construction activities (Appendix G, North Slope Construction Methods, Section 2.4.3 Alternative B: Applicant's Proposed Action). Crossings of anadromous streams by vehicles would be restricted by permit stipulations that would reduce impacts to fish and fish habitat. Impacts from stream crossings could affect sensitive life stages of fish (e.g., eggs, juvenile fish, overwintering resident fish; ADF&G 2011c). Because there are no identified spawning or overwintering areas within the Point Thomson infield area (Section 3.12), most area waters freeze to substrate (see above, Pile Driving and Blasting), and tundra travel would likely occur during winter, impacts to fish and fish habitat are expected to be minor.

Power Distribution

Power lines serving the airstrip and mine would be buried in the tundra by trenching, 15 feet from the toe of the road, and extending from the airstrip to the Central Pad. The power line would cross streams, as shown in Table 5.6-3. Trenching that is not done properly can divert water from streams, ponds, and spring runoff and create a channel in the trench. However, trenching would be performed in winter during frozen conditions and would follow permit stipulations and BMPs which would minimize impacts to fish, invertebrates, and their habitat.

5.12.3.2 Alternative B: Drilling and Operations

Under Alternative B, drilling would begin during the final year of construction, and operations would begin during drilling and continue for the life of the project. Impacts to fish would be similar during drilling and operations. Activities that could affect fish, fish habitat, and invertebrates include construction of ice roads, use and maintenance of infield road infrastructure, barging and maintenance of the barge docking area, and maintenance of infield and export pipelines. The effect of spills on fish and invertebrates during drilling and operations is discussed in Section 5.24, Spill Risk and Impact Assessment.

Ice Infrastructure

The types of impacts from ice roads on fish and fish habitat would be the same as those described for the construction phase of Alternative B, except that potential impacts would be reduced. During the drilling phase one ice road would be constructed each year between Endicott and Point Thomson (in comparison to multiple ice roads during construction), and during the operations phase ice roads would be constructed on an occasional basis when needed so there would be years during which no ice road was constructed.

Gravel Infrastructure

Permanent gravel infrastructure could affect freshwater fish and invertebrate habitat through long-term hydrologic modifications and dust. Gravel roads, pads, and the airstrip could alter hydrologic flow patterns during spring melt, when flow would be the greatest (see Section 5.6, Hydrology). Because the airstrip would have no culverts, it would divert some sheet flow from Stream 22 to Stream 24. New predicted spring flood flows would be within normal variation of stream flows (see Section 5.6, Hydrology). At bridges, strong water currents during spring breakup could cause vortices to form behind bridge abutments that could entrain small fish; however, entrainment would likely be limited because all streams that would be crossed are shallow, low gradient streams with slow water velocities during most of the open water season (Section 3.12). Although culverts at fish streams would be sized for fish passage and design flood flows (in compliance with permit stipulations), they could become packed with debris during high flow events, be obstructed by ice or drifted snow, be undersized for breakup flows that are greater than the design flow, or become perched over time from bowing or other permafrost-related effects. These changes could disrupt or delay fish passage or dislodge invertebrates attached to culverts (G.N. McDonald & Associates 1994, Ott 1993, NRC 2003a).

Dust fallout from vehicle use and maintenance of gravel roads and other infrastructure could result in increasing sedimentation of fish habitat, potentially reducing habitat quality.

Gravel Mine

During operations the gravel mine site would fill with water naturally (HDR 2011l). The resulting reservoir could become fish habitat for fish, most likely ninespine stickleback (see Gravel Mining under Section 5.12.3.1, Construction). Fish that colonize the reservoir would be confined to the reservoir except during spring flood events.

The rehabilitated mine site reservoir could be used as a permitted backup water supply for operations once it contains sufficient water (see Section 2.4.3.4, Support Facilities and Waste Disposal). Potential impacts to fish from water withdrawal are discussed below.

Barge Offloading Facilities

The service pier pilings, mooring dolphins would be permanent structures in the nearshore environment. Mooring dolphins and pilings could physically preclude the use of a small area (<0.1 acre) of nearshore habitat by fish during the summer migration period (ExxonMobil 2009b); however, they could also provide habitat if organisms colonize pilings. Strong current conditions could cause vortices to form in the lee of mooring dolphins, possibly entraining small fish in the immediate area of the pile (see Section 5.5, Physical Oceanography and Coastal Processes).

The coastal barge landing area could require annual screeding and some dredging to maintain a level surface for barge access. The impacts to fish and invertebrates would be similar to those discussed under construction.

Emergency Response Boat Launch

The emergency response boat launch would be a permanent structure and would result in the loss of a small amount of habitat for invertebrates. Fish would lose the corresponding amount of invertebrate foraging habitat, but the boat launch would not affect fish passage.

Pipeline/VSM Crossings

Because VSM placement would avoid active stream channels (see Section 2.4.2.2, Pipelines), impacts to fish habitat are not expected during operations. The potential impact of a pipeline spill on fish is discussed in Section 5.24, Spill Risk and Impact Assessment.

Although aerial inspection of pipelines would normally be carried out year-round, one or two times per year, on-the-ground inspections would be conducted using off-road vehicles or ice roads (see Section 2.4.2.2, Pipelines). Impacts from off-road travel are discussed below under Tundra Travel.

Vessel Traffic

Noise and prop wash from barges and tugs used to transport equipment and supplies from West Dock to Point Thomson and vessel traffic from the emergency response boat launch could cause disturbance to fish. Impacts from barge traffic during operations would be similar to those during construction, except there would be less traffic.

Water Withdrawal

Water sources during drilling and operations would be the same as those used during construction. The C-1 reservoir would supply the majority of water and the gravel mine reservoir, once filled, could be permitted and used as a backup water supply. The types of impacts to fish and invertebrates from water withdrawal from permitted water sources during drilling and operations would be the same as discussed under construction, however, fewer fish would likely be impacted because fewer water sources would be used and less water would be withdrawn.

Water Distribution

Trucking water from the C-1 reservoir to the Central Pad would contribute to dust generated by traffic on the gravel roads. Long-term impacts of dust are discussed under gravel infrastructure above.

Tundra Travel

Off road vehicles would be used once or twice yearly for pipeline inspections (Appendix G, North Slope Construction Methods; see Section 2.4.3, Alternative B: Applicant’s Proposed Action). The types of impacts to fish from tundra travel during operations would be the same as those discussed for construction (ADF&G 2011c). Because there are no identified spawning or overwintering areas within areas proposed for pipeline infrastructure and most area waters freeze to substrate, impacts to fish and fish habitat are expected to be minor.

Power Distribution

Fish habitat could be impacted by the power distribution lines buried in the tundra if the power cable needs to be dug up and maintained near a stream or water body. The impact would occur rarely and would have the potential to increase sedimentation in fish habitat. However, if not done properly, the types of impacts discussed under construction could occur.

Impacts Summary

Table 5.12-2 summarizes the potential impacts of Alternative B on fish, invertebrates, and habitat.

Table 5.12-2: Alternative B—Impact Evaluation for Fish, Invertebrates, and Habitat

Project Activity/ Component	Magnitude	Duration	Potential to Occur	Geographic Extent
Sea or Tundra Ice Roads	Minor	Medium term	Possible	Local to extensive
Ice Pads	Minor	Temporary	Possible	Limited
Gravel Roads, Bridges, and Culverts	Moderate	Long term	Possible	Local
Gravel Pads and Airstrip	Minor	Long term	Possible	Limited
Gravel Mining	Moderate	Temporary	Possible	Limited
Gravel Mine	Minor	Medium to Long term	Possible	Limited
Barge Bridge	Minor	Temporary	Probable	Limited
Emergency Response Boat Launch	Minor	Long term	Possible	Limited
Pipelines/VSMs	Minor	Long term	Unlikely	Extensive
Vessel Traffic	Moderate	Medium term	Probable	Local to extensive
Pile Driving/Blasting	Moderate	Temporary	Unlikely	Local
Water Withdrawal: C-1 Reservoir	Moderate	Medium term	Probable	Limited
Water Withdrawal: Other Permitted Water Sources	Moderate	Medium term	Probable	Extensive
Water Distribution	No impacts	No impacts	No impacts	No impacts
Tundra Travel	Minor	Temporary	Possible	Limited
Power Distribution	Minor	Temporary	Probable	Local

5.12.3.3 Alternative B: Essential Fish Habitat

Marine EFH is designated in the study area for arctic cod, saffron cod, and five species of Pacific salmon; however, salmon are infrequently encountered in the Beaufort Sea (see Section 3.12). Freshwater EFH is designated for pink and chum salmon in the Canning/Staines, Kavik/Shaviovik, and Sagavanirktok Rivers; however, salmon are infrequently encountered on the ACP (see Section 3.12). Consultation with NMFS regarding EFH is provided in Appendix T.

Project activities under Alternative B that could affect Pacific salmon, arctic cod, and saffron cod EFH include construction of and water withdrawal for ice roads, dredging and screeding to accommodate barges, and vessel traffic. Marine and freshwater withdrawal and ice road construction would occur during winter when arctic cod and salmon would not be present, and ice roads would be slotted at fish streams before breakup to allow fish passage. Dredging and screeding would affect a small amount of habitat (approximately 3 acres). Sediment deposition would reestablish the habitat adjacent to the bulkhead over time after sealift barging ceased; however, screeding for coastal barges would occur annually. Vessel traffic could affect EFH because repeated disturbances from noise and prop wash could mask biologically important sounds; however, this would occur for discrete periods of time and would be concentrated during barge docking activities at Point Thomson. Overall, impacts to EFH would be minor, temporary, possible, and local. NMFS has determined that dredging and screeding to accommodate barges, marine and freshwater water withdrawal, and ice road construction could result in adverse impacts to EFH (see Appendix T). However, mitigation measures listed in Table 4.4-2 and below in Section 5.12.7, Mitigative Measures, may avoid and minimize impacts to fish and EFH.

5.12.3.4 Alternative B: Arctic National Wildlife Refuge

Alternative B would not likely affect fish and fish habitat of the Arctic Refuge. Spills that could affect fish, invertebrates, and habitat resources of the Arctic Refuge are considered in Section 5.24, Spill Risk and Impact Assessment.

5.12.4 Alternative C: Inland Pads with Gravel Access Road

Under Alternative C, project components would be shifted inland to the extent practicable and a gravel access road between Endicott Spur Road and Point Thomson would be constructed. No barging would be allowed and barge facilities would not be built. The location of proposed infrastructure and the proximity to fish streams and currently permitted water withdrawal sources is shown on Figure 5.6-3 and 5.6-4.

5.12.4.1 Alternative C: Construction

Ice Infrastructure

Ice infrastructure, primarily ice roads, would be a prominent component of Alternative C during construction because all materials, modules, and supplies would be transported by ice road. Table 2.4-7 describes the ice roads that would be used. The number of stream crossings associated with ice roads for Alternative C is shown in Table 5.6-3). The impacts from ice roads on fish, invertebrates, and habitat during construction would be similar to those discussed under Alternative B.

Ice pads constructed under Alternative C would be similar to those described for Alternative B, although they could be built in different locations and would include ice pads adjacent to gravel mines developed for gravel access road construction (discussed under Gravel Mining below). The types of impacts to fish, invertebrates, and habitat from ice pads would be similar to those described for Alternative B.

Gravel Infrastructure

The primary impacts to fish from construction would be placement of bridges and culverts along gravel roads. The number of stream crossings under Alternative C is shown in (Table 5.6-3; see also Section 5.6, Hydrology).

The infield gravel roads under Alternative C would be longer than roads under Alternative B and would be oriented more parallel to hydrologic drainage. Many of the same streams would be crossed in Alternative C as Alternative B, with the crossings occurring farther inland. Because the stream crossings are farther inland and farther from anadromous reaches than Alternative B, impacts to anadromous streams from crossings would be less for Alternative C.

For the gravel road, 46 streams would be crossed (Table 5.6-3), six of which are classified as anadromous (Sagavanirktok River, East Sagavanirktok Creek, Kadleroshilik River, West Shaviovik Creek, Shaviovik River, and Stream 3 [East Badami Creek]) and are known to or may provide overwintering fish habitat (see Section 3.12.4, Freshwater Fish Habitat, and Figures 3.12-3 and 5.6-3). 27 streams would be crossed by bridges, including five major streams (Sagavanirktok River, Kadleroshilik River, Shaviovik River, an unnamed stream [east of the Shaviovik River], and Stream 3 [East Badami Creek]). The crossings would be located downstream from known overwintering areas for Dolly Varden and arctic grayling. Bridge types are summarized in Table 2.4-10; specific construction methods have not been identified for these stream crossings. The types of impacts from bridge construction would be similar to those discussed for Alternative B, except more bridge crossings would be required under Alternative C due to the all-season gravel road and there is a greater possibility of impacting anadromous streams and streams that provide passage to overwintering and spawning habitat. Impacts to water quality are discussed in detail in Section 5.7, Water Quality.

The remaining fish-bearing streams would be crossed by using culverts or culvert batteries constructed from structural line pipe and corrugated multiplate culvert as described for Alternative B (Section 5.12.3.1). While none of these streams is classified as anadromous, resident fish, particularly arctic grayling and Dolly Varden, occur in streams in the western portion of the study area. Arctic grayling spawning and rearing areas in small tundra streams could be impacted by culverts at stream crossings.

Dolly Varden is one of the two most abundant fish species captured in the western portion of the study area and they contribute to sport fisheries in the Sagavanirktok River. The number of Dolly Varden found per drainage is relatively small, but in aggregate the streams represent important summer rearing habitat for Dolly Varden. The Sagavanirktok River (in the western study area) is thought to harbor the largest Dolly Varden populations on the North Slope.

Gravel Mining

Under Alternative C, gravel would be mined from an infield gravel mine south of the location in Alternative B and five smaller mines would be located along the proposed gravel access road corridor from Endicott to Point Thomson (see Section 2.4.4.4, Support Facilities and Waste Disposal).

The infield gravel mine would be developed and rehabilitated similar to Alternative B and the types of benefits for and impacts to fish from the mine site would be similar to those discussed for Alternative B. However, the Alternative C mine site would be built in an area with wetlands that have a surface water connection to Stream 24, a fish-bearing stream (Appendix K, Wetlands Functional Assessment). Approximately 0.5 acre of these wetlands would be affected. Fish have not been sampled within the proposed mine site, but ninespine stickleback would be the most likely species present. Dolly Varden have not been caught as far upstream as the mine site (Winters and Morris 2004). Impacting certain wetland types could affect fish habitat quality; wetland impacts are discussed in Section 5.8, Vegetation and Wetlands, and Table 5.8-7.

The five gravel mines for the all-season gravel road could be constructed in river floodplains and on tundra. In addition to the same types of impacts noted above for the infield mine, mines sited in river floodplains have potential for impacts to fish during construction (see Pile Driving/Blasting below) and have the potential for fish colonization. Deep water reservoirs in river floodplains could provide overwintering habitat for resident and anadromous species, such as arctic grayling and Dolly Varden, but fish that colonize these habitats would be confined to the reservoir except during spring flooding events. Arctic grayling and Dolly Varden would likely colonize gravel mine sites located in the floodplains of larger streams during high water because arctic grayling typically migrate throughout drainages at peak discharge in spring for feeding and rearing, and Dolly Varden move from overwintering areas into marine waters and ascend smaller streams to rear during this time (Section 3.12). If arctic grayling and Dolly Varden colonize flooded gravel mines within the floodplains of larger streams under Alternative C, likelihood of survival is good, especially if mines are rehabilitated or given a connection with the floodplain (Roach 1993).

The tundra mines would have little potential for fish colonization and the types of impacts from gravel mining would be similar to construction of the infield gravel mine.

Emergency Response Boat Launch

Types of impacts from construction of the emergency response boat launch would be the same as in Alternative B.

Pile Driving/Blasting

Pile driving would be used to install bridges and blasting would be used to excavate the gravel mines. The Sagavanirktok and Shaviovik Rivers that would be crossed by the gravel access road provide overwintering habitat for Dolly Varden, broad whitefish, and other species (Section 3.12); documented overwintering areas in the East Channel Sagavanirktok River may be within impact areas for pile driving (Morris 2000).

If a gravel mine site for the gravel access road is placed in the Sagavanirktok River floodplain, it could be located near a fish overwintering area. Impacts to overwintering fish from blasting at this mine site could be avoided or minimized by locating the mine site away from known overwintering areas (ADF&G 1991, Morris 2000). Other potential mine sites are not located near fish overwintering habitats.

The types of potential impacts from pile driving and blasting noise would be the same as those identified under Alternative B; impacts would be similar to Alternative B, except that under Alternative C, pile driving and blasting would only occur near freshwater habitats. Additionally, more blasting and pile driving would occur under this alternative due to the increased need for gravel and bridges required under this alternative.

Pipeline/VSM Crossings

Under Alternative C, the export pipeline would tie into the existing pipeline system at Endicott, rather than to the existing Badami pipeline, and would require several major stream crossings (See Section 5.6, Hydrology). The number of stream crossings is shown in Table 5.6-3. While VSM placement would avoid streams and water bodies to the extent possible, wide or braided rivers may be too wide for VSM spacing and VSMs would be constructed within river channels or floodplains (see Section 5.6, Hydrology). Because of the width of stream beds and floodplains in the western portion of the study area, VSMs under Alternative C would likely have a greater impact on fish habitat than Alternative B. Impacts to freshwater fish habitat during construction include temporary changes in water quality from increased sedimentation.

Impacts associated with construction of the infield gathering lines would be the same as Alternative B.

Water Withdrawal

Water sources under Alternative C would be the same as those identified in Alternative B. Impacts to fish and invertebrates from water withdrawals from water sources that provide habitat for overwintering fish would be the same as in Alternative B.

Water Distribution

An infield pipeline installed on timber supports would be constructed along an alignment following the access road system from the C-1 water source to the Central Pad; timber spacing would be adjusted to accommodate stream crossings, so that no timbers would be placed in streams (see Section 2.4.4.1, Well and Production Pads). Construction of the water distribution system is not expected to result in impacts to fish, invertebrates, or their habitat.

Tundra Travel

Impacts from tundra travel during construction would be the same as described for Alternative B.

Power Distribution

Power lines supplying the airstrip and mine would be buried in the roadbed, and would not cause any additional impacts beyond those from construction of infield gravel roads. Impacts from infield gravel road construction are discussed above.

5.12.4.2 Alternative C: Drilling and Operations

Under Alternative C, drilling would occur during Years 5 through 7; operations would begin during drilling and continue for the life of the project. Impacts to fish would be similar during drilling and operations. Activities that could affect fish and fish habitat include use and maintenance of the gravel access road and infield road infrastructure and maintenance of infield and export pipelines. The effect of spills on fish and invertebrates during drilling and operations is discussed in Section 5.24, Spill Risk and Impact Assessment.

Ice Roads

During operations, ice roads would be built occasionally to support pipeline maintenance activities. The types of impacts from ice roads on fish, invertebrates, and habitat would be similar to Alternative B.

Gravel Infrastructure

Permanent gravel infrastructure would affect freshwater fish and invertebrate habitat through long-term hydrologic modifications associated with bridges and culverts and dust from transportation activities and road maintenance. The types of impacts to fish, invertebrates, and habitat from gravel infrastructure under Alternative C would be similar to Alternative B. Impacts from Alternative C would be greater than Alternative B because the gravel access road crosses a greater number of fish streams, including anadromous streams and streams that provide overwintering habitat.

Gravel Mines

Benefits for and impacts to fish from the infield gravel mine once it becomes a reservoir would be similar to Alternative B. However, it would be less likely for Dolly Varden to colonize the reservoir because it would be located farther upstream from where Dolly Varden have been documented.

Gravel mine sites from the gravel access road would have similar benefits and impacts as those discussed for construction.

Emergency Response Boat Launch

Impacts from the permanent placement of the emergency response boat launch would be the same as Alternative B.

Pipeline/VSM Crossings

Long-term impacts to fish habitat from export pipeline VSMs located in stream and river channels include scouring and potential entrainment of small fish in the scoured areas. The impacts would be similar to the long-term impacts of culverts and bridge abutments placed in the stream channel.

Water Withdrawal

Under Alternative C, water needs would decrease compared to Alternative B after construction of the gravel access road. Water sources during drilling and operations would be the same as those used for construction, with the C-1 reservoir being the primary water source. The types of impacts to fish and invertebrates from water withdrawal from currently permitted water sources during operations would be the same as discussed under Alternative B.

Water Distribution

No impacts to fish from a waterline above the tundra are anticipated.

Tundra Travel

Impacts from tundra travel during drilling and operations would be the same as described for Alternative B.

Power Distribution

Fish habitat could be impacted by the power distribution lines buried in the road if a power cable needs to be dug up and maintained near a stream or water body. The impact would occur rarely and would have the potential to increase sedimentation in fish habitat. Types of impacts would be the same as those discussed under Alternative B.

Impacts Summary

Table 5.12-3 summarizes the potential impacts of Alternative C on fish, invertebrates, and habitat. Potential impacts would be greater for Alternative C because of the fish streams crossed by the gravel access road.

Table 5.12-3: Alternative C—Impact Evaluation for Fish, Invertebrates, and Habitat

Project Activity/ Component	Magnitude	Duration	Potential to Occur	Geographic Extent
Sea or Tundra Ice Roads	Minor	Medium term	Possible	Local to extensive
Ice Pads and Ice Airstrip	Minor	Temporary	Possible	Extensive
Gravel Roads, Bridges, and Culverts	Moderate	Long term	Possible	Extensive
Gravel Pads and Airstrip	Minor	Long term	Possible	Limited
Gravel Mine	Minor	Medium to long term	Possible	Extensive
Gravel Mining	Moderate	Temporary	Possible	Extensive
Emergency Response Boat Launch	Minor	Long term	Possible	Limited
Pipelines/VSMs	Minor	Long term	Possible	Extensive
Pile Driving/Blasting	Moderate	Temporary	Probable	Extensive
Water Withdrawal: C-1 Reservoir	Moderate	Long term	Probable	Limited
Water Withdrawal: Other Sources	Moderate	Medium term	Probable	Extensive
Water Distribution	No impacts	No impacts	No impacts	No impacts
Tundra Travel	Minor	Temporary	Possible	Limited
Power Distribution	Minor	Temporary	Probable	Limited

5.12.4.3 Alternative C: Essential Fish Habitat

Project activities under Alternative C that could affect EFH include:

- Construction of and water withdrawal for ice road construction (tundra and sea ice roads)
- Construction of bridges and culverts over freshwater EFH (Sagavanirktok, Kavik, and Kadleroshilik Rivers [Johnson and Blanche 2011]) for the gravel access road.

Potential for marine EFH impacts would be reduced under Alternative C because:

- Barge infrastructure would not be constructed and no barging would occur and because
- The East and West Pads and the Central Processing Pad and processing facilities would be located farther from the coast

Overall, impacts to EFH would be minor, long term, possible, and local. Alternative C could adversely affect EFH because of the construction of bridges and culverts over anadromous fish streams, marine and freshwater water withdrawal, and ice road construction. Mitigation measures listed in Table 4.4-2 and below in Section 5.12.7, Mitigative Measures, would minimize impacts to fish and EFH from water withdrawal and ice road construction.

5.12.4.4 Alternative C: Arctic National Wildlife Refuge

Alternative C would not likely affect fish and fish habitat of the Arctic Refuge. Spills that could affect fish and fish habitat of the Arctic Refuge are considered in Section 5.24, Spill Risk and Impact Assessment.

5.12.5 Alternative D: Inland Pads with Seasonal Ice Access Road

Under Alternative D, project components would be shifted inland to the extent practicable and no barging would be allowed. The location of proposed infrastructure and the proximity to fish streams and currently permitted water withdrawal sources is shown on (see Figure 5.6-5 and Figure 5.6-6).

5.12.5.1 Alternative D: Construction

The construction program under Alternative D would include ice infrastructure, water withdrawal, gravel infrastructure and mining, pile driving and blasting, pipeline and VSM installation, and installation of a water diversion structure to fill the gravel mine.

Ice Infrastructure

All materials, modules, and supplies for construction would be mobilized to Point Thomson via ice roads. Ice roads that would be used during construction would be the same as Alternative C. Construction of and impacts from ice roads would be similar to those discussed under Alternative B.

Ice pads constructed under Alternative D would be similar to those described for Alternative B, although they could be built in different locations. The impacts to fish from ice pads would be similar to those described for Alternative B.

A tundra ice airstrip would be used until the completion of the gravel airstrip. An ice airstrip would have similar impacts to fish and fish habitat as ice roads, except that there would be no stream crossings.

Gravel Infrastructure

The primary impacts to fish from construction of gravel infrastructure would be placement of bridges and culverts along gravel roads. The number of stream crossings under Alternative D is shown in Table 5.6-3 (see also Section 5.6, Hydrology). The infield gravel roads under Alternative D would be similar to Alternative C and the impacts would be similar.

Gravel Mining

Under Alternative D the gravel mine site would be in the same location as proposed for Alternative B. Once gravel extraction was completed for Alternative D, a diversion channel would be constructed from Stream 24 to the mine site to fill the mine with water. The resulting reservoir would become the primary water source for the project. Water would be diverted during spring/early summer breakup, potentially redirecting up to 80 percent of normal spring flows for three consecutive years. After the reservoir was filled, less than 5 percent of spring flows would divert from Stream 24 to the reservoir (See Section 5.6, Hydrology). During the initial years when the reservoir is filling, reduced flow during spring breakup could impact the ability of fish, most likely Dolly Varden, to move up and downstream during that time period. Water diversion would occur at the same time Dolly Varden ascend streams to feed for the summer and insufficient stream water depth, lack of scouring flows to maintain deeper stream sections, and changes in the flow regime could affect fish passage within Stream 24. Dolly Varden have been documented in low abundance in Stream 24 downstream of the diversion and have not been captured upstream of the diversion (Winters and Morris 2004). Dolly Varden have not been documented spawning in Stream 24 (Winters and Morris 2004).

The diversion channel would provide direct access to the gravel mine reservoir from Stream 24 and the reservoir could provide overwintering habitat for Dolly Varden. The diversion channel would provide access between the reservoir and the stream only during spring flood flows and fish would be confined to the reservoir during the rest of the year.

Pile Driving/Blasting

Pile driving would be used to install the bridges and blasting would be used to excavate the gravel mine. Pile driving and blasting would not affect fish because fish would not be present in the area in winter when these activities would occur.

Pipeline/VSM Crossings

Under Alternative D, the export pipeline would tie into the Badami pipeline. Combined, the export and infield gathering pipelines would cross streams (See Section 5.6, Hydrology). The number of stream crossings is shown in Table 5.6-3. Types of impacts to fish associated with pipeline construction activities would be the same as Alternative B.

Emergency Response Boat Launch

An emergency response boat launch would be built adjacent to the Central Well Pad, as in Alternative B Construction (see Section 2.4.6.1, Well and Production Pads). The types of impacts from construction of the emergency response boat launch would be the same as in Alternative B.

Water Withdrawal

The sources of water and types of impacts to fish from water withdrawal would be the similar to Alternatives B and C. The C-1 reservoir would be the primary water supply for infield construction activities. The level of impacts to fish would be similar to Alternative C.

Water Distribution

No impacts to fish, invertebrates, or habitat are anticipated from trucking freshwater from the C-1 reservoir during construction. The construction of a waterline in the gravel access road would not impact fish, invertebrates, or habitat beyond impacts associated with gravel road construction.

Tundra Travel

Impacts from tundra travel during construction would be the same as described for Alternative B.

Power Distribution

The types of construction impacts from trenching power cables in the tundra would be the same as Alternative B. The placement of power cables on the VSMs would not impact fish beyond the impacts discussed for construction of the VSMs and pipelines.

5.12.5.2 Alternative D: Drilling and Operations

Under Alternative D, drilling would occur during years 5 through 9, and operations would begin during drilling and continue for the life of the project. Impacts to fish would be similar during drilling and operations. Activities that could affect fish and fish habitat include use of the gravel mine site as the primary water source, use and maintenance of gravel infield road infrastructure, and maintenance of infield and export pipelines. The effect of spills on fish and invertebrates during drilling and operations is discussed in Section 5.24, Spill Risk and Impact Assessment.

Ice Infrastructure

During operations, a tundra ice road would be built yearly to connect Point Thomson to Endicott Spur Road and ice roads would be built occasionally to support pipeline maintenance activities. The types of impacts due to the tundra ice roads would be similar to Alternative B Construction.

Gravel Infrastructure

Permanent gravel infrastructure could affect freshwater fish and invertebrate habitat through long-term hydrologic modifications and dust. The types of impacts to fish, invertebrates, and habitat from gravel infrastructure under Alternative D would be similar to Alternative B.

Gravel Mine

The diversion from Stream 24 and the gravel mine reservoir would remain in place during operations and would continue to divert spring flood water from the stream to the reservoir annually. The amount of water diverted during operations would not likely affect fish movements or habitat (See Section 5.6, Hydrology). The reservoir could provide long-term habitat for fish and invertebrates, including overwintering habitat. Similar outcomes have been observed for other reclaimed gravel mine sites with surface water connections to tundra streams on the North Slope (Roach 1993). Fish that colonize the mine site reservoir would benefit from the new habitat; however, these fish would be confined to the reservoir except during spring flood events.

Emergency Response Boat Launch

The emergency response boat launch would be a permanent facility at Point Thomson. Impacts to fish and invertebrate habitat from the launch would be the same as those in Alternative B.

Pipeline/VSM Crossings

Impacts from pipeline/VSM stream crossings would be the same as Alternative B; however, fewer streams would be crossed under this alternative. Number of stream crossings under this alternative is shown in Table 5.6-3.

Water Withdrawal

The types of impacts to fish and invertebrates from water withdrawal from currently permitted water sources and the mine site reservoir during drilling and operations would be the same as discussed under Alternative B, Construction. The magnitude of impacts would be similar to impacts described for other alternatives assuming that permit stipulations would maintain water levels needed for overwinter survival of fish and continued recharge of water sources. However, the impacts would last for the life of the project because ice roads between the Endicott Spur and Point Thomson facilities would be needed annually.

Water Distribution

Trucking water during drilling and piping water during operations would not likely affect fish, invertebrates, or fish habitat.

Tundra Travel

Types of impacts from tundra travel during drilling and operations would be the same as described for Alternative B.

Power Distribution

Fish habitat could be impacted by the power distribution lines buried in the tundra if the power cable needs to be dug up and maintained near a stream or water body. The impact would occur rarely and would have the potential to increase sedimentation in fish habitat, and would be similar to that described under Alternative B, though a much small area would be affected. Power lines on the VSMs could affect fish if maintenance is needed during the summer and tundra travel is necessary to make the repairs; these impacts would the same as those described for Alternative B.

Impacts Summary

Table 5.12-4 summarizes the potential impacts of Alternative D on fish, invertebrates, and habitat.

Table 5.12-4: Alternative D—Impact Evaluation Fish, Invertebrates, and Habitat

Project activity/Component	Magnitude	Duration	Potential to Occur	Geographic Extent
Sea or Tundra Ice Roads	Minor	Medium term	Possible	Local to extensive
Ice Pads and Ice Airstrip	Minor	Temporary	Possible	Limited
Gravel Roads, Bridges, and Culverts	Moderate	Long term	Possible	Local
Gravel Pads and Airstrip	Minor	Long term	Possible	Limited
Gravel Mining	Moderate	Temporary	Possible	Limited
Gravel Mine Reservoir and Stream Diversion	Moderate	Medium to long term	Probable	Local
Emergency Response Boat Launch	Minor	Long term	Possible	Limited
Pipelines/VSMs	Minor	Long term	Unlikely	Extensive
Pile Driving/Blasting	Minor	Temporary	Unlikely	Local
Water Withdrawal: C-1 Reservoir	Moderate	Long term	Probable	Limited
Water Withdrawal: Other Sources	Moderate	Long term	Probable	Extensive
Water Distribution	No impacts	No impacts	No impacts	No impacts

Table 5.12-4: Alternative D—Impact Evaluation Fish, Invertebrates, and Habitat				
Project activity/Component	Magnitude	Duration	Potential to Occur	Geographic Extent
Tundra Travel	Minor	Temporary	Possible	Limited
Power Distribution	No impacts	No impacts	No impacts	No impacts

5.12.5.3 Alternative D: Essential Fish Habitat

Essential fish habitat is defined and EFH in the study area is described in Section 3.12.6. Project activities under Alternative D that could affect EFH include construction of and water withdrawal for tundra and sea ice roads. Potential for marine and freshwater EFH impacts is reduced under Alternative D because:

- Barge infrastructure would not be constructed and no barging would occur (compared to Alternative B and similar to Alternative C)
- East and West Pads and the Central Processing Pad and facilities would be located farther from the coast (compared to Alternative B and similar to Alternative C)
- The gravel access road would not be constructed (compared to Alternative C and similar to Alternative B)

Overall, impacts to EFH would be minor, temporary, possible, and local. NMFS has determined that marine and freshwater water withdrawal and ice road construction could result in adverse impacts to EFH (see Appendix T). However, mitigation measures listed in Table 4.4-2 and below in Section 5.12.7, Mitigative Measures, may avoid and minimize impacts to fish and EFH.

5.12.5.4 Alternative D: Arctic National Wildlife Refuge

Alternative D would not likely affect fish and fish habitat of the Arctic Refuge. Spills that could affect fish and fish habitat of the Arctic Refuge are considered in Section 5.24, Spill Risk and Impact Assessment.

5.12.6 Alternative E: Coastal Pads with Seasonal Ice Access Road

Under Alternative E, the footprint of gravel roads would be minimized and the airstrip would be shortened. The project would rely on seasonal ice roads for access to the East and West Pads. The location of proposed infrastructure and the proximity to fish streams and currently permitted water withdrawal sources is shown on Figure 5.6-7 and Figure 5.6-8.

5.12.6.1 Alternative E: Construction

Construction would last for 3 years and would overlap with drilling activities. Construction components that could impact fish, invertebrates, or their habitats include ice and gravel infrastructure, gravel mining, barging and associated facilities, pipeline and VSM construction, and water withdrawal.

Ice Infrastructure

Seasonal ice roads that would be used to support construction would include a sea or tundra ice road from Endicott Spur Road to Point Thomson for transportation of materials and supplies, a tundra ice road from Badami to Point Thomson to support export pipeline construction, and infield ice roads to support construction of pads, airstrip, and gathering pipelines (Table 2.4-24). The number of stream crossings for each ice component is shown in Table 5.6-3. Ice roads would be similar to those described for Alternative B and types of impacts to fish, invertebrates, and habitat would be similar.

Ice pads would be used for temporary construction camps, stockpiling of gravel and overburden excavated from the gravel mine, and to extend gravel pads during drilling activities. Impacts from ice pads on fish and fish habitat would be similar to impacts from ice roads, except that there would be no stream crossings.

A sea ice airstrip would be built seasonally until the completion of the gravel airstrip. An ice airstrip would have similar impacts to fish and fish habitat as ice roads, except that there would be no stream crossings.

Gravel Infrastructure

Impacts to fish and invertebrates from gravel road, bridge, and culvert construction would be reduced under Alternative E because only one stream would be crossed (Table 5.6-3) and there would be fewer miles of gravel road. However, impacts from pads and the airstrip could increase because the larger Central Pad could affect a pond that may provide seasonal fish habitat and the airstrip could cross Stream 23.

Gravel Mining

Construction activities and types of impacts to fish, invertebrates, and their habitat from Alternative E would be the same as in Alternative B, but impacts would be reduced because the size of the impact area would be smaller.

Barge Offloading Facilities

Alternative E would include the same barge facilities for coastal and sealift barges described for Alternative B. The impacts to fish, invertebrates, and habitat from barge facility construction would be the same as Alternative B.

Under Alternative E, dredged material from barge landing areas would be disposed of on a gravel spit, as shown on Figure 2.4-9. Impact types would be similar to those in Alternative B, except there would be no impacts to salt marsh because the proposed disposal site is surrounded on both sides by marine nearshore waters.

Barge Bridge

Modules for the processing facility would be transported to the Central Pad by sealift barges as described for Alternative B. The impacts to fish and invertebrates from the barge bridge would be the same as Alternative B.

Vessel Traffic

Noise and prop wash impacts from barges and tugs would be the same as Alternative B.

Emergency Response Boat Launch

The types of impacts from construction of the emergency response boat launch would be the same as Alternative B.

Pipeline/VSM Crossings

Impacts associated with pipeline construction activities would be the same as Alternative B.

Pile Driving/Blasting

The types and level of impacts from pile driving and blasting noise would be the same as those identified under Alternative B.

Water Withdrawal

The types of impacts to fish and invertebrates from water withdrawal from currently permitted water sources would be the same as described for previous alternatives. The magnitude of impacts would be similar to impacts described for other alternatives assuming that permit stipulations would maintain water levels needed for overwinter survival of fish and continued recharge of water sources. Because of the volume of water needed and the need to refurbish multi-season ice pads and construct infield ice roads, a greater number of water sources may be needed compared to other alternatives, depending on the total volume of water used and the recharge rates of various water bodies.

Water Distribution

An infield water pipeline would be constructed on VSMs between the C-1 water source and the operations camp; all stream crossings would be accommodated by adjusting the spacing of VSMs, reducing impacts to fish habitat (see Section 2.4.6.1, Well and Production Pads). Impacts to freshwater habitat would be the same as those for pipeline/VSM crossings above, except they would affect a more limited area.

Tundra Travel

Impacts from tundra travel during drilling and operations would be the same as described for Alternative B.

Power Distribution

Power lines supplying the airstrip and mine would be elevated 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, power line would be trenched within the tundra to the airstrip. Along the pipeline route, no additional impacts are expected beyond those from construction of the water pipeline and VSM supports. Impacts from trenching would be similar to those described in Alternative B, except the trenching distance would be shorter, and streams are not expected to be crossed.

5.12.6.2 Alternative E: Drilling and Operations

Under Alternative E, drilling would occur during years 4 through 8 and operations would begin during drilling and continue for the life of the project. Impacts to fish would be similar during drilling and operations. Activities that could affect fish and fish habitat include use and maintenance of infield road infrastructure, construction of ice roads, barging, and maintenance of infield and export pipelines. The effect of spills on fish and invertebrates during drilling and operations is discussed in Section 5.24, Spill Risk and Impact Assessment.

Ice Infrastructure

The types of impact from ice roads on fish and fish habitat would be the same as those described for Alternative B construction, but impacts would be greater due to the increased need for infield ice roads under this alternative.

Impacts from ice pads would be similar to those described for Alternative B.

Gravel Infrastructure

Because the primary impacts associated with gravel fill are the culverts and bridges associated with gravel roads, impacts from gravel would be minimized in Alternative E. Stream 23 would be the only stream directly impacted with a crossing structure. The gravel airstrip may impact Stream 23. The enlarged Central Pad could directly affect a pond that may provide fish habitat.

Gravel Mine

The reservoir resulting from gravel extraction could become fish habitat for fish, most likely ninespine stickleback (see also Alternative B). Fish that colonize the reservoir would be confined to the reservoir except during spring flood events.

Barge Offloading Facilities

The low bulkhead and coastal barge dock would be used annually during the ice free season to transport materials from West Dock to the Central Pad. The high bulkhead would not be used during operations. The dock pilings and mooring dolphins would be permanent structures in the nearshore environment. Impacts and benefits to fish and invertebrates associated with barge facilities would be the same as Alternative B.

Emergency Response Boat Launch

The types and level of impacts from the boat launch would be the same as those described for Alternative B.

Pipeline/VSM Crossings

Impacts from pipeline/VSM stream crossings during drilling and operations would be the same as in Alternative B.

Vessel Traffic

Noise and prop wash from barges and tugs would have the same impacts to fish as described for Alternative B.

Water Withdrawal

The types of impacts to fish and invertebrates from water withdrawal from currently permitted water sources would be the same as described for previous alternatives. The magnitude of impacts would be similar to impacts described for other alternatives assuming that permit stipulations would maintain water levels needed for overwinter survival of fish and continued recharge of water sources. Because of the volume of water needed and the annual need for infield ice roads, a greater number of water sources may be needed compared to other alternatives, depending on the total volume of water used and the recharge rates of various water bodies. The impact to fish and fish habitat would be long term, lasting for the lifetime of the project.

Water Distribution

The water distribution pipeline would not be expected to affect fish, invertebrates, or habitat.

Tundra Travel

Tundra travel would be more likely to occur under Alternative E than other alternatives because there are no gravel roads connecting the Central Pad to the East and West Pads. Tundra-safe, low pressure vehicles would be used when allowed to support drilling and operations when air support or ice road access could not be used to access the pads, such as emergencies (Appendix G, North Slope Construction Methods; 2.4.3 Alternative B: Applicant's Proposed Action). Impacts from stream crossings could affect sensitive life stages of fish (e.g., eggs, juvenile fish, overwintering resident fish; ADF&G 2011c). Because there is no identified spawning or overwintering areas within the Point Thomson field and most area waters freeze to substrate, impacts to fish and fish habitat are expected to be minor.

Power Distribution

During operations the power distribution system would not likely affect fish, invertebrates, or habitat.

Impacts Summary

Table 5.12-5 summarizes the potential impacts of Alternative E on fish, invertebrates, and habitat.

Table 5.12-5: Alternative E—Impact Evaluation for Fish, Invertebrates, and Habitat

Project Activity/Component	Magnitude	Duration	Potential to Occur	Geographic Extent
Sea or Tundra Ice Roads	Minor	Medium term	Possible	Local to extensive
Ice Pads and Ice Airstrip	Minor	Temporary	Possible	Limited
Gravel Roads and Culverts	Minor	Long term	Possible	Limited
Gravel Pads and Airstrip	Minor	Long term	Possible	Limited
Gravel Mining	Minor	Temporary	Possible	Limited
Gravel Mine	Moderate	Medium to long term	Unlikely	Local
Emergency Response Boat Launch	Minor	Long term	Possible	Limited
Pipelines/VSMs	Minor	Long term	Unlikely	Extensive
Pile Driving/Blasting	Minor	Temporary	Unlikely	Local
Water Withdrawal: C-1 Reservoir	Moderate	Long term	Probable	Limited
Water Withdrawal: Other Sources	Moderate	Long term	Probable	Extensive
Water Distribution	Minor	Temporary	Possible	Limited
Tundra Travel	Minor	Temporary	Probable	Limited
Power Distribution	Minor	Temporary	Probable	Local

5.12.6.3 Alternative E: Essential Fish Habitat

Project activities under Alternative E that could affect EFH include construction of and water withdrawal for ice roads, dredging and screeding to accommodate sealift barges, and vessel traffic. Marine and freshwater withdrawal and ice road construction would not likely affect EFH because arctic cod and salmon would not be present during winter and ice roads would be slotted at fish streams before breakup to allow fish passage. Dredging and screeding would affect a small amount of habitat (approximately 3 acres) and sediment deposition would reestablish the habitat over time after sealift barging ceased. Vessel traffic could affect EFH because repeated disturbances from noise and prop wash could mask biologically important sounds; however, this would occur for discrete periods of time and would be concentrated during barge docking activities at Point Thomson. Overall, impacts to EFH would be minor, temporary, possible, and local. NMFS has determined that dredging and screeding to accommodate barges, marine and freshwater water withdrawal, and ice road construction could result in adverse impacts to EFH (see Appendix T). However, mitigation measures listed in Table 4.4-2 and below in Section 5.12.7, Mitigative Measures, may avoid and minimize impacts to fish and EFH.

5.12.6.4 Alternative E: Arctic National Wildlife Refuge

Alternative E would not likely affect fish and fish habitat of the Arctic Refuge. Spills that could affect fish, invertebrates, and habitat resources of the Arctic Refuge are considered in Section 5.24, Spill Risk and Impact Assessment.

5.12.7 Mitigative Measures

This section describes measures to mitigate impacts to fish, fish habitat, and invertebrates from the Point Thomson Project. The Applicant has proposed design measures that would be included as part of the project; BMPs and permit requirements would be stipulated by federal, state, and local agencies, and the Corps has considered additional mitigation measures.

5.12.7.1 Applicant's Proposed Design Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on fish, EFH, and invertebrates.

- Minimizing impact to natural stream flow conditions through application of hydrology study results to pad, road, bridge, and culvert design using conservative criteria.
- Constructing ice roads in a manner that protects fish habitat and slotting ice roads at designated stream crossings at the end of the season.
- Limiting lake withdrawal volumes and using proper withdrawal methods to protect fish.
- Implementing a tracking system including coordination with other water users to ensure water withdrawal limitations are met.
- Maintaining natural stream flow through the design of bridges and culverts to accommodate fish passage.
- Implementing spill prevention and response programs, as detailed in Section 5.24, Spill Risk and Impact Assessment.
- Managing snowmelt and runoff under site-specific SWPPPs to protect water quality.
- Using long-reach directional drilling to develop offshore resources without placing drilling structures in marine waters.
- Limiting dredging/screeding for the barge-bridge system and service pier to a small area in the vicinity of the Central Pad (Alternatives B and E only).
- Dredging the barge landing area through the ice during the winter preceding an open water sealift to minimize sedimentation effects on water quality.
- Limiting structures in marine waters to six vertical piles for the service pier and eight mooring dolphins for barge landings (Alternatives B and E only), and a small boat launch at the shoreline (all action alternatives).
- Locating the sealift bulkhead and approach gravel ramp for the service pier above MHW to minimize the effect on sediment transport or deposition (Alternatives B and E only).
- Maintaining the barge-bridge system in place for the minimum time period needed to offload the modules (estimated 2 to 4 weeks) each sealift open water season, which limits the effects on coastal sediment transport (Alternatives B and E only).
- Conducting field surveys during breakup and other times to identify natural drainage patterns and to measure streamflows at proposed road crossings.
- Routing infield roads a sufficient distance inland to avoid coastal marshes and estuarine habitat, as well as major stream crossings.
- Routing the export pipeline and gathering lines to avoid locating VSMs in lakes, and crossing streams at locations that minimize the need for VSMs in active channels.

- Designing bridges and culverts at stream crossings for a 50-year flood design flow to reduce impacts to natural drainage to the extent practicable.
- Reducing surface discharge of wastewaters through use of a disposal well, including zero discharge of produced water and drilling wastes.
- Managing snow melt and runoff under site-specific Stormwater Pollution Prevention Plans (SWPPPs) to protect water quality.
- Implementing dust control measures for roads and construction areas to avoid impacts of dust on nearby water bodies.
- Constructing a permanent service pier on piles, not fill, for offloading coastal barges to reduce the number of barge trips and minimize disturbance to the ocean bottom and associated impacts to marine water quality (Alternatives B and E only).
- Installing mooring dolphins and pilings through the ice in the winter to minimize potential suspended sediment effects on water quality (Alternatives B and E only).
- Dredging the barge landing area through the ice during the winter preceding an open water sealift to minimize sedimentation effects on water quality (Alternatives B and E only).

5.12.7.2 BMPs and Permit Requirements

Permits from the Corps, ADNR, ADF&G, and NSB would address impacts to fish and fish passage. As discussed above in Section 5.12.3, Alternative B: Applicant's Proposed Action, permits would include the following BMPs and requirements that would avoid, minimize, and mitigate impacts to fish and fish passage:

- **Ice roads:** align ice roads to avoid deepwater pools where overwintering fish may be present, and slot ice roads at stream crossings before breakup to allow fish passage during spring flood events.
- **Water withdrawal from sources providing habitat for overwintering fish:** water sources must be permitted for water withdrawal; the amount of water permitted for withdrawal is stipulated for each water source; water sources must recharge sufficiently during the summer for a water source to be used as a water withdrawal source the following winter; water intake pipes used to remove water from fish-bearing waterbodies must be surrounded by a screened enclosure to prevent fish entrainment and impingement. Screen mesh size must be no greater than 1 mm (0.04 inches), unless another size has been approved by ADF&G; the maximum water velocity at the surface of the screen enclosure may be no greater than 0.1 fps, unless an alternative velocity has been approved by ADF&G.
- **Stream crossing structures:** design and construct bridges and culverts over fish-bearing streams to allow fish passage.
- **Blasting and pile driving:** detonation of explosives within or in proximity to fish-bearing waters must not produce instantaneous pressure changes that exceed 2.7 psi in the swim bladder of a fish. Detonation of explosives within or in close proximity to a fish spawning bed during the early stages of egg incubation must not produce a peak particle velocity greater than 0.5 inches per second.
- **Removal of snow** from fish-bearing rivers, streams and natural lakes is subject to prior written approval by ADF&G. Compaction of snow cover overlying fish-bearing waterbodies is prohibited except for approved crossings. If ice thickness is not sufficient to facilitate a crossing, ice or snow bridges may be required.

Additional permit stipulations may be required under the Magnuson-Stevens Fishery Conservation and Management Act. This Act provides for the conservation and management of the fishery resources of the U.S., including long-term protection of essential fish habitats. Consultation with NMFS will determine what, if any, permit stipulations would be required.

5.12.7.3 Corps-proposed Mitigation

In addition to the Applicant's proposed design measures and BMPs and permit requirements, the Corps, in consultation with others, is proposing the following actions to avoid or minimize impacts to fish and invertebrates:

- Where appropriate, consider placing gravel mine sites developed during construction of the 44-mile-long gravel access road at locations that enhance potential for colonization by fish species of interest such as Arctic grayling. Locations should be within floodplains of larger streams or connected to the floodplains.
- Prepare and implement an invasive species plan that addresses plants and aquatic species. The plan should include a simple analysis of the physical environment (salinity, temperature) of the likely ports of origin and a comparison provided between these data and similar data for the project area. BMPs for controlling invasive aquatic species should include measures to address species that can travel on the infrastructure of the vessel or be discharged from other waste streams, as well as ballast water exchange. This plan should be reviewed and approved by the Corps, in consultation with others, prior to start of construction.

5.12.8 Climate Change and Cumulative Impacts

5.12.8.1 Climate Change

Overall, populations and habitats could either be stressed or benefited by climate change in all alternatives. In the marine environment, sea ice has been thinning and shrinking and is expected to disappear during the summers in the Beaufort Sea in as few as 50 years (ACIA 2005). Sea ice edges are important regions that produce substantial phytoplankton blooms, which support many species of marine life, including invertebrates. If the ice cap were to disappear, then many species would need to locate a new prey base. Potential climate change effects could lead to increased freshwater runoff (Section 5.5, Physical Oceanography and Coastal Processes), decreasing the salinity of nearshore waters. This could negatively impact marine fish requiring a saline environment. Ocean acidification (Section 5.7, Water Quality) could negatively impact fish or invertebrates. A sudden decrease in pH could inhibit physiological functions. Even if organisms were able to adapt to a decrease in pH, the marine food web would likely be altered.

In the freshwater environment, increased snowfall would lead to increased spring runoff and changes in stream morphology with accompanying changes in fish habitat. Warmer winters would reduce the depth to which lakes and streams freeze, thus creating more overwintering habitat and increasing the productivity of algae and macroinvertebrates (NRC 2003a).

5.12.8.2 Cumulative Impacts

Past and present actions across the North Slope and in the Beaufort Sea nearshore marine environment include oil and gas exploration and development, scientific research and surveys, community development/capital projects, transportation (onshore, marine, and aircraft based), commercial fishing, military activities, disease, and global industrial pollutants. These activities will continue to occur and are likely to occur in the future in the nearshore marine habitat and near freshwater streams that support fish and invertebrates across the North Slope. Relevant and reasonable future actions in the study area include the full field development of Point Thomson and planned exploration activities in the Beaufort Sea OCS lease areas. Additionally, a Gas Treatment Plant is proposed in Prudhoe Bay as part of the Alaska Pipeline Project, which includes a gas line from Point Thomson to Prudhoe Bay. The plant would be the largest gas plant in the world and would include a large gravel footprint and large scale sealift activities during construction. A complete list of past, present, and RFFAs considered in this Final EIS is detailed in Section 4.2, Cumulative Impacts Methodology.

Potential cumulative impacts to fish and invertebrates could occur through additive impacts to water quality, disturbance, direct harvest or mortalities, degradation of fish and invertebrate habitat, impairment of fish passage or migration routes, and bioaccumulation of chemicals in fish tissue.

Drainage patterns are altered by the construction of roads or pads in or across wetlands or drainage areas. As of 2001, 9,225 acres of gravel footprint, which includes on and off-shore gravel pads, airstrips, and more than 544 miles of roadways, have been constructed in association with oil-field development on the North Slope (NRC 2003a). Industrial development on the eastern North Slope, however, has been relatively limited up until this point. (See Table 5.2-10 in Section 5.2, Soils and Permafrost, for the cumulative acreage of existing and potential oil and gas infrastructure on the eastern North Slope. During spring ice break-up, there is substantial flow across wetlands into lakes and streams. Fish use high water levels to disperse during spring ice break-up to reach small drainages and shallow lakes used for summer feeding. When long stretches of gravel road interrupt flow, the difference in water surface elevation from one side of the gravel surface to the other can produce high-velocity water flow in the cross-gravel drainage structures, typically culverts, which can inhibit upstream fish movements and delay migration to various summer habitats. An opposite effect can occur in mid- to late summer when stream flow is low. Reduction of flow from changes in drainage patterns can affect the ability of fish to reach deeper overwintering areas before shallower summer habitats freeze (NRC 2003a).

In addition to overwintering issues associated with blocked fish passage, the current practice for ice road construction is to permit withdrawals from a large number of lakes along a desired route, then to allow the ice road contractor to draw from the nearest suitable lake. While this provides flexibility for construction, it complicates tracking of withdrawal volumes, as substantially more water is permitted for withdrawal than is actually used. For example, between 1998 and 2001, Phillips Alaska used between 3.9 and 10.5 percent of its permitted water withdrawals (NRC 2003a). Current ADF&G policy, which limits water withdrawals from fish-bearing lakes to 15 percent of the estimated minimum winter water volume, seeks to preserve most of the water for wintering fish. Despite apparently arbitrary criterion, there are no data to support a different withdrawal volume, fish populations in lakes subjected to this maximum allowable withdrawal appear to be unaffected (NRC 2003a). Although the effects of withdrawals on populations of invertebrates have not been studied, cumulative impacts on invertebrates are not likely to be adverse because during winter most invertebrates inhabiting shallow lakes are in freeze-tolerant resting stages (BLM 2004).

Coastal facilities that change physical conditions that are important to nearshore biota pose the greatest risk of causing effects that accumulate in nearshore habitats. Such structures include causeways that can modify water temperature and salinity, and affect coastal fish movements. Existing causeways near Prudhoe Bay have been evaluated for potential fish blockage, and while the West Dock Causeway was found to block fish passage in certain wind conditions, it has since been modified to allow fish passage (NRC 2003a).

The action alternatives would contribute to a cumulative effect to fish and invertebrate habitat, with Alternative C having a greater potential impact to freshwater streams due to the length of the road and the creation of a parallel pipeline to a pipeline already in existence between Endicott and Badami. Alternative E has reduced impacts due to minimized gravel road and airstrip infrastructure. Adverse cumulative impacts to arctic fish populations found on the North Slope are not anticipated. In addition, past, present, and RFFAs are not expected to adversely affect the viability of fish and invertebrate populations. Cumulatively, non-oil and gas activities and spills would have little impact on fish and invertebrates (see Section 5.24, Spill Risk and Impact Assessment).

5.12.9 Alternatives Comparison and Consequences

All of the proposed action alternatives have the potential to affect fish, invertebrates, and their habitat. The species most likely to be affected by the project would be Dolly Varden and the habitats most likely affected would be freshwater streams and lakes. The primary impacts and differentiators among the alternatives include the following:

- Bridges and culverts at fish-bearing streams have long-term impacts to fish because changes in hydrology at the crossing structure (culvert pipe or bridge abutment) can lead to reduced water quality, changes in the stream bed, and entrainment of fish in small whirlpools on the downstream sides of the crossing structures. Over time, culverts tend to have higher impacts on fish than bridges. In the study area, these impacts could reduce fish access to spawning, summer feeding, and overwintering habitats upstream of crossing structures.
    - Alternative C has the most potential for impacting fish from crossing structures, with 21 culverts and 27 bridges. Most of these crossings would be along the all-season gravel road, which crosses more major streams and greater potential impacts on fish access to spawning and overwintering areas. The all-season gravel road also has the potential to impact pink salmon EFH.
    - Alternatives B (5 culverts and 4 bridges) and D (5 culverts and 2 bridges) would have similar potential to impact fish within the infield gravel roads.
    - Alternative E would have only 1 bridge and 0 culverts.
- Over time, water withdrawal from water bodies containing overwintering fish can reduce overwintering habitat quality through lower water levels, reduced water quality (DO), and increased proportion of frozen water. In addition, individual fish may be impinged or entrained in water withdrawal equipment, resulting in their death. Depending on the water source, water withdrawal could affect pink salmon EFH. Alternatives D and E have the most potential to have long-term impacts on overwintering.
    - Alternative D would require an annual ice road to access Point Thomson from Deadhorse, requiring annual water withdrawals from multiple water sources for the life of the project.
    - Alternative E would require annual ice roads between the Central Pad and East and West Pads, requiring annual water withdrawals from multiple water sources for the life of the project.
- Noise from pile driving and blasting is documented to impact fish by causing hearing loss, masking biologically important sounds, increasing stress levels, impacting immune systems, and causing death. Alternative C has the greatest potential to impact fish through pile driving at bridge crossings and blasting mine sites in the western portion of the all-season gravel road near fish overwintering areas.
- 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. This impact would not occur for other alternatives because no stream diversion would occur.
- Because the all-season gravel road under Alternative C would cross large braided streams, some VSMs for the export pipeline could be constructed in stream channels and floodplains. The VSMs could have similar impacts to bridge abutments and culverts and could affect pink salmon EFH.

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5.13 LAND OWNERSHIP, USE, AND MANAGEMENT

The key findings for land ownership, land use, and land management are summarized below with a brief summary of the differentiating effects.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

Alternatives B, C, D, and E: Minor to moderate impacts to land use, land ownership, and land management would be likely to occur and would be long-term in duration. Impacts would be localized to the study area.

Alternative A: No impacts

Differentiators:

- The greatest difference would be between the presence of the project (any action alternative) and absence of the project (No Action Alternative). Only minor differences exist among the action alternatives.
- Alternative A would be counter to state and NSB management objectives for their lands, but it would not change the management or technically alter the state's ability to lease its lands for oil and gas development in the future.

5.13.1 Methodology

The primary potential impacts to land use, ownership, and management would be the response needed by the land owners or managers, whether the impact were perceived as beneficial or detrimental. A major adverse impact would be one associated with a forced change in ownership or management that is not consistent with existing plans. Table 5.13-1 describes how impact is addressed in this section.

Table 5.13-1: Impact Criteria—Land Ownership, Land Use, and Land Management

Impact Category*	Intensity Type*	Specific Definition for Land Use, Ownership, and Management
Magnitude	Major	Land owner must respond in substantial ways to the action—change in ownership (condemnation) or substantial change in management–major inconsistency with land plan that forces amendment of plan. Complete change in land use not anticipated in plans.
	Moderate	Land owner must respond to the action, but response is minor, routine. Action is neither wholly consistent nor wholly inconsistent with existing plans. Substantial change in land use but anticipated in plans.
	Minor	Land owner need not respond to action in any substantive way; action is substantially consistent with existing management plans. Substantially similar land uses.

Table 5.13-1: Impact Criteria—Land Ownership, Land Use, and Land Management		
Impact Category*	Intensity Type*	Specific Definition for Land Use, Ownership, and Management
Duration	Long term	Land use, ownership, or management changes are expected to last the length of the project and beyond (effectively permanent).
	Medium term	Land use, ownership, or management changes may reasonably be expected to convert (or revert) to another use within less than the life of the project.
	Temporary	Land use, ownership, or management changes are expected to last through construction or some equally clearly limited time that is substantially less than the life of the project.
Potential to Occur	Probable	No avoidance.
	Possible	May or may not occur.
	Unlikely	Not expected to occur.
Geographic Extent	Extensive	Affects land use, ownership, and management over a large area—beyond the project area.
	Local	Affects land use in the project area only.
	Limited	Affects land use, ownership, and management in the immediate vicinity of the project footprint.

* Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology.

Methods for determining impacts involve assessing plans and policies of government land owners to determine if the proposed alternatives meet the intent of the plans or conflict with them, and what kind of response may be required by the land owner.

5.13.2 Alternative A: No Action

Under Alternative A, a Corps permit for gravel fill and other construction activities at the existing Point Thomson development would not be issued and the Applicant would suspend project engineering and planning activities for the evaluation of the Thomson Sand and other hydrocarbon resources at Point Thomson as planned. 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).

Because the State of Alaska manages Point Thomson lands for oil and gas development, and because the NSB has zoned these lands for Resource Development, selection of Alternative A would be counter to the State and NSB management objective for their lands, and selection of Alternative A would also be counter to recent land use permits and leases intended to carry out the intent to develop these lands for oil and gas leasing and production. However, selection of Alternative A would not change the state or NSB management or technically alter the state's ability to lease its lands for oil and gas development in the future; Alternative A would alter the project itself but not the basic land classification or management intent.

5.13.3 Impacts Common to the Action Alternatives

Direct and indirect (secondary) impacts of the Point Thomson Project on land issues are the same for all phases of the project and are similar across the various action alternatives; therefore, they are discussed together.

5.13.3.1 Land Ownership

No change in underlying land ownership is anticipated as a result of the project. This includes the State of Alaska for its lands; the U.S. government for the Arctic Refuge and Bullen Point lands, and holders of Native Allotment rights for their lands

The land rights associated with the oil and gas leases for the Point Thomson Unit could be very long term. The original leases have been in place since 1969 and typical time lines, depending on future production, could run from 50 to 70 years or more. As an example, the Prudhoe Bay fields are considered to be in decline after approximately 35 years of production, but oil still is being produced from old reservoirs, and new reservoirs in the area continue to be tapped, with an outlook to 2050 and beyond (NETL 2009). Eventually, at the end of the project's useful life, the leases would be expected to terminate, and all land rights would revert to the state.

The Bullen-Staines River Trail is an RS-2477 public access route that would intersect the project area under all of the action alternatives (see Figure 3.13-1). The State of Alaska would need to address this ROW to avoid conflicting intentions (public access versus private hydrocarbon development). This would be principally a paper exercise—an impact to state government but not to the general public or to an actual public access route currently in use—because the ROW does not contain an actual trail or road and because the surrounding general state lands allow public access. To address this issue, ADNR would likely formally designate a suitable alternative route for the Bullen-Staines River Trail that did not conflict with project development plans, or would require project alterations to avoid conflicts with trail alignment, or some combination. Administrative options may allow for deferring final designation of the trail until a later time, possibly after the life of the project.

5.13.3.2 Land Management—State

The general management direction for state lands would not be expected to change. The state would continue to manage land in the area for oil and gas leasing and development, and the project is expected to lead to substantial new hydrocarbon production in accordance with the management intent for the area.

A secondary impact of any of the action alternatives could be effects to land rights associated with Shell Oil's Sivuliiq (formerly Hammerhead) outer continental shelf proposal currently in the early stages of permitting for exploration and development offshore of the Canning River delta. Land use permitting for either project ahead of the other likely would influence state land permitting for the other project, because their export pipelines or access facilities likely would cross or parallel. It is possible the two companies would cooperate on some facilities, or that Shell would use the export pipeline constructed as part of the Point Thomson Project, changing land areas that would require state permits. These effects to the state, while not necessarily simple to resolve, likely would be considered routine. For the companies, any shared use of land likely would be undertaken if financially advantageous.

5.13.3.3 Land Management—Federal

Management direction in the Arctic Refuge may change somewhat regardless of the outcome of this project because the Arctic Refuge is currently updating its 1988 Comprehensive Conservation Plan (CCP; USFWS 2011c; see Section 3.13, Land Ownership, Land Use, and Land Management). Opening of the Arctic Refuge to oil and gas development or designation of the 1002 Area as part of the National Wilderness Preservation System is not considered reasonably foreseeable at this time. However, the Corps acknowledges that development at Point Thomson could spur debate and pressure on Congress to make a decision to either open the 1002 Area to oil and gas drilling or to formally include it as part of the National Wilderness Preservation System. While the exact influence is not known, the Corps felt it appropriate to acknowledge that approval of any of the action alternatives could heighten debate in Congress, which could spur a decision.

5.13.3.4 Land Management—Borough

Any of the action alternatives would require that the Applicant submit a master plan to the NSB (the NSB asserts authority through zoning to require or prohibit actions on lands owned by others). In March 2012, the Applicant submitted a Master Plan for the Point Thomson Resource Development District to the NSB. The Master Plan was accompanied by an Application for Zoning Map Amendment to expand the Point Thomson RD District to encompass the proposed export pipeline route between the Point Thomson RD District and the Badami RD District. The NSB Planning Commission recommended approval, with conditions, of the Point Thomson Master Plan and Rezone Application to the NSB Assembly in April 2012. A final decision on the Point Thomson Master Plan and Rezone Application by the NSB Assembly is anticipated in July 2012.

The rezone would convert 5,120 acres of land currently classified as Conservation District to RD District. The area, already zoned RD, is approximately 116,000 acres–similar in size to the Point Thomson Unit. This translates as a small reduction in lands zoned for conservation of the NSB's subsistence economy and lifestyle and an increase in lands zoned for industrial uses, which pay fees to the NSB that support a "cash" economy and lifestyle. However, lands classified RD would not be lost for subsistence purposes. The NSB typically institutes conditions within RD lands specifically to protect subsistence resources and activities to the extent possible, while allowing for industrial development. For comparison, the NSB is about 60.6 million acres total, most of it classified as Conservation District. As of 2005, the NSB had rezoned about 933,000 acres as RD District lands (URS 2005).

The NSB has selected several parcels, plus offshore islands in the area, as part of its 89,850-acre municipal entitlement under state law (AS 29.65.010). This entitlement is applied to state lands across the NSB. The scattered selections at the proposed project site include a 320-acre NSB selection south of the proposed Central Pad location. The existing C-1 Pad is located on the parcel, and the proposed components of several alternatives would be located on and near this parcel. The state's current position regarding NSB-selected lands in the Prudhoe Bay area is that the state considers much of the land to be essential to its own oil and gas interests and therefore not conveyable to the NSB (ADNR 2010a). In that area, the state is proposing to convey fewer than 7,000 acres of approximately 23,000 NSB-selected acres. Based on this precedent, the state could reject the NSB's selections to some lands near Point Thomson. If the state were to determine that the lands were essential for oil and gas production, the 320-acre parcel would most likely be rejected. The NSB has no land interest; it has only a reasonable expectation that the claim would eventually be resolved. So far only about 5,000 acres of the nearly 90,000-acre allocation has been conveyed. If the state rejects enough lands overall that the NSB is left with less than its allotted acreage, the state likely would provide new opportunity for land selection by the NSB. The state has done so in the past (HDR 2010h). However, any new land selections would occur only after all NSB land selections had been adjudicated and an entitlement remained. Because the NSB does not have a plan for the selected lands, the impact to the NSB of any project use of the land would be minor.

5.13.3.5 Land Use

If there were a typical municipal or borough land use map for the North Slope, actual land use on state land in the immediate vicinity of the project site prior to 2009 would likely be classified as "vacant" or "open public lands." With the proposed project, the actual land use would change from undeveloped land used principally for wildlife habitat, subsistence, and some recreation, to oil and gas development (industrial use), which is consistent with the state's oil and gas management intent, including the state's certification order and the intent of the oil and gas and gas-only lease program. With the project, industrial land uses would dominate in the immediate vicinity of the project footprint. Recreation and subsistence uses, including recreational hunting, are thought to be low in the immediate vicinity but would be partially displaced. The partial displacement of these existing human uses would extend west to the western extent of the pipeline and road under each of the alternatives (pipeline and road length would be 22 to 50 miles), replaced by industrial land use. This would occur in a narrow band perhaps 2 miles wide (see also Section 5.18, Recreation, regarding effects to those land uses) and would be consistent with the state's management intent.

In the distant future, after the life of the project and any future use by the Applicant for oil and gas production, leases would terminate. The state would not likely require removal of gravel roads and drilling pads and could make new use of these roads and pads, altering land use in the area. The land may or may not revert to general uses, depending on future state decisions. If it reverted to general uses, and depending on surrounding development before then, the land may or may not function again as it did prior to 2009 principally for wildlife habitat, subsistence, and dispersed recreation, but permanent physical changes are likely to change land uses permanently.

Existing land use within the Arctic Refuge would not be expected to change because of the project. Land use would continue to be wildlife habitat, recreation (including recreational hunting–particularly along the Canning River corridor), subsistence, and scientific research.

The project would be expected to have no substantial effect on the Bullen Point radar site. Its land use is in the process of changing from industrial (radar site) to vacant, regardless of the project. Coastal ice roads, whether sea ice or tundra, would pass immediately adjacent to the Bullen Point site and could cross federal property at this site under most of the action alternatives.

When and if the NSB's selected lands are conveyed to the NSB from the state, the NSB would have title to the lands for its own uses and would be able to manage the lands as it sees fit. At that time, land use could change, but there is no known plan for development by the NSB, so any impact from the project on those potential future uses is unknown.

Camps and cabins are the most likely future uses of Native Allotments, although the project and its export pipeline theoretically could prompt oil and gas exploration on patented allotments.

The following sections address some of the minor variations between alternatives.

5.13.4 Alternative B: Applicant's Proposed Action

Alternative B would include a 22-mile export pipeline to Badami. A long corridor from 300 to 1,000 feet wide likely would be a leased ROW easement similar to the existing Badami pipeline, and its land use would be industrial. Functionally, in an area about 2 miles wide along this corridor, existing land uses such as subsistence hunting would be altered but not disallowed. This corridor would lie 1 to 2 miles inland from the coast.

Based on preliminary ADNR mapping of the Bullen-Staines River Trail RS 2477 ROW and broadly defined corridors for project roads and pipelines, the proposed permanent gravel road system would cross the ROW a minimum of five times, and the system of gathering and export pipelines would cross the ROW a minimum of four times. The routes parallel each other in close proximity in some areas and could overlap. As indicated in Section 5.13.3.1, resolving this overlap would be a minor impact to the State of Alaska.

The 320-acre NSB-selected parcel would be bisected by a private gravel road, and the eastern end of the runway could be located on the parcel. These developments would affect the NSB's ability to use the land. Without an

NSB plan for use of the land, and without tentative approval of the conveyance by the state, there would be no tangible impact to the NSB.

The seasonal sea ice road would pass immediately adjacent to the Bullen Point federal property (see Section 3.13, Land Ownership, Land Use, and Land Management) and may use a portion of the property under all action alternatives except Alternative E. The ice road could provide access to the Bullen Point property for expected building demolition and for any future use.

5.13.5 Alternative C: Inland Pads with Gravel Access Road

Alternative C would include a 44-mile gravel access road that would connect Point Thomson with the Endicott Spur and the U.S. road system. The export pipeline would run 50 miles to Endicott. These developments would lie within a long corridor from 300 to 1,000 feet wide, which would likely be a leased ROW easement similar to the existing Badami pipeline, and its land use would be industrial. Functionally, in an area about 2 miles wide along this corridor, existing land uses such as subsistence hunting would be altered but not disallowed. This corridor would lie roughly 5 miles inland from the coast. The western half of the route would parallel the existing Badami pipeline corridor, expanding the width of an existing industrial land use corridor to several miles, in which subsistence or other existing uses may be altered.

Based on preliminary ADNR mapping of the Bullen-Staines River Trail RS 2477 ROW and broadly defined corridors for project roads and pipelines, the proposed permanent gravel road system would cross the ROW a minimum of four times, and the system of gathering and export pipelines would cross the ROW a minimum of three times. The routes parallel each other in close proximity in some areas and could overlap. The East and West Pads could conflict with the ROW. As indicated above, resolving this overlap would be a minor impact to the State of Alaska.

The 320-acre NSB-selected parcel likely would not be used for permanent facilities, although an ice road would be built across it each winter. The export pipeline and gravel access road proposed under Alternative C would be located just downstream of an NSB selection at the confluence of the Kavik and Shaviovik Rivers. The road could be used to provide access to the NSB parcel. This development could affect the NSB's ability to use the land. Without a plan for use of the land, however, and without tentative approval of the conveyance by the State, there would be no tangible impact.

The permanent gravel access road under Alternative C could provide easier access to a 160-acre Native Allotment that is located on one of the larger lakes near the Kadleroshilik River between Badami and Prudhoe Bay. The road would provide crossings of the Sagavanirktok and Kadleroshilik Rivers but still would lie more than 3 miles north of the allotment. Oil and gas companies, as road owners, do provide access by special permission to residents and land owners, such as Nuiqsut residents, so there is precedent for access if this new road were built. The access may benefit other allotment holders as well, and could lead to land use changes, but no other allotment is nearly as close.

The seasonal sea ice road would pass immediately adjacent to the Bullen Point federal property and may use a portion of the property under all action alternatives except Alternative E. The ice road could provide access to the Bullen Point property for expected building demolition and for any future use.

5.13.6 Alternative D: Inland Pads with Seasonal Ice Access Road

Alternative D would include a 22-mile export pipeline to Badami and would create a long corridor from 300 to 1,000 feet wide, which likely would be a leased ROW easement similar to the existing Badami pipeline, and its land use would be industrial. Functionally, in an area about 2 miles wide along this corridor, existing land uses such as subsistence hunting would be altered but not disallowed. The corridor would lie 3 to 4 miles inland from the coast like the pipeline, these uses would alter local land uses such as subsistence hunting or overland travel but would be less predictable or obvious to the user without a permanent facility. It is likely that, except to pass by, most users would avoid use of the developed project area in most cases.

Based on preliminary ADNR mapping of the Bullen-Staines River Trail RS 2477 ROW and broadly defined corridors for project roads and pipelines, the proposed permanent gravel road system would cross the ROW a minimum of four times, and the system of gathering and export pipelines would cross the ROW a minimum of three times. The routes parallel each other in close proximity in some areas and could overlap. The proposed locations of the East and West Pads could conflict with the ROW. As indicated above, resolving this overlap would be a minor impact to the State of Alaska.

The 320-acre NSB-selected parcel would be adjacent to or part of the CPF Pad and gravel pit area. The export pipeline and infield gravel roads likely would cross it. These developments would affect the NSB’s ability to use the land. Without a plan for use of the land, however, and without tentative approval of the conveyance by the state, there would be no tangible impact.

The seasonal sea ice road would pass immediately adjacent to the Bullen Point federal property and may use a portion of the property under all action alternatives except Alternative E. The ice road could provide access to the Bullen Point property for expected building demolition and for any future use.

5.13.7 Alternative E: Coastal Pads with Seasonal Ice Roads

Alternative E would include a 22-mile export pipeline to Badami and would create a long corridor from 300 to 1,000 feet wide, which likely would be a leased ROW easement similar to the existing Badami pipeline, and its land use would be industrial. Functionally, in an area about 2 miles wide along this corridor, existing land uses such as subsistence hunting would be altered but not disallowed. This corridor would lie 1 to 2 miles inland from the coast.

Based on preliminary ADNR mapping of the Bullen-Staines River Trail RS 2477 ROW and broadly defined corridors for project roads and pipelines, the proposed permanent gravel road system would cross the ROW once, and the system of gathering and export pipelines would cross the ROW a minimum of five times. The routes parallel each other in close proximity in some areas and could overlap. As indicated above, resolving this overlap would be a minor impact to the State of Alaska.

The 320-acre NSB-selected parcel would be adjacent to or part of the project’s gravel pit area. This development could affect the NSB’s ability to use the land. Without a plan for use of the land, however, and without tentative approval of the conveyance by the state, there would be no tangible impact.

Alternative E does not include a sea ice road. There would be no use of the federal Bullen Point property, including no access benefit for any current or future use of the Bullen Point property.

5.13.8 Impact Conclusion for All Action Alternatives

The difference in overall effects to land ownership, land management, and land use among the four action alternatives would be minor. The common impacts discussed above are the most important. Table 5.13-2 summarizes the impact assessment for all action alternatives.

Table 5.13-2: Action Alternatives—Impacts Summary for Land Ownership, Use, and Management				
Impact Category	Magnitude	Duration	Potential to Occur	Geographic Extent
Land Ownership, Use, and Management	Minor to moderate	Long term	Likely	Local

Based on Table 5.13-1, and under all action alternatives, the magnitude of land ownership, land management, and land use changes would be expected to be minor to moderate. All changes would be of long-term duration and would be likely to occur. The geographic extent of changes would be local to the project area. See also Section 5.14, Arctic National Wildlife Refuge, for further discussion of Arctic Refuge-specific management impacts.

5.13.9 Mitigative Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize impacts on land ownership, use and management.

- Consulting with land owners or managers within or adjacent to the project area, including the U.S. Department of the Interior (Arctic Refuge), U.S. Department of Defense (USAF, Bullen Point), ADNR, NSB, Iñupiat Community of the Arctic Slope (ICAS), community of Kaktovik, and Native Allotment owners/heirs.
- Ensuring project activities do not encroach upon Native Allotments or Traditional Land Use sites through survey and demarcation, to avoid any trespass or impact to the allotments.
- Facilitating traditional uses of the project area.

5.13.10 Climate Change and Cumulative Impacts

5.13.10.1 Climate Change

Climate change is not likely to directly affect ownership of land in the project area or its management in any of the alternatives. Climate change does have the potential to affect the overall land use within the project area, however, the effects would be through impacts on subsistence (see Section 5.22) and recreation resources (e.g., berry patches, caribou, and other megafauna; see Section 5.18) distribution or abundance.

5.13.10.2 Cumulative Impacts

Over the past several decades, land ownership, use, and management on the North Slope have been impacted by ANCSA land selections and conveyances, increased industrial development for oil and gas exploration and extraction, development of military sites for communications, establishment of the Arctic Refuge, subsistence and traditional cultural uses of NSB lands and waters, and recreation and tourism activities. Issuance of leases and rights-of-way on state and federal lands and waters has resulted in a broad reach of industrial use, ranging from the eastern portion of NPR-A to Point Thomson and federal offshore waters east of Prudhoe Bay. As of 2004, the contained development area of oil and gas facilities on the North Slope was approximately 3,000 mi^2 with a coastline of 230 miles. The total North Slope area is approximately 55,000 mi^2 and includes 650 miles of coastline (BLM 2004). These values do not include the TAPS corridor. The state continues to hold lease sales annually in the general area and sold new leases near Point Thomson and the boundary of the Arctic Refuge in its most recent lease sale in 2011, although at this time the Point Thomson Project is the only reasonably foreseeable future development proposed in the area. See Section 3.13.3 and Figure 3.13-2 for further discussion and a map of leased lands that could develop in the future.

The changes in land use anticipated due to development at Point Thomson (direct and indirect impacts) would be part of this cumulative trend toward increased industrial land use on the North Slope and away from "general" land uses, such as wildlife habitat, subsistence hunting, and occasional recreation. Because most of the Point Thomson area is already owned and managed by the state for oil and gas development, no change in land ownership or management is anticipated to occur. With the exception of Alternative C, the action alternatives would have a similar contribution to the cumulative effect. Alternative C would be more likely to contribute to other industrial uses in the future because it is the only alternative that would result in a permanent gravel road between the existing highway system and the minimally developed project site.

RFFAs include proposed projects that continue the trend of industrial development including expansion into undeveloped or minimally developed areas. Without a long-term management plan for land use after oil and gas fields are no longer economically viable, and because that end is at an indeterminate time in the future (30 years to perhaps beyond 100 years), it is possible that "general" uses would be substantially reduced over time and industrial uses would dominate the area on a permanent basis. The geographical growth of industrial land use represents an additive and cumulative large-scale change to the land use of Alaska's North Slope, but these impacts would likely only be perceived on a local level in the immediate vicinity of widely dispersed industrial facilities (NRC 2003a). The potential future designation of the 1002 Area as part of the National Wilderness Preservation System or opening of the 1002 Area for oil and gas development could affect land management and land use substantially, but Congressional action on this issue is not considered to be reasonably foreseeable. In summary, no adverse cumulative impacts on land ownership and management have been identified at this time.

5.13.11 Alternatives Comparison and Consequences

The greatest difference among alternatives is between the action alternatives, or the presence of the project, and absence of the project (No Action Alternative). No change in underlying land ownership for state, federal (Arctic Refuge and Bullen Point lands), and holders of Native Allotment rights is anticipated as a result of any of the action alternatives. Some land rights on state lands, such as oil and gas leases, would change because the Applicant would require rights to greater land area needed for drilling and other project-related facilities. The general management direction for state lands would not be expected to change. The state would continue to manage land in the area for oil and gas leasing and development, and the project is expected to lead to substantial new hydrocarbon production in accordance with the management intent for the area.

The Applicant has requested expansion of the existing RD District classification currently in place around the project site, which would result in converting some lands currently classified as Conservation District to RD District. Functionally, along the export pipeline corridor for all action alternatives, existing land uses such as subsistence hunting would be altered but not disallowed.

The differences among the action alternatives are subtle and no substantial differences in impacts to land ownership, use, and management exist between any two of them. Minor differences among the action alternatives include the extent and locations of the proposed project roads and pipeline systems crossing the Bullen-Staines River Trail, but, as noted, resolving this overlap would be a minor impact to the State of Alaska. Also, the proximity of the action alternatives to the Bullen Point federal property could provide access to the site for use of a portion of it under all action alternatives except Alternative E.

The 320-acre NSB-selected parcel would be impacted by all action alternatives via crossing of an ice or gravel road or the location of the CPF and gravel pit as in Alternatives D and E. These developments would affect the NSB's ability to use the land; however, without an NSB plan for use of the land, and without tentative approval of the conveyance by the state, there would be no tangible impact to the NSB.

Alternative C would be the most likely to contribute to other industrial uses in the future because it is the only alternative that would result in a permanent gravel road between the existing highway system and the presently undeveloped project area.

5.14 ARCTIC NATIONAL WILDLIFE REFUGE

As described in Section 3.14, the Arctic Refuge (see Figure 3.14-1) is part of the National Wildlife Refuge System, and has been the subject of national debate regarding the conflict between resource development and protection of wilderness qualities and wildlife. The key findings for the Arctic National Wildlife Refuge are summarized below with a brief summary of the differentiating effects.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

Alternatives B, C, D, and E: Impacts to the Arctic Refuge would be similar for all action alternatives:

- Impacts to refuge wildlife populations and hydrocarbon resources would be possible or unlikely, minor in magnitude, and limited in extent.
- Impacts to subsistence and traditional land use would be moderate, but would impact little or none of the Arctic Refuge.
- Impacts to wilderness qualities and values would be moderate, essentially irreversible, and perception of change would potentially apply to areas of the refuge beyond the extreme northwest corner of the refuge, and among people nationwide.
- Impacts to research would be moderate, would last several years, and would affect areas of the refuge near the project site.

Alternative A: No impacts

Differentiators:

- The greatest difference is between the presence of the project (any action alternative) and absence of the project (No Action Alternative).
- Under all action alternatives, potential impacts to recreation, wilderness qualities and values, and subsistence and traditional land use are likely to have the greatest magnitude, potential to occur, and geographic extent.

5.14.1 Methodology

This section uses analyses presented in the wildlife, fish, bird, subsistence and traditional land use, land use/ownership/management, recreation, visual, and noise sections of Chapter 5 to evaluate potential impacts to the Arctic Refuge. Types of impacts could include:

- Effects that would require changes in management for the Arctic Refuge.

- Effects to wildlife populations, including bird and fish populations, that might consolidate more wildlife activity within the Arctic Refuge, displace wildlife from the Arctic Refuge, or enhance or reduce populations of species found within the Arctic Refuge.
- Effects to subsistence, such as restrictions on hunting, fishing, camping, trapping, or transportation or changes in distribution of harvest species that would change existing use or the importance of the Arctic Refuge for subsistence and traditional uses.
- Changes to Arctic Refuge recreation that might enable or inhibit visitor access, or displace recreationists to other parts of the Arctic Refuge or to other areas entirely.
- Changes in the perception of wilderness values in the Arctic Refuge and the 1002 Area, whether in the Mollie Beattie Wilderness unit or outside it.
- Changes in Arctic Refuge wildlife research or other research.
- Changes that would affect Congressional designation of the 1002 Area as an oil and gas leasing area or as part of the National Wilderness Preservation System.
- Effects on hydrocarbon resources beneath the Arctic Refuge.

Table 5.14-1 defines impact criteria used in this section.

Table 5.14-1: Impact Criteria—Arctic National Wildlife Refuge

Impact Category*	Intensity Type*	Specific Definition for Arctic National Wildlife Refuge
Magnitude	Major	Change to wildlife populations, wilderness qualities, subsistence use, or recreational use (or combination) that substantially enhances or detracts from Arctic Refuge purposes, intent, or plan, would be readily evident, and would likely prompt a change in management response.
	Moderate	Change to wildlife populations, wilderness qualities, subsistence use, or recreational use (or combination) that enhances or detracts from Arctic Refuge purposes, intent, or plan but may not be readily evident and does not likely require management response.
	Minor	Little or no change to wildlife populations, wilderness qualities, subsistence use, or recreational use.
Duration	Long term	Impact would be irreversible or so long term that no end would be known; there would be no plan for elimination of impact at end of project.
	Medium term	Impact would last for several years but less than life of project, or known elimination of impact as part of the project's end.
	Temporary	Impact would last through project construction or similar clearly-limited time frame that would be substantially less than the life of the project.
Potential to Occur	Probable	Virtually no avoidance.
	Possible	May or may not occur.
	Unlikely	Not expected to occur.
Geographic Extent	Extensive	Affects larger areas of the Arctic Refuge, beyond the "local" geographic extent.
	Local	Affects portions of the Arctic Refuge near project site.
	Limited	Affects little or none of the Arctic Refuge.

* Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology.

5.14.2 Alternative A: No Action

Under Alternative A, a Corps permit for gravel fill and other construction activities at the existing Point Thomson development would not be issued and the Applicant would suspend project engineering and planning activities for the evaluation of the Thomson Sand and other hydrocarbon resources as planned. With the exception of two well covers for PTU-15 and PTU-16 and rig mats, as described in Chapter 2, Alternatives, the site would remain in the same status it held prior to 2009 and most Arctic Refuge wildlife visitors would have no visual or auditory awareness of its existence. There would be no impacts to the Arctic Refuge from the No Action Alternative.

5.14.3 All Action Alternatives

The analysis and discussion of impacts was combined for all of the action alternatives because, from an Arctic Refuge perspective, the impacts would be essentially the same or very similar under any of the action alternatives. In the discussion below, impacts that differ between alternatives are described.

5.14.3.1 Construction, Drilling, and Operations

The action alternatives include a three-stage development scenario: construction, drilling, and operations. In each alternative, drilling would begin while construction is underway, and would continue as needed over the course of field life. During construction of any of the action alternatives, the additional activity and noise of mobilizing equipment to the site, mining gravel, and constructing roads, airstrip, and drilling pad embankments, would make the site more conspicuous as viewed from the western edge of the Arctic Refuge than during drilling and operations.

From an Arctic Refuge perspective, Point Thomson facilities can be described as follows:

- ***Central Processing Facility Proximity:*** The CPF would be the site of the largest collection of buildings, storage tanks, and pipelines (including the beginning of the export pipeline). It would also be the site of the communications tower (200 feet) and flare stack (150 feet), which would be visible from the northwest part of the Arctic Refuge.
- ***East Pad:*** The East Pad would be the closest facility to the Arctic Refuge boundary, 2 miles for each action alternatives.
- ***Air Traffic/Airport Proximity:*** Air traffic would approach and take off from the project airstrip in easterly and westerly directions, and aircraft would be likely to use an area of approximately 3 miles east of the airstrip to make turns to and from Deadhorse. The airstrip itself would contain four navigation and communications towers ranging from 35 to 55 feet high, which would be lighted and visible from the Arctic Refuge.
- ***Infield Roads/Vehicle Use:*** All alternatives would have similar needs for transportation between pads, mostly on gravel roads (except Alternative E, which does not include all-season roads to the East and West Pads). The length of roads differs between alternatives, suggesting that vehicle miles traveled would differ proportionately. Traffic would be most visible in summer as vehicles created dust in dry conditions. The roads themselves would not be visible from the ground within the Arctic Refuge.
- ***Drilling Duration:*** The drilling rig would be one of the most prominent visible components of the action alternatives. After the drilling phase was complete, the drilling rig could be removed from the site completely, removing a strongly contrasting visual element from Arctic Refuge view. It is also possible drilling would be extended indefinitely, as discussed under Cumulative Impacts (see Section 5.14.5).

- ***Construction Duration:*** The construction phase would be the time of greatest activity, including greatest use of helicopters before the airstrip was complete.

The following subsections discuss potential impacts to Arctic Refuge resources and management activities. Section 3.14 provides a description of the affected environment of the Arctic Refuge.

Refuge Management Impacts

The proximity of development at Point Thomson may influence management by the USFWS, particularly if oil and gas development beyond the Arctic Refuge's borders affects movements and behaviors of wildlife that use Arctic Refuge lands or if recreation use patterns shift. More specific management activities that may require change as a result of further development of facilities at Point Thomson include wildlife population monitoring, subsistence and sport harvest oversight if wildlife population shifts occurred, and guiding and recreation oversight if changes in Arctic Refuge visitation occurred.

The following subsections explain further effects that may affect refuge management.

Wildlife Populations

Terrestrial Mammals

As indicated in Section 5.10, Terrestrial Mammals, caribou and other terrestrial mammals could be partially displaced in areas within about 2.5 miles of project facilities. This could include the area of the Arctic Refuge boundary closest to the East Pad under all action alternatives, though most displacement would be local and limited to immediately adjacent similar habitat within 0.5 mile. A very small number of the animals displaced by the project could be displaced toward or into the Refuge, but it is unlikely that the numbers would be distinguishable from normal variations in animal numbers. Activity at Point Thomson would not be likely to displace animals out of the Arctic Refuge.

Birds

The analysis detailed in Section 5.9, Birds, indicates that Arctic Refuge bird populations would not be disturbed or displaced by any of the action alternatives. Birds using lands and waters near Point Thomson may be locally displaced, but it does not appear likely that they would be displaced into the Arctic Refuge.

Marine Mammals

As described in Section 3.11, Marine Mammals, the Southern Beaufort Sea stock of polar bears that inhabits the study area has a core activity range from Herschel Island, Yukon to Point Barrow, and individual polar bears likely move back and forth between the project site and the Arctic Refuge. Polar bear denning and other habitat use in the Arctic Refuge could be affected if project activities, such as ice roads and traffic, affect polar bear movements (see Section 5.11, Marine Mammals).

Fish

Based on analysis in Section 5.12, Fish, Essential Fish Habitat, and Invertebrates, no impact to Arctic Refuge coastal or inland fish populations would be expected under any of the alternatives.

Subsistence and Traditional Use

Based on information in the Subsistence and Traditional Land Use Patterns technical report prepared for this project (Appendix Q) and based on information in Section 5.22, Subsistence and Traditional Land-Use Patterns, subsistence hunters from Kaktovik often use the area near Point Thomson and, somewhat less, the areas west of

Bullen Point along the coast and up to perhaps 3 to 5 miles inland (usually fairly close to the coast) for camping and hunting (Figure 5.22-2 and Figure 5.22-3 show subsistence use areas). Some hunting from the coast likely would be displaced because of changes in wildlife and/or human behavior, which could increase hunting activities and hunting pressures on wildlife populations within the Arctic Refuge.

Recreation

As stated in Section 5.18, Recreation, it is likely that some recreationists would see and hear project facilities and that facility lights would be conspicuous in dim and dark conditions in the northwestern portion of the Arctic Refuge (see Figure 5.19-5). Although modeling of project-related average noise levels in the Arctic Refuge generally showed little difference between the alternatives, the increased use of helicopters and fixed wing aircraft under Alternative E would likely add to the conspicuous nature of the site to visitors to the Arctic Refuge (Section 5.17, Transportation, and Section 5.20, Noise). Because of recreationist concern about the wilderness experience, a few recreationists per year may avoid the Canning River corridor to use other Arctic Refuge rivers under any of the action alternatives. This could be a large percentage of the typically small number of annual users, and could affect the management of other areas within the Arctic Refuge or possibly in the arctic national parks.

Indirectly, increased public and political focus on the Arctic Refuge that results from the proposed project could influence Arctic Refuge use for recreation. People may decide to visit the Arctic Refuge before oil and gas facilities are constructed or in case the 1002 Area is opened for oil and gas leasing and potential development. Conversely, people who have planned a future trip to the Arctic Refuge may cancel because of the perception that the area no longer has the wilderness qualities they once perceived.

Perception of Wilderness Qualities and Values

As discussed in Section 3.13, the 1002 Area currently is a Minimal Management Area managed in part for wilderness values, although the area is not a designated wilderness and is not managed differently than other nondesignated parts of the refuge. As discussed in Section 3.14.4 and 3.18, Recreation, based on a survey of a large proportion of visitors to the refuge, visitors highly value the refuge's wilderness qualities, and a segment of the population perceives the refuge as symbolic for its wilderness values even if they never visit. Current actual conditions coupled with current management results in a public perception that the lower Canning River and Staines River area have high wilderness qualities. Industrial activity within the visual and auditory range of the 1002 Area is likely to be perceived as an adverse effect to wilderness values. This change could be experienced by visitors to the northwestern corner of the Arctic Refuge and by those planning trips to the refuge. Because of recreationist concern about the experience of wilderness qualities and values, a few recreationists per year may avoid the Canning River corridor (see Recreation immediately above), and this displacement could affect the recreation experience and management in other areas within the Arctic Refuge. The proximity of industrial facilities could increase the national perception that Arctic Refuge wilderness qualities were diminished, especially for the segment of the population across the nation that perceives the Arctic Refuge's wilderness qualities symbolically (as described in 3.14.4 and 3.18.3).

Research Activities

Development of the proposed project could indirectly lead to increased research activities in the Arctic Refuge. Research could be related to wildlife populations, hydrocarbon spill potential, subsistence harvest patterns, oil and gas potential, or other topics. Increased interest in or need for research could occur in response to changes in wildlife populations or movement patterns, corresponding changes in subsistence harvest activities, concerns regarding the impact of hydrocarbon spills along the coast line, or increased Congressional debates about the

1002 Area. Research activities would increase scientific knowledge about the topic under investigation, but would increase human activity and air traffic within the Arctic Refuge for the duration of the studies.

Congressional Designation of the 1002 Area

The Point Thomson Project is likely to raise the awareness of the oil industry, the nationwide conservation community, and Congress because the proximity of an oil export pipeline to the 1002 Area is likely to make development within the 1002 Area appear economically more attractive, and because the conservation community is likely to see this as a threat to wildlife and wilderness qualities there. However, Congress authorized exploratory oil and gas activities in the 1002 Area in ANILCA in 1980, reserving further decisions regarding oil and gas potential to itself, and so far has not acted further on this question. Congressional action to change the status of the 1002 Area is not considered to be an RFFA. The Corps acknowledges that approval of any of the development alternatives could become another point of discussion in the debate concerning opening the 1002 Area to oil and gas leasing versus formal designation of the area as part of the National Wilderness Preservation System. Although the outcome of any such debate is unknown, the Corps acknowledges the potential that approval of any of the action alternatives could indirectly result in heightened debate in Congress that could spur a decision. Because there is no way to know whether Congress would change the 1002 Area status—and if changed, whether it would lean toward preservation of wilderness qualities or toward development of hydrocarbons — impacts of this decision cannot be evaluated in this EIS. However, the proximity of the project and a hydrocarbon export pipeline to the Arctic Refuge boundary is likely to spur proponents on both sides of the debate to lobby Congress for action.

Hydrocarbon Resources

The ADNR, based on publically available and proprietary information from the Applicant, is confident to highly confident of the extent of the reservoir as depicted by the Applicant (see Figure 1.1-1). Based on that delineation, extraction of hydrocarbons from the Thomson Sand Reservoir as proposed by this project would not be expected to impact hydrocarbon resources beneath the Arctic Refuge.

5.14.3.2 Impacts of the Action Alternatives

Table 5.14-2 summarizes the potential impacts of the development of the proposed project on the Arctic Refuge. Level of impact may differ for resources discussed elsewhere in Chapter 5 because this table focuses on impacts from an Arctic Refuge perspective. Congressional designation of the 1002 Area is not included in the table because any final action to change the current status is not considered reasonably foreseeable.

Table 5.14-2: Action Alternatives—Impact Evaluation for Arctic Refuge

Impact Category	Magnitude	Duration	Potential to Occur	Geographic Extent
Wildlife Populations	Minor	Long term	Possible	Limited
Subsistence and Traditional Land Use	Moderate	Long term	Probable	Limited
Recreation*	Major*	Long term	Probable	Extensive*
Wilderness Perception	Moderate	Long term	Probable	Extensive
Research	Moderate	Medium term	Possible	Local
Use of Hydrocarbons	Minor	Long term	Unlikely	Limited

*The major magnitude and extensive geographic area ratings under recreation are based primarily on the potential for displacement of a portion of recreationists from the Canning River area to other areas, as described in text, which could prompt a management response related to Arctic Refuge recreation. Actual visual or noise impacts that would affect the backcountry or wilderness qualities of the recreation experience are acknowledged to apply to the far northwest corner of the Arctic Refuge and not to larger areas of the refuge.

5.14.4 Mitigative Measures

The Applicant has included design measures as part of the project design to avoid or minimize adverse effects to many of the impact categories and affected resources described above related to the Arctic Refuge. These measures are detailed in the following sections of this Final EIS:

- Terrestrial Mammals (Section 5.10)
- Marine Mammals (Section 5.11)
- Recreation (Section 5.18)
- Visual Aesthetics (Section 5.19)
- Noise (Section 5.20)
- Subsistence and Traditional Land-Use Patterns (Section 5.22)

5.14.5 Climate Change and Cumulative Impacts

5.14.5.1 Climate Change

The Arctic Refuge is experiencing the same effects from current measurable changes in the North Slope climate as described in previous sections. The USFWS lists increasing temperatures, melting glaciers, reduced surface area and thickness of sea ice, thawing permafrost, and rising sea level as indications of observed warming throughout the Arctic. These changes could impact the Arctic Refuge.

The Arctic Refuge contains 43 fish species, 45 mammal species, more than 195 bird species, and many types of plants that have adapted to the Arctic climate. As described in Section 5.9, Birds, many shorebirds and waterfowl nest and stage for migration in areas that could be affected by rising sea level or increased storm surges due to a changing climate. The USFWS has documented a decline in muskox numbers, potentially attributable to rain-on-snow events that reduce access to winter forage, though increases in predation, increases in disease, or changes in plants could also have a role in that decline (USFWS 2009b; see Section 5.10, Terrestrial Mammals). Polar bear denning locations and hunting success in and around the Arctic Refuge could change due to reductions in sea ice (see Section 5.1, Marine Mammals).

Unlike areas west of the Arctic Refuge, studies do not show dramatic or consistent changes in Arctic Refuge vegetation. The action alternatives, however, in addition to the climate change impacts above, could provide an entry point for invasive plant species, and the changing climate could make it easier for these species to become established and spread into the Arctic Refuge via wind and animals (see Section 5.8, Vegetation and Wetlands).

5.14.5.2 Cumulative Impacts

The central portion of the ACP has seen considerable change since the 1970s with the development of major oil fields and construction of the TAPS. Past projects have resulted in changes in wildlife populations and distribution, subsistence harvest patterns, recreational use of the ACP, air quality, noise, visual aesthetics, and overall human use of the North Slope.

Most of the past and present industrial developments, however, have been geographically distant from the eastern portion of the ACP located in the Arctic Refuge; industrial activity in and near the Arctic Refuge area has been primarily limited to exploration activity. Between 1975 and 1996, a total of 17 exploratory wells were drilled within the boundaries of the Point Thomson Unit, west of the Arctic Refuge. Additional wells were also drilled at the Kavik and Kemik sites, south of the Point Thomson Unit and west of the Refuge, and at Hammerhead, located offshore of the Arctic Refuge's western border (Banet 1991, Hartz et al. 2008). In 1985, an exploratory well was drilled within the Arctic Refuge's boundaries on private land owned by the Kaktovik Inupiat Corporation (USFWS 2009c). At this time, none of these wells have been developed for hydrocarbon production. Currently, the nearest gravel road and oil support facilities lie more than 50 miles west of the Arctic Refuge's 1002 Area (USFWS 2009c). To the east of the Arctic Refuge, the Mackenzie River delta in Canada has also been evaluated for oil and gas potential.

Development of the proposed Point Thomson and other RFFAs, including full field development at Point Thomson, the development of Badami, the construction of the Alaska Pipeline Project, and the exploration and potential development of offshore resources north of the Canning River delta, would bring industrial development near the western edge of the Arctic Refuge.

From an Arctic Refuge perspective, the past, present, and RFFAs, including the proposed project, have the potential to result in the following adverse cumulative impacts:

- The need to adjust management of wildlife populations that rely on the Arctic Refuge coastal plain because of changes in distribution, population levels, and habitat pressures.
- Changes in subsistence harvest patterns that may increase the need for resource management.
- Changes in the aesthetic environment of the coastal plain and front range of the Brooks Range as industrial noise and lighting becomes more perceptible.
- Change in perception of the coastal plain of the Arctic Refuge as an "island" habitat of no development and the last intact coastal plain on the North Slope.
- Changes in recreational use of the Arctic Refuge because of real or perceived changes to the area.
- Increased pressure from both wilderness and oil and gas development proponents on Congress to change the current designation of the 1002 Area.

These potential cumulative effects could require changes in Arctic Refuge management practices, result in the need for additional USFWS personnel to respond to the change, and alter the perception of the Arctic Refuge by the public.

5.14.6 Alternatives Comparison and Consequences

The potential effects on the Arctic Refuge would be essentially the same or very similar under any of the action alternatives. The primary difference in the Arctic Refuge evaluation is between the absence of the project (No Action Alternative) and the presence of the project (action alternatives). Proximity of the Point Thomson development 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. Management changes in the Arctic Refuge as a result of any of the action alternatives could include wildlife population monitoring, subsistence, and sport harvest oversight if wildlife population shifts occur, and guiding and recreation oversight if changes in Arctic Refuge visitation occur. The proximity of the project and a hydrocarbon export pipeline to the Arctic Refuge boundary is likely to raise awareness in the oil and gas industry and conservation community and spur debate about development versus conservation of wilderness qualities as well as the lobbying of Congress for action on the 1002 Area.

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5.15 SOCIOECONOMICS

This section addresses the potential social and economic effects of the construction and operation of hydrocarbon production facilities at Point Thomson. The key findings of both positive and negative effects on the social and economic environment are summarized below with a brief summary of the differentiating effects between alternatives.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

Alternatives B, C, D, and E:

- Minor negative impacts on community characteristics and culture in Kaktovik would be probable as a result of impacts to subsistence activities. Impacts would last the life of the project and be localized to the study area.
- Minor to moderate positive impacts on employment, income, and tax base would be possible to probable. Impacts would last the life of the project and affect the NSB and beyond.

Alternative C and D: Temporary, moderately negative impacts on Deadhorse infrastructure and services would be probable and localized.

Alternative A: No impacts.

Differentiators:

- Infrastructure and activity near the coast in Alternatives B and E could result in greater negative impacts to traditional activities.
- The increase in the number of workers needed, the length of the construction and drilling phases, and the total capital investment in Alternatives C and D could result in greater positive impacts to employment, income, and the NSB tax base.
- Lack of barge access in Alternatives C and D could result in greater impacts to the public services and infrastructure in Deadhorse.

5.15.1 Methodology

NEPA requires analysis of social and economic impacts (i.e., socioeconomic impacts; 40 CFR 1508.8 [b], 40 CFR 1508.14). This section examines potential social and economic effects from the three main project phases: construction, drilling, and operations in the NSB and the State of Alaska. The project could potentially have impacts at the scale of individual communities, the borough, and the state as a whole. The primary area of potential impact is the communities of Kaktovik and Nuiqsut as they are closest in proximity and most likely to experience impacts to community culture, employment, and income. The NSB as a whole may experience impacts to tax revenue and resident employment as a result of the project.

For this analysis, many of the potential economic and social effects associated with the project would extend beyond the NSB and be more diffused. Potential beneficial effects include increased domestic energy production, manufacture and purchase of specialized materials, increased utilization of the existing TAPS, increased state tax revenues from permits and oil royalties, and increased employment for highly-skilled and highly-paid workers who may live outside the NSB or even the State of Alaska. The State of Alaska as a whole is briefly considered for impacts to state revenue.

The socioeconomic analysis addresses those social or economic factors that have a reasonable likelihood of experiencing more than a minor effect from project construction, drilling, and operation; were raised as an issue during the public scoping process; or are otherwise controversial. Potential impacts from the project alternatives were assessed through both qualitative and quantitative measures to the social and economic environment, but more specifically to:

- Demographics
- Community characteristics and culture
- Employment
- Income
- Tax base
- Housing
- Community facilities and services

5.15.1.1 Impact Criteria

The impact assessment criteria for socioeconomics are shown in Table 5.15-1.

Table 5.15-1: Impact Criteria—Socioeconomics

Impact Category*	Intensity Type*	Specific Definition for Socioeconomics
Magnitude	Major	Greater than a 10% change in resident population or population demographics. Greater than a 10% change in resident employment or income. Change in housing vacancy rate to more or less than 5% (the assumed equilibrium point between renters and landlords). Substantial increase/reduction in tax base. Substantial change to community characteristics or culture, such as separating or isolating any portion of the community (e.g., minority, elderly, disabled, transit-dependent, large family, income level, and owner/tenant status), from the rest of the community or services. Substantial change to traditional culture of the NSB.
	Moderate	Greater than a 5% change in resident population or population demographics. Greater than a 5% change in resident employment or income. Change in housing vacancy rate that does not disrupt equilibrium. Modest increase/reduction in tax base. Modest change to community characteristics or culture. Modest change to traditional culture of the NSB.
	Minor	Less than a 5% change in resident population or population demographics. Less than a 5% change in resident employment or income. Slight or no change in housing vacancy rate. Slight or no effect to tax base. Slight or no change to community characteristics or culture.
Duration	Long term	Irreversible impact on socioeconomics.
	Medium term	Impact lasts for life of project.
	Temporary	Impact lasts through project construction.
Potential to Occur	Probable	No avoidance.
	Possible	Potential to occur (can avoid).
	Unlikely	Not likely to occur.
Geographic Extent	Extensive	NSB and beyond.
	Local	NSB.
	Limited	Project area.

* Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Methodology.

5.15.1.2 Multiplier Effect

Economic analyses describe three types of impacts: direct, indirect, and induced. Direct impacts are those financial transactions that occur as the result of direct spending. Indirect economic impacts are economic activities that occur “offsite” but are directly attributable to the project. Induced impacts represent the increase in business output over the direct and indirect impacts, generated by successive rounds of spending (often referred to as the multiplier effect) in the economy. For example, when a property owner hires construction workers to build a house, employment and income increase; this is a direct benefit to the economy where the workers live. When the property owner buys construction materials for the house, this is also a direct impact to the economy from where the materials came. When the construction workers use their wages from the construction project to buy goods or services, this is an indirect economic impact. When a business owner uses the money they received from the construction worker to buy more goods or hire more workers, this is an induced economic impact. The multiplier effect is the amount of respending in an economy as a result of a project, and is a measure of the economic benefit that a project brings to a community. High multipliers indicate that communities are able to capture spending within the community and reduce the economic "leakage" from the community.

5.15.2 Alternative A: No Action

Under the No Action Alternative, the Applicant would suspend project engineering and planning activities for the evaluation and development of hydrocarbon resources at Point Thomson. The PTU-15 and PTU-16 wells would continue to be monitored until the time that they are closed or brought into production in the future. The No Action Alternative would not affect the nearby communities and would result in no socioeconomic impacts.

5.15.3 Alternative B: Applicant's Proposed Action

Alternative B would include three coastal gravel pads for production, as well as infield collection pipelines and gravel roads. Construction materials would be imported by barge and ice road; the ice road would be rebuilt every year of construction to supply the facility. The export pipeline would be built between 1 and 2 miles inland from the coastline of the Beaufort Sea.

5.15.3.1 Alternative B: Construction

Demographics

Based on the history of the Alaskan North Slope oil industry since construction of the TAPS in the mid-1970s, construction of Alternative B would be unlikely to result in more than a minor increase in the number of full-time residents in the NSB. The majority of oil facility construction workers are not permanent 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). Nonresident workers leave the NSB between shifts and at the conclusion of construction activities in order to move to their next job. Locally-recruited workers are already included in the population of the NSB.

Oil facility construction workers are generally demographically distinct from the resident NSB population. The oil industry worker population is generally male, white, and has a higher median age than the NSB at large. Oil facility construction workers are generally highly skilled and experienced, and are recruited from a broad national market

Community Characteristics and Culture

Oilfield construction has been the major industrial activity in the NSB for the past 35 years and construction of the Point Thomson facility would be consistent with this established activity, but extending into an area that previously has seen relatively little development. The scale of the Point Thomson Project would not be extraordinary compared to other past projects, such as the massive TAPS project.

The remote and isolated nature of the Point Thomson Project is likely to limit the impacts that Point Thomson workers would have on the characteristics and culture of the NSB communities. Point Thomson is located 60 miles from Kaktovik and 112 miles from Nuiqsut, with no physical connection to either community. Point Thomson would be fully contained during construction and workers would have no reason or ability to travel to any NSB community other than Deadhorse. The lack of physical connection between Point Thomson and the communities of the NSB would limit interaction between workers and local community members.

The Point Thomson Project may have secondary impacts on community characteristics through an increase in opportunities and resources for education. As part of the its 2009—2010 Point Thomson Economic Opportunity Plan, developed to comply with NSB municipal code, the Applicant has made monetary and in-kind donations, developed a science ambassadors program, and supported Inupiat culture programs at the Harold Kaveolook School in Kaktovik (ExxonMobil 2010d). The Applicant has also supported programs district-wide in the NSB, at the Ilisagvik College in Barrow, and at the University of Alaska-Anchorage. This support, if it continues, may have positive impacts on community characteristics by increasing educational opportunities and cultural programs for residents in Kaktovik and the NSB.

The Point Thomson Project has the potential to have negative impacts on community culture by affecting subsistence activities for residents in Kaktovik and Nuiqsut. Subsistence activities are of economic and cultural importance, and are pivotal to community culture and organization. Alternative B places the Point Thomson facility, including the export pipeline, close to the Beaufort Sea, overlapping with a portion of Kaktovik residents' subsistence use area. Infrastructure placement and barge activity could disrupt subsistence user access and resource availability for the residents of Kaktovik. Project infrastructure and activity minimally overlaps with subsistence use area for most resources used by Nuiqsut residents. Minor impacts to the harvest amounts of caribou for Kaktovik and bowhead whale for Nuiqsut are probable and may last for two years or more. These impacts would be localized to the subsistence study area. The extent and type of effects on subsistence hunting are described further in Section 5.22, Subsistence and Traditional Land-Use Patterns, and to a lesser extent in Section 5.16, Environmental Justice.

Industrial developments in proximity to traditional communities on the North Slope can also have indirect impacts on the health and well-being of residents through impacts to community culture. The NRC observed that many Inupiat residents of the North Slope felt anxiety and stress over increased oil and gas development and the potential impacts of development on subsistence resources (NRC 2003a). These and other health impacts are discussed in Section 5.23, Human Health.

As a result of the potential changes to subsistence hunting for caribou, construction of Alternative B would be expected to have a minor effect on community characteristics and culture in Kaktovik.

Employment

Construction of Alternative B would be a multiyear project that generates employment within the NSB and the State of Alaska. Employment would peak in the fifth year of construction when approximately 1,100 workers would be employed in construction, drilling, and operations (HDR 2011b). An estimate of total project employment is detailed by year and discipline in Table 5.15-2. Total project employment was calculated using onsite workforce estimates in Figure 2.4-13 with consideration for personnel rotations during each project phase (HDR 2011m).

Table 5.15-2: Alternative B Maximum Employment [a]										
Project Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
North Slope Construction[b]	200	875	675	675	675	—	—	—	—	—
Drilling	—	—	—	275	275	275	—	—	—	—
Operations[c]	—	—	—	—	160	160	160	160	160	160
Total Employment	200	875	675	950	1,100	435	160	160	160	160

Source: HDR 2011b

[a] Maximum employment values are estimated on available camp bed space and personnel rotations during each project phase (HDR 2011m).

[b] North Slope construction only includes work that occurs in the NSB, including Point Thomson, Deadhorse/Prudhoe Bay, or at a temporary work camp. Some construction activities, such as module construction, would occur outside of the NSB and are not included in these values.

[c] Operations include post-construction, onsite operation of the facility. Operations employment continues for the 30-year life of the project.

The Applicant has committed to hiring local residents and Alaska Natives for construction jobs, and sponsored a job fair in Kaktovik in 2009 and 2010 with plans to conduct it annually. The Applicant has also committed to using local suppliers, contractors, and subcontractors provided they meet safety, health and environmental requirements, and has encouraged its independent contractors working on the project to “hire, train, and retain” Native residents (Appendix D, RFI 31).

During the exploratory phase of the Point Thomson Project, which took place from 2008 through 2011, several North Slope native corporations, including the Arctic Slope Regional Corporation (ASRC), Kaktovik Inupiat Corporation (KIC), and Kuukpik Corporation (KC) were among the largest contractors when evaluated by revenues earned. These included Jago Contracting and Management LLC (Jago) and Marsh Creek Services, a joint venture company and subsidiary of KIC; Nanuq/ Alaska Frontiers Constructors (AFC), a joint venture between a subsidiary of KC and AFC; and ASRC Energy Services. In the winter of 2009/2010, Jago provided construction project management, operations support, and camp facilities for the Point Thomson exploration activities and reported that 55 NSB residents were employed on the Point Thomson Project, primarily in labor and heavy equipment operations (ExxonMobil 2010d). In 2009 and 2010, the Applicant and its contractors also hired NSB residents for several subsistence and wildlife monitoring positions (ExxonMobil 2010d). If ASRC, KIC, and KC receive similar contracts during project construction, these companies would be well-positioned to assist residents of the NSB in obtaining additional employment.

The past history of NSB resident employment in the oil industry on the North Slope suggest that despite efforts to encourage local employment, increased resident employment would likely be a minor and temporary positive impact on the NSB population. Of the over 8,000 positions in the oil and gas industry on the North Slope in 2009, only 75 were held by residents of the NSB (ADLWD 2009). At the Alpine development operated by ConocoPhillips Alaska, for example, training programs, internships, and financial incentives for contractors were offered to encourage the local hire of residents of the nearby community of Nuiqsut. Despite these incentives, local employment levels have been relatively low, a source of frustration for many residents (Haley et al. 2008). In 2010, there were 35 full-time positions for Nuiqsut residents at the Alpine development. Of these positions, 23 were full time but seasonal, and 15 were internships and student positions (HDR 2011n).

There have been several barriers to increased local resident employment in the oil industry: skills, required licenses and certifications, social and cultural differences, a young resident population, and drug testing. Oil industry positions often require highly specialized skills and extended training. Enrollment rates in training programs are generally low and drop-out rates high (Haley et al. 2008). Advanced education and full-time employment may not always be desirable for many residents of the NSB as it often requires them to spend extended time away from home and may limit participation in subsistence activities (NRC 2003a, Haley et al. 2008). Some residents also feel that the jobs offered to locals are often menial or token jobs and are thus less desirable (NRC 2003a).

Based on the history of past development projects on the North Slope, the construction of the Point Thomson Project would likely have a minor impact on NSB resident employment. Most of the positions for this project would likely be filled by nonresident workers who would leave the area in between shifts.

Income

North Slope construction jobs pay very well due to the harsh working conditions, isolation, scarcity of trained and experienced personnel, and the market value of the end product. The average oil industry wage on the North Slope is over $100,000, a value more than twice the statewide average wage (Fried 2008, QCEW 2009). Although constructing the Point Thomson facility would generate a great deal of income per employee, the majority of these wages would not be captured in the local economy. Almost all of the construction workers would leave the borough between shifts and after the completion of construction, taking their earned income with them. There is likely to be a minimal amount of oil industry-related employment income spent within the borough, resulting in a relatively low multiplier effect and few indirect and induced benefits from Point Thomson employment.

Residents of the NSB are more likely to benefit from increased income from the Point Thomson Project through dividends paid out by the regional and local native corporations. These corporations pay out dividends to Native shareholders, most of whom are NSB residents, based on annual profits. As previously discussed, ASRC, KIC, and KC and their subsidiaries and joint ventures have received substantial contracts related to the exploratory phase of the Point Thomson Project from 2008 to 2011 (ExxonMobil 2010d). These companies may be competitively positioned to garner additional contracts as part of the Point Thomson development, resulting in an increase in corporation profits and dividends paid out to shareholders. As a result, the construction of the Point Thomson Project could have a positive minor to moderate, possible impact on income levels in Kaktovik, Nuiqsut, and the NSB as a whole.

Tax Base

The Point Thomson Project may have the largest impact on the local economy of the NSB by increasing tax revenues collected by the borough. Oil- and gas-related taxes account for 98 percent of the property tax revenues within the NSB, although this revenue is projected to decline in future years due to a decline in production of the North Slope oil fields (NSB 2009). However, in the short term, increased development and exploration activity would result in a temporary stabilization or moderate increases in assessed property values (NSB 2009). Development of the Point Thomson facility would account for a portion of this stabilization or increase in tax revenue within the NSB. Tax benefits would begin when the project is first installed.

Taxes in the NSB are divided into two categories: those collected for operating expenses and those collected for bond repayment. Taxes collected for operating expenses are limited by Alaska Statue 29.45.080 and based on the equivalent tax base, defined by the state as 225 percent of the state average per capita property tax value times the population of the NSB (AS 29.45.080, NSB 2009). The tax structure of the NSB is discussed in detail in Section 3.15, Socioeconomics.

The Point Thomson Project is unlikely to have a major direct effect on the borough's long-term operating expense tax income, but it may have two indirect impacts on operating expense taxation by affecting the factors that go into the equivalent tax base calculation. First, the Point Thomson Project may increase the state average per capita property tax by increasing the total property tax value of the state (HDR 2011o). Given the scale of the Point Thomson Project relative to other property in the state, this effect is likely to be minimal but would extend for the life of the project. Second, the NSB includes nonresident workers in the population of the NSB for taxation purposes. By increasing the population of the NSB, particularly during construction, when between 200 and 875 additional workers would be present on the North Slope, the Point Thomson Project would increase the equivalent tax base (HDR 2011o, HDR 2011b). For example, the addition of 1,000 construction workers to the total population of the borough could result in a 6.5 percent increase in the total NSB operating budget relative to the fiscal year 2009 budget values. This increase in the operating budget would be temporary and limited, however, to the construction phase of the project.

The Point Thomson Project would also have direct impacts on tax revenue raised for bonding repayment, which unlike operating expense tax collection, is based on the actual and true full property value of the NSB. The Point Thomson Project will be assessed by the Alaska Department of Revenue (ADOR) based on the total capital investment in the project; costs related to drilling are exempt from taxation (HDR 2011o). The development at Point Thomson is predicted to add approximately $1 billion to the actual and true property value of the NSB (ExxonMobil 2009). This would represent an increase of about 8 percent relative to the total NSB actual and true property value of $12.9 billion reported in 2009 (NSB 2009). Increasing the tax revenue of the NSB may have cascading effects across the borough. The NSB provides most of the services and employment in the borough; it also funds most of the capital improvement projects in the region. An increase or a stabilization of revenue could allow a maintenance or improvement in these benefits in all of the communities in the NSB.

In addition to taxes, the Applicant would also be required to pay additional permit application fees to the NSB. Between 2008 and 2010, the fees for the Point Thomson exploration activities were approximately $140,000 (ExxonMobil 2010d).

At the state level, Alaska collects neither income tax nor sales tax. Thus, construction wages would not generate any income tax benefit to the state and purchase of construction materials would not generate state sales tax revenue (NSB 2009). Increased use of the state-owned Deadhorse Airport and Deadhorse landfill during construction would result in a minor, temporary increase in fees to the state and the NSB.

Housing

Construction of Alternative B would not be expected to have an effect on the supply of or demand for housing in any NSB communities. Workers would reside in onsite housing during construction and would leave the site when off-duty to make room for replacement crews. Off-duty employees would return to their homes, either in the local communities or outside the area. Construction workers may spend a night or two in Deadhorse while en route to or from the Point Thomson site and they would join the 5,000 to 7,000 North Slope oil field workers who currently pass through Deadhorse (ADCCED 2011).

Utilities, Community Facilities, and Services

Most utility services for the Point Thomson Project would be provided onsite. The borough would collect fees for the disposal of solid waste transferred to the Oxbow landfill in Deadhorse (ADCCED 2011). Electricity for Point Thomson would be generated by natural gas generators located onsite. Because the Point Thomson facility would be isolated from nearby NSB communities, project construction would not alter the use of community facilities or services.

The NSB does not have a sufficiently-developed industrial base to supply materials or other project-related supplies, and thus would likely see few direct benefits from materials and supply purchase in the region. Most, if not all, of the materials needed would be transported into the region from elsewhere in the state, country, and world. Project construction would require stockpiling material at Deadhorse in anticipation of the upcoming construction season; storage space may need to be expanded to meet this increased demand. Because the summer and winter construction seasons are short (2 to 4 months) and the demand for heavy equipment on the North Slope can be high (HDR 2010a), development of the Point Thomson facility would also increase the demand for construction equipment and may cause or exacerbate an equipment shortages. Construction workers coming and going to Point Thomson would increase traffic at the state-owned Deadhorse Airport.

5.15.3.2 Alternative B: Drilling

The socioeconomic effects of drilling at Point Thomson would be the same as those described above for construction, except the magnitude of the economic effects would be less because fewer workers would be required to drill the wells than to construct the facility. Drilling-related positions would vary depending on drilling activity, but a maximum of 275 workers would likely be employed during drilling (see Table 5.15-2).

Impacts to the NSB tax base would also be less than during construction because of the employment of fewer workers, resulting in a smaller increase in the NSB population used to determine the equivalent tax base for NSB operating expenses. Most drilling-related costs are also exempt from taxation (HDR 2011o).

5.15.3.3 Alternative B: Operation

Demographics

Operation of the proposed Point Thomson facility would have a minimal effect on the population of the NSB. A total of 160 permanent employees are expected to work at the Point Thomson site during operations (see Table 5.15-2). North Slope oil field workers usually work 2-week shifts and most leave the area, and often the state, when not on duty (ADCCED 2011).

Community Characteristics and Culture

Natural gas and oil production is the major commercial/industrial activity in the NSB and operation of the Point Thomson facility would be consistent with the characteristics of the borough’s industrial developments. The project would not be out-of-scale compared with other production activities in the area.

As with the construction activities, operation of the Point Thomson facility would be fully self-contained and workers would have no reason to travel to any of the NSB communities, other than Deadhorse. The lack of physical connection between Point Thomson and the other communities would minimize interaction between the workers and local community residents. This lack of interaction would limit the potential for adverse effects to community characteristics and culture.

The minor adverse effect of Alternative B on subsistence caribou hunting for Kaktovik residents would be expected to continue throughout the 30-year life of the Point Thomson facility. The extent and type of adverse effect on subsistence hunting is described further in the Subsistence and Traditional Land-Use Patterns (Section 5.22) and the Environmental Justice (Section 5.16) sections of this Final EIS.

Employment

Of the 160 full-time employees associated with the Point Thomson facility, the Applicant would employ two shifts of workers to operate the facility; additional workers would be employed by contractors for equipment operators, maintenance staff, and other direct support positions (Appendix D, RFI 31; HDR 2011b). Additional seasonal workers would be employed as Marine Mammal Observers, Subsistence Advisors, and Polar Bear Monitors; residents of the NSB, including Alaska Natives, would be well-qualified to fill these seasonal positions. Additionally, ASRC, KIC, and the KC would be well positioned to help staff operations positions. The Point Thomson facility would be expected to have an operational life of 30 years and these jobs would continue throughout the life of the project (ExxonMobil 2010d).

The Applicant has committed to continuing the local hiring program initiated during construction, and encouraging independent contractors to "hire, train, and retain" Native residents (Appendix D, RFI 31). Past history of employment on the North Slope suggests that resident employment may be relatively limited. Continued support and investment in education, training, and cultural programs, as outlined in the Applicant's Economic Opportunity Plan (ExxonMobil 2010d), may contribute to long-term workforce development and promote increased cultural awareness between the oil industry and Native residents.

Deadhorse would experience a small increase in activity during operation of the Point Thomson facility, which would generate some minor indirect employment and income during the 30 years that the facility would be expected to operate.

Income

As with the construction positions, operational jobs at Point Thomson would command premium pay due to the harsh conditions at the site, isolation, relative scarcity of experienced or trained workers, and commercial value of the end product. Local residents who work at the Point Thomson facility would benefit from increased income. An increase in cash income and jobs would help local residents, especially those of working age, to stay in the area and maintain their culture and community characteristics. However, few oil industry workers are residents of the NSB and this effect is likely to be relatively small. Most of the income earned through employment at Point Thomson is likely to leave the NSB, creating relatively few indirect benefits for the region.

Hydrocarbon production at the Point Thomson Project would generate revenue for the Alaska Permanent Fund. Increased revenues to the Alaska Permanent Fund could increase income for the residents of the NSB, as well as all residents of the state. This income would help offset the high cost of living in the NSB and would continue throughout the 30-year productive life of the facility. Dividends from regional and local native corporations may also increase if these corporations are successful in securing long-term contracts for services at Point Thomson.

Tax Base

Developing the Point Thomson Unit would enable the Applicant to generate revenues and profits from domestic hydrocarbon production. Initial production from PTU-15 and PTU-16 would generate estimated gross annual revenues of $274.9 million, based on initial production of 10,000 barrels per day or 3.65 million barrels per year and a forecasted price of $75.32 per barrel (ADOR 2010).

The Applicant would pay both taxes and royalties to the State of Alaska on the hydrocarbon condensate product removed from Point Thomson, which would increase the tax base for the state. The state forecasts a production tax rate of $13.00 per barrel of taxable hydrocarbon in fiscal year 2011. Assuming that all of the Point Thomson production was taxable, the facility would be expected to generate annual tax revenue of $47.45 million to the state from production of 3.65 million barrels per year. This benefit would continue throughout the productive life of the facility and would change depending on production and the tax rate. For comparison, the state production tax on petroleum generated $3.112 billion of state revenue in 2009 (ADOR 2010).

The NSB would continue to receive benefits to its tax revenue as discussed in Section 5.15.3.1, Alternative B: Construction. Benefits to NSB tax revenue for operational expenses would continue to occur, but are likely to be minimal during operations because the relatively small number of workers that would be employed at Point Thomson during this phase. The Point Thomson Project would likely have a larger long-term positive impact on the borough's bonding capacity and revenue for bond repayment as it would increase the actual and true full property value of the NSB. The increased revenue from the Point Thomson Project would slow the depreciation of total taxable property values in the NSB and provide the NSB with funds to continue to provide employment, services, and funding for projects in the region. This benefit would likely continue for the 30-year life of the project.

Housing

Operation of the Point Thomson facility would be unlikely to alter the demand for housing within any of the NSB communities. Workers would be housed onsite and workers who are not current residents would leave the NSB when not on duty.

Utilities, Community Facilities, and Services

As in the construction phase of the project, utility services for the Point Thomson facility would be largely onsite. The NSB would collect fees for the disposal of solid waste in the Oxbow landfill in Deadhorse. Point Thomson's isolation from nearby NSB communities would limit use of community facilities or public services during operations.

The limited industrial base of the NSB suggests that the NSB would not see large benefits from the manufacture and sale of materials and other project supplies from the proposed project. Workers coming and going to Point Thomson would increase traffic at the Deadhorse Airport although, given the small size of the operational workforce, this would be a minor impact.

5.15.3.4 Alternative B: Impact Evaluation

Table 5.15-3 provides the impact evaluation for socioeconomic resources for Alternative B. Potential impacts are both positive and negative, range from minor to moderate in magnitude, medium-term duration, unlikely to probable potential to occur, and local to extensive in geographic extent.

Table 5.15-3: Alternative B—Impact Evaluation for Socioeconomics

Impact Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Population	Minor	Medium term	Possible	Local
Community Characteristics and Culture	Minor	Medium term	Probable	Local
Employment and Income	Minor	Medium term	Possible	Extensive
Tax Base	Moderate	Medium term	Probable	Extensive
Housing	Minor	Medium term	Unlikely	Local
Utilities, Community Facilities, and Services	Minor	Temporary	Possible	Local

5.15.4 Alternative C: Inland Pads with Gravel Access Road

Alternative C would include four gravel pads for production and processing, infield gravel roads, a 44-mile gravel access road, and an export pipeline. In this alternative, infrastructure is moved one-half mile back from the coast. Relocating project facilities, including the pipeline, away from the coast could potentially reduce impacts to subsistence activities. However, moving the East and West Pads back from the coast could reduce the extent to which the reservoir can be effectively produced. It is not possible, based on existing publicly available information, 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 Final EIS, a rough estimate of reservoir coverage (in two dimensions) was determined 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. 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. At this time it is not possible to accurately determine if that is sufficient coverage to fully develop the resource and what, if any, impact there might be to resource recovery and potential socioeconomic impacts.

Alternative C does not include transport of construction materials by barge, but relies on transport via ice roads during construction and the gravel access road during drilling and operations. Construction employment would be greater without barge access to the site because facility modules would need to be smaller and more numerous to allow for overland transport. The technological and logistical constraints associated with transporting module infrastructure and all necessary construction materials via ice road are discussed in Section 5.17, Transportation.

The building of a 44-mile gravel road would require additional staff for three seasons of road construction. Building a year-round gravel road instead of a seasonal ice road could also open up the area for additional oil field development.

5.15.4.1 Alternative C: Construction

Demographics

Construction of Alternative C would be expected to have similar, minor effects on the population of the NSB as described for Alternative B.

Community Characteristics and Culture

The effects of oilfield construction would be similar under Alternative C as those described above for Alternative B. Minimizing the coastal impacts and locating the facilities and export pipeline inland would be expected to reduce the adverse effect on subsistence caribou hunting within the Point Thomson area. Alternative C may result in more widespread impacts, however, to caribou movement and hunter success because of the impacts resulting from the 44-mile-long gravel access road between the project area and the road system near Deadhorse. The effects of Alternative C on subsistence resources and hunting are described further in the Terrestrial Mammals section (Section 5.10), Subsistence and Traditional Land-Use Patterns section (Section 5.22), and the Environmental Justice section (Section 5.16).

Employment

Construction employment under Alternative C could be as much as 50 percent greater than employment under Alternative B due to the additional workforce needed to construct the gravel access road and to transport and assemble the facility modules from Deadhorse (HDR 2011b). All of the construction materials needed under Alternative C would be transported overland and the size of each load would be restricted by the weight and width capacity of the transporters. The additional module assembly and commissioning would require between 8 and 10 months, rather than the 60-day to 120-day range estimated by the Applicant for Alternative B (HDR 2010a). Maximum total employment in Alternative C would peak in Year 6 at about 1,500 workers. An estimate of total project employment is detailed by year and discipline in Table 5.15-4. Total project employment was calculated using onsite workforce estimates in Figure 2.4-20 with consideration for personnel rotations during each project phase (HDR 2011m).

Table 5.15-4: Alternative C Maximum Employment [a]

Project Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
North Slope Construction[b]	—	—	575	750	1,100	1,100	—	—	—	—
Drilling	—	—	—	—	275	275	275	275	—	—
Operations[c]	—	—	—	—	—	160	160	160	160	160
Total Employment	—	—	575	750	1375	1535	435	435	160	160

Source: HDR 2011b

[a] Maximum employment values are based on available camp bed space and personnel rotations during each project phase HDR 2011m.

[b] North Slope construction only includes work that occurs in the NSB, including Point Thomson, Deadhorse/Prudhoe Bay, or at temporary work camps for gravel road construction. Some construction activities, such as module construction, would occur outside of the NSB and are not included in these values.

[c] Operations include post-construction, onsite operation of the facility. Operations employment continues for the 30-year life of the project.

Construction for Alternative C would also begin 2 years later than construction of the Point Thomson facility under Alternative B.

Income

Impacts to the income of residents in the NSB would be the same as those described in Alternative B. Additional employment and contract opportunities may occur as the result of increased amount of infrastructure built in Alternative C. This may allow residents and native corporations to capture additional wages and revenue. This could increase the benefits to NSB resident income through these wages and native corporation dividends.

Tax Base

Construction of Alternative C would be expected to have similar benefits to the NSB's tax base as those described for Alternative B. However, moving project components inland would increase infrastructure costs for the project, thus reducing the net project revenue to the company.

Tax revenues generated by the project would begin to benefit the NSB when the facility is installed. These benefits would also likely be slightly greater than those expected under Alternative B because the additional construction workers needed to implement the logistics of Alternative C and to construct the gravel access road would increase the population of the NSB for tax purposes and result in a larger tax base for operating expenses and bond repayment.

Housing

Construction of Alternative C would be expected to have the same minor impact on the supply of and demand for housing as described for Alternative B. Increased access to the area via the gravel access road would not be expected to reduce the barriers to living in the NSB sufficiently to cause any project-related change in the demand for housing.

Utilities, Community Facilities, and Services

Construction of Alternative C would be expected to have similar effects on utilities and community facilities as described for Alternative B. However, development of the site, including the construction of the gravel access road at the same time as the Point Thomson facility may impact the available infrastructure in Deadhorse and Prudhoe Bay. Schedule and logistical constraints are also likely to extend the construction period by 1 year, extending construction impacts beyond the 2 years estimated for Alternative B.

The logistical constraints discussed in Section 5.15.4.1, Alternative C: Construction and Section 2.4.4, Alternative C: Logistics and Sequencing, are likely to impact material supply chains in Deadhorse and throughout Alaska. The lack of barge access to the Point Thomson site in Alternative C would require facility modules and permanent fuel tanks to be barged to Prudhoe Bay and then transported via ice road to Point Thomson. These modules would need to be stored in the Deadhorse and Prudhoe Bay area between barging season in the summer and the completion of a rig and module-ready ice road in January. The storage and movement of these modules may also require the construction or upgrade of infrastructure in Deadhorse and Prudhoe Bay areas, including the storage pad space, barge dock, access roads, culverts, and pipelines. The additional workers needed in Alternative C may also result in the need for additional construction camp space in the Deadhorse area.

The logistics of resupplying the Point Thomson facility during construction in the available ice road window each year may also result in adverse impacts on the supply of fuel and raw materials in Prudhoe Bay. The Applicant has indicated that 60 temporary fuel tanks would be needed for the construction of Alternative C and would likely require the dedication of the resources of tank fabrication shops in Fairbanks for more than 2 years (HDR 2011g). Permanent fuel tanks would likely be fabricated worldwide and would need to be barged and then stored in Deadhorse prior to transportation via ice road to the Point Thomson site. These tanks would be needed to store up to 6 million gallons of diesel fuel to support construction activities between the end of the ice road season in Year 1 and the beginning of the ice road season in Year 2. A like amount would be needed for Year 3. This fuel requirement is likely to require an expansion of the existing fuel depot infrastructure in Deadhorse to meet the high demand (See Section 2.4.4, Alternative C: Well and Production Pad, for additional discussion). The impacts to the infrastructure and capacity of Deadhorse and Prudhoe Bay would be likely to have adverse indirect effects on other industrial activities operating on the North Slope.

5.15.4.2 Alternative C: Drilling

The drilling activities prescribed for Alternative C are expected to have similar minimal socioeconomic effects as those described for Alternative B.

5.15.4.3 Alternative C: Operations

The operations activities for Alternative C would be similar to those described for Alternative B. The gravel access road could reduce the cost of developing other hydrocarbon-producing areas in the eastern NSB and induce additional field development in the area.

Demographics

The operations at Point Thomson under Alternative C would be expected to have similar, minor effects to the population of the NSB as described for Alternative B. The gravel access road would not be expected to reduce the barriers to living in the NSB sufficiently to generate any project-related population growth.

Community Characteristics and Culture

Operational effects of Alternative C on the community character and culture would be less than those described for Alternative B because the facilities and pipelines are located away from coastal villages and subsistence areas. The reduced effects of Alternative C on subsistence caribou hunting are described in the Construction section. These effects are expected to continue throughout the 30-year life of the facility.

Employment

Operation of Alternative C would have similar impacts to employment as those described for Alternative B.

Income

The operations impacts on income for Alternative C would be similar to those described for Alternative B.

Tax Base

Operation of Alternative C would have similar impacts to employment as those described for Alternative B. The increased investment in the project as the result of the construction of the gravel access road may increase the actual and true value of NSB property, and as a result, NSB tax revenue for bond repayment.

Housing

Operation of Alternative C would not affect the supply of or demand for housing in the NSB. These effects are the same as those described for Alternative B. The presence of the gravel access road would not be expected to alter the demand for housing in the area.

Utilities, Community Facilities, and Services

Operation of Alternative C would have the same minor effects on utilities, community facilities, and public services as described for Alternative B. If the residents of Kaktovik are allowed access to the gravel access road and can develop a gravel or ice road route from Kaktovik to Point Thomson, this would improve their access to the Dalton Highway at Deadhorse. The distance between Point Thomson and Kaktovik, as well as the associated cost of developing a connecting road between the two, may render this infeasible.

5.15.4.4 Alternative C: Impact Evaluation

Table 5.15-5 provides the impact evaluation for socioeconomic resources for Alternative C. Potential impacts are both positive and negative, range from minor to moderate in magnitude, temporary to medium-term duration, unlikely to probable potential to occur, and local to extensive in geographic extent.

Table 5.15-5: Alternative C—Impact Evaluation for Socioeconomics				
Impact Type	Magnitude	Duration	Potential to Occur	Geographic Extent
Population	Minor	Medium term	Possible	Local
Community Characteristics and Culture	Minor	Medium term	Probable	Local
Employment and Income	Minor	Medium term	Possible	Extensive
Tax Base	Moderate	Medium term	Probable	Extensive
Housing	Minor	Medium term	Unlikely	Local
Utilities, Community Facilities, and Services	Minor	Temporary	Possible	Local

5.15.5 Alternative D: Inland Pads with Seasonal Ice Access Road

The configuration of Alternative D is similar to Alternative C, except that road access during drilling and operations would be by seasonal ice road rather than by a gravel access road. Alternative D also does not include the use of barging to transport materials and thus shares many of the same logistical and infrastructure challenges as Alternative C. However, these challenges extend over the life of the project as ice roads and air would be the only two mechanisms for resupplying the site during both drilling and operations.

Impacts to community characteristics and culture would be similar to those described for Alternative C. Minimizing the coastal impacts and locating the facilities and the export pipeline inland would be expected to reduce the adverse effect on subsistence caribou hunting within the Point Thomson area. The effects of Alternative D on subsistence resources and hunting are described further in Terrestrial Mammals (Section 5.10), Subsistence and Traditional Land-Use Patterns (Section 5.22), and Environmental Justice (Section 5.16).

Employment under Alternative D is likely to be similar to that under Alternative C except that fewer workers would be needed because Alternative D does not include the construction of a gravel road. Alternative D would still have increased employment levels relative to Alternative B because of the additional workforce needed to transport and assemble the facilities modules overland via ice road. Employment would peak in Year 6 at about 1,200 workers (HDR 2011b). Long-term employment during operations in Alternative D is expected to be higher than in Alternatives B and C because an additional construction crew would be needed each winter to construct an ice road to the Point Thomson facility. An estimate of total project employment is detailed by year and discipline in Table 5.15-6. Total project employment was calculated using onsite workforce estimates in Figure 2.4-25 with consideration for personnel rotations during each project phase (HDR 2011m).

Table 5.15-6: Alternative D Maximum Employment [a]										
Project Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
North Slope Construction[b]	—	—	250	425	775	775	75	75	75	75
Drilling	—	—	—	—	275	275	275	275	275	—
Operations[c]	—	—	—	—	—	160	160	160	160	160
Total Employment	—	—	250	425	1050	1210	510	510	510	235

Source: HDR 2011b

[a] Maximum employment values are based on available camp bed space and personnel rotations during each project phase (HDR 2011m).

[b] North Slope construction only includes work that occurs in the NSB, including Point Thomson, Deadhorse/Prudhoe Bay, or at a temporary work camp. Some construction activities, such as module construction, would occur outside of the NSB and are not included in these values.

[c] Operations include post-construction, onsite operation of the facility. Operations employment continues for the 30-year life of the project.

Alternative D is likely to have similar impacts to the infrastructure and capacity in Deadhorse and Prudhoe Bay as Alternative C. However, as Alternative D does not include the construction of a gravel access road, the transportation constraints related to access of the site by ice road only would continue for the life of the project. The transportation and logistics constraints also extend drilling activities 1 year beyond Alternative C and 2 years beyond Alternative B.

All of the other socioeconomic effects are expected to be the same for Alternative D as those described above for Alternative C.

5.15.6 Alternative E: Coastal Pads with Seasonal Ice Roads

The economic and social consequences of Alternative E would be similar to those described for Alternative B. Alternative E reduces the development footprint to minimize impacts to wetlands and surrounding water resources by reducing gravel fill for production pads and infield roads. Access to pads would be provided by ice road in the winter and by helicopter year-round. Alternative E includes development of facilities to produce 10,000 barrels of condensate per day, so the economic benefits would be the same for the Applicant, the state, and the NSB.

Impacts to subsistence resources and activities may be greater than in Alternative B as the increased use of helicopters has the potential to disturb wildlife in the project area. Schedule and logistical constraints associated with moving the drill rig between pads during the ice road season are likely to extend the drilling phase by 2 years beyond the 3 years needed in Alternative B. Employment in Alternative E would be similar to that under Alternative B except for an increase in the length of drilling employment over 5 years as opposed to 3 years in Alternative B (HDR 2011g). In addition, long-term employment during operations in Alternative E is expected to be higher than in Alternatives B because an additional construction crew would be needed each winter to construct an ice road to the Point Thomson facility. An estimate of total project employment is detailed by year and discipline in Table 5.15-7. Total project employment was calculated using onsite workforce estimates in Figure 2.4-29 with consideration for personnel rotations during each project phase (HDR 2011m).

Table 5.15-7: Alternative E Employment [a]										
Project Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
North Slope Construction[b]	—	250	775	775	775	75	75	75	75	75
Drilling	—	—	—	275	275	275	275	275	—	—
Operations[c]	—	—	—	—	160	160	160	160	160	160
Total Employment	—	250	775	1,050	1,210	510	510	510	235	235

Source: HDR 2011b

[a] Maximum employment values are based on available camp bed space and personnel rotations during each project phase (HDR 2011m).

[b] North Slope construction only includes work that occurs in the NSB, including Point Thomson, Deadhorse/Prudhoe Bay, or at temporary work camps. Some construction activities, such as module construction, would occur outside of the NSB and are not included in these values.

[c] Operations include post-construction, onsite operation of the facility. Operations employment continues for the 30-year life of the project.

Other impacts to socioeconomic resources are expected to be the same for Alternative E as those for Alternatives C and D.

5.15.7 Mitigative Measures

The Applicant has included the following design measures as part of the project design to avoid or minimize adverse impacts on socioeconomics, and to provide socioeconomic benefits.

- Providing employment opportunities for North Slope and other Alaska residents
- Providing contracting and business opportunities for North Slope and other Alaska companies
- Generating revenue for the State and NSB governments
- Making contributions and providing other support for local schools, social, and cultural needs

Measures to avoid or minimize impacts to subsistence activities are detailed in Section 5.22, Subsistence and Traditional Land-Use Patterns.

5.15.8 Climate Change and Cumulative Impacts

5.15.8.1 Climate Change

Potential effects of climate change on the socioeconomics of the region include impacts to transportation infrastructure (see Section 5.2, Soils and Permafrost), vegetation and wildlife (see Sections 5.8 through **Error! Reference source not found.**), recreation (see Section 5.18), and the coastal environment (see Section 5.5, Physical Oceanography and Coastal Processes). As annual temperatures in the Arctic become warmer and winter seasons shorter, climate change could disrupt current aspects of regional socioeconomics. It could, however, also provide opportunity for new sources of revenue and infrastructure to support the economy. For example, residents of the NSB may find it more difficult to harvest subsistence resources as a result changes in migratory routes of important subsistence hunting prey species, but may gain increased opportunities to fish harvest (see Section 5.22, Subsistence and Traditional Land-Use Patterns). Reducing the available quantity of subsistence resources would force residents to import more food, rely more heavily on the cash economy, and increase the cost of living above the Arctic Circle.

Climate change may also have impacts on community infrastructure and transportation. A longer open-water season could increase opportunity for shipping along the coast, adding additional regional transportation opportunities (ACIA 2004). Increased open water, however, has also been identified as a cause of the flooding that has occurred annually at Kaktovik's airport since 2006 as shore fast and pack ice is not consistently present to dampen the effects of early season winter storm surges (NSB n.d.). Planning is already underway to evaluate potential sites for airport relocation (FAA 2009a, b). Coastal erosion has also been an issue in Kaktovik, particularly in the vicinity of the airport (NSB n.d.).

The effects of climate change and resulting impacts to transportation and oil and gas infrastructure (e.g., melting permafrost resulting in instability of infrastructure) may have engineering solutions, but could result in substantial costs to mitigate. These additional costs could impact oil production revenues, with concomitant employment and tax revenue impacts. The effects of climate change described above are expected to be the same under all alternatives.

5.15.8.2 Cumulative Impacts

Past, present, and reasonably-foreseeable oil and gas related actions could cause impacts on the economy and culture of the North Slope. Following its formation in 1972, the NSB used oil and gas tax income to provide new services, infrastructure, and employment opportunities to residents (NRC 2003a). In 2010, NSB tax revenues from current oil and gas production represented 98 percent of the tax base and provided 85 percent of the revenue of the borough government (NSB 2010a). In 2009, the total actual and true property value of the NSB, which consists almost entirely of oil and gas infrastructure, was reported to be $12.9 billion (NSB 2009). Since oil production on the North Slope began, personal income of residents of the NSB has also increased dramatically relative to many other parts of rural Alaska (NRC 2003a).

All action alternatives for the Point Thomson Project and all reasonably-foreseeable oil and gas-related actions would increase the quantity of commercial-grade hydrocarbons extracted from the North Slope of Alaska and shipped via the TAPS to the Port of Valdez in south-central Alaska. The construction and development of any of the RFFAs would also increase the utilization of the existing oilfield infrastructure and create employment opportunities for oil field workers and support staff throughout Alaska. Increased oil and gas development would also generate additional tax revenue for the borough and the state.

Even with an increase in hydrocarbon production from the Point Thomson Project and other RFFAs, the State of Alaska forecasts that North Slope hydrocarbon production will decrease over the next 10 years. Production in 2009 was 706,000 barrels per day and, factoring in potential Point Thomson production, the state forecasts that production would decrease to 631,000 barrels per day in 2014 and 530,000 barrels per day in 2019. Without including Point Thomson production, the state forecasts that production would decrease to 621,000 barrels per day in 2014 and 520,000 barrels per day in 2019 (ADOR 2010). Declining hydrocarbon production would reduce economic activity in the NSB and reduce the economic vitality of the area and the state. Developing the Point Thomson facility would slow the decline in oil production and result in a beneficial, cumulative economic effect on the NSB and the State of Alaska.

Past and present developments have had impacts on community culture and characteristics through impacts to subsistence and traditional activitites. The Point Thomson Project and other RFFAs could also have adverse effects on local community characteristics and culture by increasing industrial activity in subsistence areas with a potential for impacts to subsistence resources. These cummulative impacts are discussed in more detail in Section 5.22, Subsistence and Traditional Land-Use Patterns.

5.15.9 Alternatives Comparison and Consequences

Under all of the action alternatives, residents of Kaktovik, Nuiqsut, and the NSB as a whole are likely to experience both positive and negative socioeconomic impacts as a result of the construction and operation of the

Point Thomson Project. Impacts to community characteristics are likely to be the result of impacts on subsistence resources and usage areas, which could result in secondary impacts on community culture and health.

The size and likelihood of impacts, however, varies among the four action alternatives. Alternatives B and E, which include barge traffic and nearshore infrastructure, would have the greatest impacts on residents' subsistence activities through the potential displacement of subsistence resources and impacts to user access along the coast. Alternatives C and D are likely to have fewer impacts to subsistence resources along the coast, although Alternative C may cause a more widespread disruption to subsistence resources as a result of the construction of the gravel access road.

Impacts to NSB resident employment and income, and the NSB tax base are likely to be greater under Alternatives C and D due to the increase in total workers needed during construction, the length of the construction and drilling phases, and total capital investment in the project relative to Alternatives B and E. Alternatives C and D, however, would also have greater negative impact on the services and infrastructure of the industrial enclaves of Deadhorse and Prudhoe Bay as the lack of barging in these alternatives constrains project logistics.

5.16 ENVIRONMENTAL JUSTICE

The key findings of effects for the environmental justice analysis are summarized below with a brief summary of the differentiating effects. The remainder of the section describes the methodology for assessing impacts and the full results of the assessment.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

All Alternatives: Minor impacts to subsistence and traditional land use and human health would not result in disproportionately high adverse environmental effects on the minority communities of Kaktovik and Nuiqsut.

5.16.1 Methodology

This section will examine potential effects from the three main project phases, construction, drilling, and operations, on the low-income and minority communities of Kaktovik and Nuiqsut. Within the NSB, Kaktovik and Nuiqsut are the communities that are most likely to experience disproportionate project-related adverse effects related to the Point Thomson Project due to their physical proximity to the project area and the overlap between subsistence use areas and project activities and infrastructure.

5.16.1.1 Impact Criteria

Executive Order 12898 directs federal agencies to identify and address disproportionately high and adverse human health or environmental effects of proposed federal actions, such as permitting development at Point Thomson, on minority and low-income populations (Executive Order No. 12898). Federal agencies also are required to give affected communities opportunities to provide input into the environmental review process, including identification of mitigation measures.

As discussed in Section 3.16, Environmental Justice, the NSB's population is composed largely of members of an ethnic minority in the state (Alaska Native) who live a subsistence lifestyle with limited cash income. The communities of Kaktovik and Nuiqsut have higher percentage minority populations (90 percent) than the NSB at large (67 percent; USCB 2010a). In addition, Kaktovik and Nuiqsut also have lower per capita incomes than the NSB and the rest of the state (Shepro et al. 2003). Based on these characteristics, the populations of Kaktovik and Nuiqsut qualify as minority and low-income populations.

This analysis of impacts related to environmental justice considers if implementation of one of the proposed alternatives would result in disproportionately high and adverse environmental effects to the communities of Kaktovik or Nuiqsut, or if such effects would occur with greater frequency for these communities than for the general population of the NSB or state as a whole. Environmental justice analyses weigh the benefits of a proposed project (oftentimes increased economic activity or access to improved infrastructure) on the environmental justice community, which may offset the adverse environmental effects from construction or operation.

The issues to be addressed in the Environmental Justice section, as they affect minority or low-income populations, include:

- Potential destruction or disruption of subsistence resources
- Potential destruction or disruption of community cohesion
- Employment effects from the creation or loss of jobs
- Potential impacts to human health

The assessment for environmental justice impacts is based on the impact evaluations for each of the aforementioned resources.

Other impacts that could affect environmental justice communities include noise and visual aesthetics. However, the community of Kaktovik is located more than 60 miles east of the proposed Point Thomson facility and Nuiqsut is located 112 miles southwest of Point Thomson. As discussed in 5.19 Visual Aesthetics and Section 5.20, Noise the construction of the facility would not alter the community's visual landscape, dominate the visual setting, or cause a serious diminution of aesthetic values for Kaktovik residents. Similarly, noise from the project would not be experienced in Kaktovik or Nuiqsut. Therefore, noise and visual aesthetics impacts are not included in the discussion of potential environmental justice impacts. However, noise and visual impacts to residents traveling and hunting near Point Thomson were considered and incorporated into the environmental justice assessment within the context of the subsistence and traditional land use analysis.

5.16.2 Alternative A: No Action

Subsistence impacts for Alternative A would be minimal, long-term, unlikely, and limited in geographic extent (see Section 5.22, Subsistence and Traditional Land-Use Patterns). Minor to no impacts to subsistence and traditional land use activities, community culture and cohesion, human health, and employment would result from suspension of project planning activities and the lack of further development of the hydrocarbon resources at Point Thomson. Alternative A would not result in disproportionately high and adverse environmental effects on the minority and low-income populations in the study area.

5.16.3 Alternative B: Applicant's Proposed Action

The construction of Alternative B has the potential to impact subsistence activities in subsistence use areas for the people of Kaktovik as a result of enlarging the existing Central Pad and construction of additional pads (East Pad, West Pad, and airstrip), additional wells, a new pipeline to Badami, and the CPF. The proposed facility would occupy a small percentage of land in the NSB. Developing the site would result in a more industrial, developed setting.

5.16.3.1 Alternative B: Construction

As discussed in detail in Section 5.22, Subsistence and Traditional Land-Use Patterns, the residents of Kaktovik currently use the site of the proposed Point Thomson facility and export pipeline for subsistence caribou hunting and to access marine and fresh water aquatic resources. The project area is used less frequently than other areas in closer proximity to the community, but the project area may be an important harvest area if resources are less abundant in other areas. Locating the facility and export pipeline near the coast of the Beaufort Sea has the potential to disrupt subsistence activities through the loss of subsistence use areas, reduced resource availability, and reduced user access resulting from project infrastructure, noise, traffic, avoidance, contamination concerns, and hunting regulations. The majority of impacts to subsistence would be minor in magnitude, long-term, unlikely to possible, and limited in geographic extent; however, impacts to caribou hunting for Kaktovik would be probable, local in geographic extent, and minor in magnitude (see Section 5.22, Subsistence and Traditional Land-Use Patterns). For the community of Nuiqsut impacts to bowhead whale hunting would be moderate in geographic extent, but minor in magnitude and unlikely to occur.

Construction at the site would not bisect any communities, prevent access between communities, or disrupt any established communities in the area. Because the proposed project would be built in an unpopulated area with no direct links to established communities, the project would have no effect on community isolation. Because of the predominance of Alaska Natives in the NSB, minority individuals form "the broader community" of the area. Construction of the proposed project would not isolate minority or low-income individuals from the broader community.

Construction of the facility would be likely to increase employment opportunities as residents take advantage of the local hire program sponsored by the Applicant and its contractors. Local residents who work at the Point Thomson facility would benefit from jobs and increased income. Long-term residents of the NSB, including Alaska Natives from Kaktovik and Nuiqsut, would be well qualified to fill the seasonal positions for Marine Mammal Observers, Subsistence Advisors, and Polar Bear Monitors (ExxonMobil 2010d). Although the number of jobs the Point Thomson Project generates for local residents would not be known until after contracts are awarded and construction begins, it would be possible, and perhaps even probable, that construction would generate a moderate number of positions for local residents. However, based on the history of past development projects on the North Slope, the construction of the Point Thomson Project would likely have a minor impact on NSB resident employment. Most of the positions for this project would likely be filled by nonresident workers who would leave the area in between shifts.

An increase in employment and in cash income from both employment and dividends would help local residents, especially those of working age, to stay in the area and maintain their culture and community characteristics. Residents may also experience economic benefits through increased income from native corporate dividends, and through indirect effects of increased tax income for the NSB government. Section 5.15, Socioeconomics provides additional discussion of impacts to employment, income, and the NSB tax base.

Health impacts related to Alternative B construction were predominantly rated low, as the core subsistence areas near Kaktovik would be unaffected, harvests of bowhead whales for Nuiqsut would not be reduced, and there would be little interaction between workers at the site and the local community, thereby having minor impacts to food, nutrition, subsistence, and social determinants of health. Exposure to hazardous materials was rated as medium; however, emissions would be regulated for protection of human and environmental health.

5.16.3.2 Alternative B: Drilling

The effects of drilling at Point Thomson on the minority communities of Kaktovik and Nuiqsut would be similar to those described above for construction, except that fewer workers would be employed to drill the wells than to construct the facility.

5.16.3.3 Alternative B: Operations

Operational effects of the project on the communities of Kaktovik and Nuiqsut would be similar to those described for construction, except for additional benefits to socioeconomic conditions. Fewer workers would be employed at the site during operation, but operation of the Point Thomson facility would generate oil royalties and increase income for low-income and minority residents of the state, as well as all other residents of Alaska, via the Alaska Permanent Fund Dividend (PFD). An increase in cash income and jobs would help local residents, especially those of working age, to stay in the area and maintain their culture and community characteristics.

5.16.3.4 Alternative B: Impact Summary

Adverse impacts to subsistence caribou hunting for Kaktovik, bowhead whale hunting for Nuiqsut, and human health could occur under Alternative B; however, these impacts are anticipated to be minor. No impacts to community cohesion are anticipated, and economic impacts would provide benefits to the NSB communities. Health impacts were predominantly rated as low. Exposure to hazardous materials was rated as medium; however, emissions would be regulated for protection of human and environmental health. Alternative B is not anticipated to result in disproportionately high and adverse impacts to minority and low-income populations in the study area.

5.16.4 Alternative C: Inland Pads with Gravel Access Road

Alternative C is designed to minimize coastal impacts and differs from Alternative B in that the production facilities, infield gathering pipelines, and export pipeline are located away from the coast of the Beaufort Sea. Without barge access to the site, facility modules would need to be smaller and more numerous to allow for overland transport, which would require more ice road traffic and additional onsite staff to assemble the module units. Relocating project facilities, including the pipeline, away from the coast could reduce impacts to Kaktovik and Nuiqsut, although building a gravel access road instead of a seasonal ice road could open the area for additional industrial development.

5.16.4.1 Alternative C: Construction

Construction effects on the communities of Kaktovik and Nuiqsut would be similar to those described for Alternative B. Locating the facilities inland and the lack of barge use would result in impacts that are less concentrated in and located farther from areas of high use for subsistence activities, resulting in fewer concerns and less visual impacts for Kaktovik residents hunting and fishing along the coast. However, some caribou displacement is still likely to occur due to the presence of pipelines, roads, and other infrastructure in the project area. Subsistence impacts of Alternative C to Kaktovik caribou hunting activities would be minor in terms of effects on harvest amounts, long-term, probable, and local in geographic extent. (See Section 5.22, Subsistence and Traditional Land-Use Patterns, for additional information.) Impacts for all other subsistence resources would be minor, long-term, unlikely, and limited in geographic extent. Using the ice road instead of barging to bring in construction materials would reduce potential impacts to summer subsistence harvest for residents of Kaktovik and avoid adverse effects to bowhead whale migration and whaling for the residents of Nuiqsut and Kaktovik. Community cohesion for the communities of Kaktovik and Nuiqsut from construction of Alternative C would be similar to Alternative B.

Positive impacts resulting from increased employment opportunities, income, and NSB tax revenue would be similar to those described for Alternative B. However, employment opportunities are likely to be greater as a result of an extended construction phase and increased construction employment relative to Alternative B (see Section 5.15, Socioeconomics for additional discussion).

During construction, potential impacts to human health as a result of exposure to hazardous materials were rated as medium. Other impacts related to reduced consumption of subsistence resources and changes in social determinants of health were rated as low. The potential for increased roadway accidents and injuries was rated as high due to the high amount of truck traffic on the gravel access road, with potential negative impacts on the ability of the local emergency services to respond.

5.16.4.2 Alternative C: Drilling

The effects of drilling on the minority communities of Kaktovik and Nuiqsut would be the same as those described for Alternative B.

5.16.4.3 Alternative C: Operations

The effects of operating the Alternative C facility would be similar to those described for Alternative B, although the location of the facilities and export pipeline could reduce the subsistence and caribou resource impacts described for Alternative B. Additionally, the gravel access road, if it were open to general traffic, could increase access for nonlocal hunters in the area and could cause additional competition for subsistence resources between local residents and nonlocal recreational and subsistence hunters. However, no isolation or separation of communities would result.

5.16.4.4 Alternative C: Impact Summary

Adverse impacts to subsistence hunting could occur under Alternative C; however, impacts would be minor. No impacts to community cohesion would result from construction, drilling, or operations for Alternative C, and economic impacts would provide benefits to the NSB communities. Health impacts were predominantly rated as low to medium, with the exception being the potential high negative impacts from roadway accidents and injuries and to health infrastructure and delivery during construction and drilling. However, the potential for negative impacts from roadway accidents would be experienced by anyone traveling on the roadway and would not be considered a disproportionately high effect to minority and low-income populations. Therefore, Alternative C is not anticipated to result in disproportionately high and adverse impacts to minority and low-income populations in the study area.

5.16.5 Alternative D: Inland Pads with Seasonal Ice Access Road

The configuration of Alternative D is similar to that of Alternative C, except that long-term road access would be by seasonal ice road rather than a gravel access road. Because Alternative D locates the facilities away from the coast, the lack of barge activity, and the lack of an all-season gravel access road, it has the least potential of all the action alternatives to cause impacts to subsistence and traditional activities.

Impacts of Alternative D to subsistence, community cohesion, and human health are similar to Alternative C. The economic benefits of Alternative D would be similar to Alternative C, with an extended construction phase and increased construction employment relative to Alternative B. The Alternative D ice road would not provide the same degree of access to the area between Deadhorse and Point Thomson.

5.16.5.1 Alternative D: Impact Summary

Although adverse impacts to subsistence hunting could occur under Alternative D, impacts would be minor. No impacts to community cohesion would result from construction, drilling, and operations for Alternative D, and economic impacts would provide benefits to the NSB communities. Health impacts were predominantly rated as low to medium, with the exception being the potential high negative impacts from roadway accidents and injuries and to health infrastructure and delivery during construction and drilling. However, the potential for negative impacts from roadway accidents would be experienced by anyone traveling on the roadway and would not be considered a disproportionately high effect to minority and low-income populations. Therefore, Alternative D is not anticipated to result in disproportionately high and adverse impacts to minority and low-income populations in the study area.

5.16.6 Alternative E: Coastal Pads with Seasonal Ice Roads

Alternative E reduces the development footprint to minimize impacts to wetlands and surrounding water resources, but still sites the facility and export pipeline near the Beaufort Sea coastline. Alternative E does not include infield gravel roads for access to the East and West Pads. Ice roads, tundra-safe vehicles, and helicopters would be used to bring in personnel and supplies.

Subsistence impacts of Alternative E construction, drilling and operations are similar to Alternative B; however, effects to Kaktovik caribou hunting activities may be slightly higher than in Alternative B because of increased helicopter activity, and impacts to bowhead whale hunting for Nuiqsut would be local in geographic extent. Community cohesion and human health effects to the communities of Kaktovik and Nuiqsut from Alternative E would be similar to Alternative B. Alternative E would have the same potential as the other alternatives to have beneficial impacts in terms of employment opportunities, increased income, and NSB tax revenue.

5.16.6.1 Alternative E: Impact Summary

Adverse impacts to subsistence hunting for caribou for Kaktovik, bowhead whale hunting for Nuiqsut, and human health could occur under Alternative E; however, these impacts are anticipated to be minor. No impacts to community cohesion are anticipated, and economic impacts would provide benefits to the NSB communities. Health impacts were predominantly rated as low. Exposure to hazardous materials was rated as medium; however, emissions would be regulated for protection of human and environmental health. Alternative E is not anticipated to result in disproportionately high and adverse impacts to minority and low-income populations in the study area.

5.16.7 Mitigative Measures

The Applicant has included design measures as part of the project design to avoid or minimize adverse effects to subsistence activities and socioeconomics, and to provide socioeconomic benefits. These measures would reduce impacts and/or provide benefits to the environmental justice communities in the project area, and are detailed in the following sections of this Final EIS:

- Socioeconomics (Section 5.15)
- Subsistence and Traditional Land-Use Patterns (Section 5.22)
- Human Health (Section 5.23)

5.16.8 Climate Change and Cumulative Impacts

5.16.8.1 Climate Change

As discussed in detail in Section 5.10, Terrestrial Mammals, climate change could result in more rain-on-snow events, deeper snow, warmer summers, and changes in plant phenology and community structure, all of which could adversely affect the distribution, abundance, or survivability of species important to the subsistence lifestyle of the Native communities of Kaktovik and Nuiqsut (see Section 5.22, Subsistence and Traditional Land-Use Patterns). These climate change impacts to environmental justice would be the same in all alternatives, including the No Action Alternative.

5.16.8.2 Cumulative Impacts

Past and present actions and events that have affected the environmental justice populations of the NSB and its communities include transportation activities, ongoing oil and gas exploration and development, and recreation and tourism by nonresidents. These past and current activities affect the current status of employment, subsistence and traditional activities, aspects of Iñupiat culture, health, and safety of local residents. Some of these impacts have been positive, increasing total personal income and providing tax revenue for the NSB which funds community facilities, health clinic, capital improvements to water and sewer systems, and schools (NRC 2003a). The Point Thomson Project and other RFFAs (see Section 4.2, Cumulative Impacts Methodology) are likely to continue to contribute to personal income and NSB revenue in the region.

The Point Thomson Project and other RFFAs could potentially impact subsistence and other traditional activities. Increased oil and gas development in the Point Thomson area could reduce the quantity of caribou harvested by residents of Kaktovik, and impact Nuiqsut bowhead whale hunting in the coastal waters. Potential impacts to subsistence and traditional land use could result adverse impacts to the minority communities of the North Slope depending on the degree to which subsistence resources would be affected. With the exception of Alternative C, the proposed action's contribution to cumulative impacts would be similar for all action alternatives. In Alterative C, the gravel access road from the Endicott Spur Road to Point Thomson could provide access to potential hydrocarbon production sites situated along the road and reduce the costs and physical challenges of developing additional production sites in the area. Alternative C, therefore, enhances the opportunity for additional oil and gas field development and access by nonresidents to the area. Increased development could have both adverse and positive effects on the minority and low-income population of the NSB, by increasing employment, income, and the NSB tax base or by increasing impacts to subsistence resources, subsistence user access, and community culture. The Point Thomson Project is likely to contribute to both positive and adverse cumulative impacts on the environmental justice populations of the NSB.

5.16.9 Alternatives Comparison and Consequences

Under all action alternatives, residents of the minority communities of Kaktovik and Nuiqsut are not likely to experience disproportionally high and adverse impacts as the result of disruption to subsistence resources and activities. The primary effects on subsistence activities resulting from the project include impacts on subsistence use areas, resource availability, and user access for caribou. The location and placement of the project facilities and export pipeline in each of the alternatives shifts the location of impacts to subsistence resources.

Alternatives B and E are likely to have the largest impact to subsistence resources because of barge traffic and the location of the facilities and pipeline within 1 to 2 miles of residents' coastal hunting areas. Alternative E is likely to have greater impacts to subsistence resources as the lack of infield gravel roads in the alternative design necessitates the more frequent use of helicopters, which can cause further disruption to subsistence resources and users. Alternatives C and D are less likely to have direct impacts to subsistence users as the infrastructure and activity in these alternatives is located farther inland, away from coastal hunting areas. These alternatives still have the potential to disrupt subsistence resources. In addition, Alternative C may cause further disruption to subsistence resources as a result of the construction and use of the gravel access road. During the construction and operations phases, the potential for increased roadway accidents and injuries would be higher for Alternatives C and D due to use of the access road and could result in higher negative impacts on human health.

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5.17 TRANSPORTATION

The key findings for transportation are summarized below with a brief summary of the differentiating effects.

Key Impact Findings and Differentiators Among Alternatives

Key Findings:

Alternatives C and D: Moderate impacts on roadways would be possible, and minor impacts on marine transportation would be unlikely. For both, impacts would continue for the life of the project and would occur within 5 miles of project components.

Alternative B and E: Minor to moderate impacts on roadways would be possible and unlikely for marine transportation. Impacts on roadways would last more than one phase of the project, while impacts on marine transportation would last the life of the project. For both, impacts would occur within 5 miles of project components.

Alternatives B, C, D, and E: Moderate impacts to aviation would be possible, while minor impacts to pipeline infrastructure would be unlikely. For both, impacts would last the life of the project and would occur within 5 miles of project components.

Alternative A: Minor impacts on the existing transportation networks are unlikely, but would last during one phase of the project and occur within 5 miles of project components.

Differentiators:

- Alternatives C and D have moderate, long-term impacts on roadways because they rely on land transportation for the life of the project. Alternative E has moderate, medium-term impacts on roadways because it includes a longer drilling phase.
- Alternatives B and E have long-term impacts on marine transportation because coastal barging will continue throughout the operations phase of the project.

5.17.1 Methodology

Currently, there are no permanent roads between Endicott Spur Road east of Prudhoe Bay and Point Thomson. The project area is accessed by seasonal and temporary surface and marine facilities along with rotary-wing aircraft. The transportation evaluation is based on traffic generation, potential congestion, and safety. There is no public access to Point Thomson; therefore, impacts would be to existing travel modes and marine, road, and pipeline facilities at Prudhoe Bay and the Deadhorse airport, or other communities in the area.

Impacts from construction and drilling are presented together because these activities overlap and impacts would be similar. In some of the alternatives, drilling starts later in the construction phase. Although drilling may start later than construction, it would still require a similar workforce. Impacts to the natural and human environment by transportation facilities associated with the alternatives are discussed within the respective topics elsewhere in this chapter.

Alternative evaluations are based on the impact criteria developed for transportation and are compared to Alternative A.

The project's transportation impact criteria addresses trip generation, potential congestion, and traffic safety, and evaluate how transportation infrastructure impacts travel modes and other existing transportation systems in the affected environment. Table 5.17-1 describes how impacts are addressed in this section.

Table 5.17-1: Impact Criteria—Transportation

Impact Category*	Intensity Type*	Specific Definition for Transportation
Magnitude	Major	Use of transportation modes and infrastructure would create unacceptable congestion, create increased safety risks, and disrupt other existing transportation systems.
	Moderate	Use of transportation modes and infrastructure would create manageable congestion, create moderate safety risk, and cause noticeable but manageable changes in existing transportation systems.
	Minor	Use of transportation modes and infrastructure would create minimal or no congestion, introduce no safety risks, and cause easily-manageable or no change to existing transportation infrastructure.
Duration	Long term	Impacts would continue for the life of the project.
	Medium term	Impacts would last more than one phase of project development.
	Temporary	Impacts would last for a single phase of project development.
Potential to Occur	Probable	No avoidance.
	Possible	Impact may occur, but is avoidable.
	Unlikely	May occur, but is unlikely to occur.
Geographic Extent	Extensive	Dalton Highway to Staines River, within 5 miles of project components.
	Local	Between the Sagavanirktok and Staines River.
	Limited	Within 2.5 miles of project components.

* Impact categories and intensity types were developed based on CEQ NEPA regulations as described in Section 4.1, Impact Determination Criteria.

5.17.2 Alternative A: No Action

Two production wells (PTU-15 and PTU-16) were drilled and capped on the Central Pad. Protective wellhead covers approximately 16 feet tall and 8 feet in diameter were installed and rig mats remain onsite. If the No Action Alternative is selected, the wells would continue to be monitored in accordance with AOGCC regulations and prudent operator practices until such time they are closed or brought into production in a future project.

Transportation to and from the site for occasional well monitoring would be unlikely to create enough traffic to impact the existing transportation network. Impacts from the No Action Alternative would be minor, temporary, unlikely, and extensive.

5.17.3 Alternative B: Applicant's Proposed Action

Alternative B takes advantage of nearly year-round access by using seasonal modes of travel, including barge access in the summer, ice roads in the winter, and helicopters and fixed-wing aircraft as weather permits. To facilitate the transport of large facility modules to Point Thomson, a sealift facility would be constructed. Large modules would be brought to Point Thomson via sealift barge and 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. The number of round trips to Point Thomson by mode and phase of the project is summarized in Table 5.17-2. Trip numbers in construction and drilling are cumulative for each 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 Chapter 2, Alternatives.

Table 5.17-2: 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.

5.17.3.1 Alternative B: Construction and Drilling

Of the transportation options studied by the Applicant, 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 on receipt of the ROD. Under Alternative B, the pipeline and infrastructure construction would be executed over three winter construction seasons. The drilling program would take place over approximately 2.5 years.

Marine

Under Alternative B, two forms of barging would be available to access Point Thomson: coastal barges and oceangoing (sealift) barges. 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. When barging during the whaling season is needed, the Applicant would follow the protocols outlined in the Conflict Avoidance Agreement to avoid or minimize interactions with whaling vessels and whales.

Coastal barging would also provide a means for the resupply of bulk materials and for the removal of wastes and excess equipment. Coastal barging for construction and drilling mobilization would occur during the open-water season, mid-July running through September, for each of the 3 years of construction and drilling, depending on weather. There would be between 190 and 270 total coastal barge round trips between West Dock and Point Thomson for the construction and drilling phases of the project or an average of between 63 and 90 round trips each open-water season. Table 5.17-2 above summarizes round trips by transportation mode. The drill rig would be demobilized to Prudhoe Bay by barge. The number of barge trips may vary per year depending on weather and when the ice pack returns to shore.

Bowhead Transport barge service makes one annual trip to Barrow, Prudhoe Bay, and Kaktovik between July and September. Barges originate in Seattle and carry general freight cargo to the communities on the North Slope. Crowley Marine Services out of Anchorage or Nikiski delivers petroleum products to Barrow, West Dock at Prudhoe Bay, Nuiqsut, and Kaktovik. It takes several barge trips to fill each village's fuel needs. Between Bowhead Transport and Crowley Marine Services, there are an estimated 15 barge trips per open-water season (July through September). The additional barge trips would not likely cause delays or congestion in the ocean shipping lanes and would have minimal impacts to local and regional barge service pier facilities because Point Thomson would have its own dock at the project site.

During the open-water season of Year 4, approximately seven to nine sealift barges would carry facility modules direct from the manufacturer to Point Thomson. It would take several weeks to unload these barges. Modules would be unloaded using SPMTs and would not require trucks for transport. While one barge is unloaded, the remaining barges would be anchored away from the docking area. The barges would not be anchored in the shipping lanes, so annual barging to Kaktovik would not be impacted.

Roadways

Ground transport to Point Thomson would only be available during the ice road season. Table 5.17-2 summarizes the estimated round trips by phase. Up to 10,760 land transport round trips could occur on the ice road during the construction and drilling phases. While the number of round trips would vary depending on the activity, land transport trips could average around 1,800 trips annually over 6 years.

Point Thomson suppliers from Anchorage and Fairbanks would make up to 20 tractor trailer trips a day during the winter season (February 1 to May 1) on the Dalton Highway during construction (Appendix D, RFI 55); a total of almost 2,000 trips annually over the 3 years of construction and drilling (see Table 5.17-2). Average capacity for a two-lane road is 1,000 vehicles each direction over a 24-hour period. While traffic along the Dalton Highway has been increasing since 2005, its average of 230 trips per day remains well below capacity for the road (ADOT&PF 2010). The addition of 20 tractor trailer trips a day for Point Thomson would have a minor impact on the Dalton Highway.

Large loads of up to 100 tons would require heavy-haul tractors with specialized trailers. The number of these kinds of trailers would be determined by the final modularization plan for the facilities and barging capacities. These tractor trailer combinations are permitted to carry long, wide loads, such as extra-long runs of pipe, and would have escort trucks to provide warning to oncoming traffic and improve overall safety. Oncoming traffic can pass depending on the location and vertical and horizontal design of the road. Trucks this size usually travel in a convoy, nose to tail, to aid the heavy truck on steep mountain passes. Trucks with extra-wide loads (wider than 8 feet, 6 inches) may be restricted by permit from traveling during heavy commuter traffic hours in urban areas around Anchorage and Fairbanks, and would not impose a significant impact on highway users (ADOT&PF 2010). Once the heavy-haul trucks get to Prudhoe Bay, they would take existing roads to Endicott where either a sea ice or tundra ice road would allow them to continue to Point Thomson. Once on the Point Thomson ice access road, these loads would pose no impact to existing transportation systems.

The ice and gravel roads to and within Point Thomson would constitute new infrastructure and would be privately managed and operated by the Applicant. While the amount of traffic would be relatively small, travelers would share the same risks of arctic travel as the longer haul roads. Because this is a closed-road system, it would not have impacts to other regional roads.

Summer ground travel between Deadhorse and Point Thomson would be limited; instead, most traffic would consist of fixed- and rotary-wing aircraft. Tundra-safe, low ground pressure vehicles could be used in the case of an emergency, but they would not operate on existing transportation infrastructure and therefore would not impact any public or private roads in the area.

Aviation

Point Thomson employees arriving at Deadhorse would be transported primarily by helicopter to Point Thomson, until the gravel airstrip would be operational in the second year of construction. Helicopters would be able to carry 12 to 15 people. A summary of estimated round trips is included in Table 5.17-2. There would be up to 990 helicopters trips for the construction phase; no helicopter trips are anticipated for the drilling phase.

Upon completion of the gravel airstrip, the Applicant anticipates two to three round trip fixed-wing flights per day, depending on the manpower needs, resupply requirements, and weather conditions on a given day (Appendix D, RFI 55). There would be up to 1,390 fixed-wing aircraft trips for the construction and drilling phases or approximately 230 round trips annually over 6 years. The gravel airstrip could potentially accommodate passenger aircraft directly from Anchorage; however, the Applicant would likely continue to route personnel through the Deadhorse airport and shuttle them to Point Thomson on small fixed-wing aircraft (less than 20-passenger capacity).

Based on existing usage, the Deadhorse airport could easily accommodate the anticipated additional number of flights to and from Point Thomson during construction and the drilling phase. Impacts to the Deadhorse airport would be minor, medium term, probable, and local. In the event that direct flights to Point Thomson from Anchorage or Fairbanks are required, the Applicant would coordinate with Trade Services at Prudhoe Bay as a means of easing possible air space congestion.

While the Point Thomson airstrip would be designed to accommodate a Lockheed-Martin C-130 Hercules, the Applicant would use that aircraft only to deliver critical, time-sensitive materials such as in the event of a well blowout emergency during drilling. There are very few C-130s available for private use, and using the C-130 would pose a possible temporary, but moderate impact to that particular resource (HDR 2010a).

Pipelines

The export pipelines would be built according to USDOT requirements; however, the infield pipelines are not subject to these requirements. The construction of the infield and export pipelines would not impact existing transportation infrastructure. See Section 5.17.3.2 for impacts related to operations of the pipelines.

5.17.3.2 Alternative B: Operation

All transportation infrastructure would be in place for the operation phase of Point Thomson.

Marine

During operations, two coastal barges would provide the primary access and resupply to Point Thomson, making up to 15 round trips annually, though the average number of trips may be fewer, depending on the season's anticipated infield activities (HDR 2010a). Table 5.17-2 summarizes the estimated round trips for barges. There would be no anticipated sealift barges in support of normal field operations.

Roadways

During operations, the ice road to Point Thomson would only be built if needed in any given year. Trucks could be used to move supplies up the Dalton Highway to Deadhorse for barging to Point Thomson.

Aviation

After the gravel airstrip is completed in Year 2, personnel transfer would take place primarily by fixed-wing aircraft from Anchorage, Fairbanks, or Deadhorse directly to Point Thomson. After the airstrip is available, both fixed-wing aircraft and helicopters would be used to transport personnel during operations(HDR 2011c). Table 5.17-2 summarizes the estimated round trips. There would be up to 545 fixed-wing aircraft and 4 helicopter round trips during the operations phase.

Pipelines

The transport of condensate through the export pipeline would contribute, over the course of the project life, to maintaining the flow within TAPS. The common carrier pipeline at Badami, to which the Point Thomson export pipeline would connect, is capable of handling the added flow that would be introduced by this project. The existing pipeline system, including TAPS, has the capacity to receive product from Point Thomson.

5.17.3.3 Alternative B: Impact Summary

Table 5.17-3 summarizes the impacts of Alternative B.

Table 5.17-3: Alternative B—Impacts Summary

Mode	Magnitude	Duration	Potential to Occur	Geographic Extent
Marine	Minor	Long term	Unlikely	Extensive
Roadway	Minor	Medium term	Possible	Extensive
Aviation	Moderate	Long term	Possible	Extensive
Pipeline	Minor	Long term	Unlikely	Extensive

5.17.4 Alternative C: Inland Pads with Gravel Access Road

Alternative C relies on ice roads, gravel roads, and aircraft for transportation and does not include barging. The existing coastal barging access would cease and no barge facilities would be constructed at Point Thomson. Within the Point Thomson Project area, the infield gravel road network would provide the primary means for personnel, materials, and equipment to travel. All sealift and some truckable modules may be staged in Deadhorse awaiting ice road opening.

To provide year-round access to Point Thomson, this alternative would also include the construction of a 45-mile gravel access road from Point Thomson to the Endicott Spur Road. 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. A gravel airstrip would be built at Point Thomson providing the only year-round fixed-wing aircraft access to the area once it is constructed. Table 5.17-4 below summarizes round trips by mode and phase.

Table 5.17-4: 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.

5.17.4.1 Alternative C: Construction and Drilling

The gravel road to Point Thomson would not be available during construction and most of the drilling. Table 5.17-4 summarizes the estimated round trips by phase. Transportation to and from the field would occur via helicopter, seasonal tundra ice road, and seasonal sea ice road or tundra-safe vehicles when allowed. Module transport would include sealift barge to Deadhorse then use of the heavy-duty tundra ice road for transport.

Marine

Alternative C relies on ice roads, gravel roads, and aircraft for transportation, 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 barges (up to 10) and some truckable modules may be staged in Deadhorse awaiting ice road opening.

Bowhead Transport and Crowley Marine Services, among others, use West Dock to deliver general supplies and petroleum products; barge traffic would be coordinated among all users.

Modules would be designed and built to be transported by sealift barge and truck over gravel and ice roads to Point Thomson. SPMT would be used to transport modules from Deadhorse to Point Thomson. Without barging activity, around 60 SPMT round trips would be required.

Roadways

In Alternative C there would be up to 50 trailer truck trips each day up the Dalton Highway from Anchorage or Fairbanks, with similar impacts to those described in Alternative B due to the number of average daily trips on the highway.

As discussed under Marine transportation, barges would arrive at West Dock in Prudhoe Bay and the equipment, building materials, and supplies would be stored from the time of delivery (mid-July to September), then trucked to Point Thomson during the winter ice road season (February 1 through mid-April) until the gravel road is completed. The total number of trips to Point Thomson by mode and phase of the project is detailed in Table 5.17-4. 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. Up to an estimated 18,570 round trips via ground transportation would be made on ice and gravel access roads during these phases. Over 8 years, that would average approximately 2,320 trips annually for construction and drilling phases. Annual trips 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 Chapter 2, Alternatives.

The number of trucks operating in Deadhorse unloading the barges and transporting the contents to storage, then months later, transporting the contents from storage to Endicott Spur Road, could create periods of congestion in Deadhorse. Congested areas could create the opportunity for accidents and impact traffic throughout Deadhorse.

Modules transported on the sealift barges would be transported using SPMTs, resulting in approximately 60 round trips and would not require trucks for transport to Point Thomson. The modules would have to be built to a size that could then be driven on the existing road system in the Deadhorse area. Staging the modules at Deadhorse, however, could create congestion because of the size and slow-moving nature of the SPMTs.

As in Alternative B, ice and gravel roads constructed for transportation to and within Point Thomson would constitute a closed system and would not impact existing traffic systems. The gravel access road from the Endicott Spur Road to Point Thomson would likely be closed to the public and would not be expected to impact other road facilities.

Air Travel

As in Alternative B, a gravel airstrip would be constructed during the second year of construction, and employees would be flown into Point Thomson from Deadhorse by helicopter or small, less than 20-passenger, airplanes. Up to 1,580 fixed-wing and 7,410 helicopter round trips are estimated for the construction and drilling phases. Over 8 years, that would average approximately 200 fixed-wing and 925 helicopter trips annually. Annual trips would likely increase or decrease depending on the activities being performed in a given year.

Pipelines

Similar to Alternative B, construction of the export pipeline would have no impact on existing transportation systems.

5.17.4.2 Alternative C: Operation

Under Alternative C, Point Thomson would start operations at the end of Year 6; at the same time, a gravel access road between Endicott Spur and Point Thomson would be completed.

Marine

Resupply of goods for Point Thomson would continue at West Dock and be transported to Point Thomson on the all-season road. Two barges making up to five trips each are anticipated annually until operations cease at Point Thomson. Barge traffic and dock usage would drop dramatically from the construction phase, so there would be little to no impact on existing transportation facilities.

Roadways

Resupply barges would off-load at West Dock and trucks would haul the supplies to Point Thomson on the all-season road. The annual resupply of Point Thomson would be about 370 trips. The gravel access road would make it possible to travel to Point Thomson in 2 to 3 hours. If parts are needed from Deadhorse or some special equipment comes up the haul road, the vehicles would have direct access. A long-haul truck delivery would not anticipated every day to Point Thomson; trips most likely would be made on an as-needed basis. Although there would be no impacts to transportation, the roadway would impact other resources.

Air Travel

Air travel would continue for crew changes during operations. It is anticipated that fixed-wing aircraft would make around 45 round trips annually and up to 5 helicopter round trips annually.

Pipelines

The 50-mile export pipeline proposed in Alternative C ties into the Endicott common carrier, which connects to TAPS at Pump Station 1 and creates a partial parallel common-carrier pipeline from Badami to Pump Station 1. As in Alternative B, Alternative C would contribute, over the course of project life, to maintaining the flow within TAPS. TAPS has the capacity to receive product from Point Thomson.

5.17.4.3 Alternative C: Impact Summary

Table 5.17-5 summarizes the impacts of Alternative C.

Table 5.17-5: Alternative C—Impacts Summary

Mode	Magnitude	Duration	Potential to Occur	Geographic Extent
Marine	Minor	Medium term	Unlikely	Extensive
Roadways	Moderate	Long term	Possible	Extensive
Aviation	Moderate	Long term	Possible	Extensive
Pipeline	Minor	Long term	Unlikely	Extensive

5.17.5 Alternative D: Inland Pads with Seasonal Ice Access Road

To minimize impacts, Alternative D would move the project components inland and as far away from the coast as practicable and feasible. 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. The total number of trips to Point Thomson by mode and phase of the project is detailed in Table 5.17-6. 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 Chapter 2, Alternatives.

Table 5.17-6: 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.

5.17.5.1 Alternative D: Construction and Drilling

Construction and drilling impacts for Alternative D would be similar to Alternative C because both would be relying on winter ice roads to transport supplies and materials. All sealift barges (up to 10) and some truckable modules may be staged in Deadhorse awaiting ice road opening. The difference would be that Alternative D would not have the gravel access road available for the later stages of drilling, which would result in a longer drilling period (5 years compared to 4 years).

Marine

Alternative D relies on a tundra ice road, gravel roads, and aircraft for transportation, 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.

Roadways

In Alternative D, just as in Alternative C, there would be up to 50 tractor trailer truck trips daily up the Dalton Highway from Anchorage or Fairbanks, with similar impacts to those described in Alternative B.

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 23 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, 22-mile 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 2 years of construction, this 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. 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.

Up to 17,495 land transport trips would occur during construction and drilling. Over 9 years, that would be an average of about 1,950 trips annually, although averages would vary depending on the activities. Modules transported on the sealift barges would be transported using SPMTs resulting in approximately 60 round trips and would not require trucks for transport to Point Thomson. The modules would have to be built to a size that could then be driven on the existing road system in the Deadhorse area. Staging the modules at Deadhorse, however, could create congestion because of the size and slow-moving nature of the SPMTs.

As in Alternative B, ice and gravel roads constructed for transportation to and within Point Thomson would constitute a closed system and would not impact existing traffic systems.

Air Travel

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. Up to 7,740 helicopter trips would occur during drilling and construction, averaging about 830 trips per year over 9 years. 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 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. Up to 1,880 fixed-wing aircraft trips would occur during drilling and construction for an average of about 200 trips annually over 9 years.

Pipelines

Similar to Alternative B, construction of the export pipeline would have no impact on existing transportation systems under Alternative D.

5.17.5.2 Alternative D: Operation

Under Alternative D, operations transportation would be much like the drilling and construction phases. Access to Point Thomson for resupply would be limited to a winter ice road, thus extending drilling further into operations.

Marine

Approximately 10 barge loads of supplies would be delivered to West Dock annually during open-water season to await ice road transport to Point Thomson in winter. Use of West Dock would be minimal during Point Thomson operations, with minimal impact to the docks or barge routes.

Roadways

Approximately 100 truckloads of goods would move along the Dalton Highway in winter toward Point Thomson. Additionally, 250 round trips on the ice road are estimated annually.

Air Travel

Approximately 465 fixed-wing aircraft and 5 helicopter round trips are estimated annually during operations.

Pipelines

The export pipeline in Alternative D would connect with a common carrier pipeline at Badami; therefore, the pipeline impacts would be similar to those described for Alternative B.

5.17.5.3 Alternative D: Impact Summary

Table 5.17-7 summarizes the impacts of Alternative D.

Table 5.17-7: Alternative D—Impacts Summary

Mode	Magnitude	Duration	Potential to Occur	Geographic Extent
Marine	Minor	Medium term	Unlikely	Extensive
Roadways	Moderate	Long term	Possible	Extensive
Aviation	Moderate	Long term	Possible	Extensive
Pipeline	Minor	Long term	Unlikely	Extensive

5.17.6 Alternative E: Coastal Pads with Seasonal Infield Ice Roads

Alternative E would be similar to Alternative B, relying on barging and an ice road to bring materials and supplies to Point Thomson. The total number of trips to Point Thomson by mode and phase of the project is detailed in Table 5.17-8. Land transport numbers in construction and drilling include the overland transportation of large fuel tanks, modules, and the drill rig by way of the ice access road before barging would be established. Alternative E is the only alternative with routine infield helicopter travel between pads, with an estimated 730 flights infield flights, in addition to the routine flights between Deadhorse and Point Thomson. Additional discussion of the logistics of Alternative E can be found in Chapter 2, Alternatives.

Table 5.17-8: 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 (to/from Deadhorse) 730 (infield)

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

5.17.6.1 Alternative E: Construction and Drilling

Construction would occur similarly to Alternative B. Drilling, however, would be drawn out for 4 years more than in Alternative B due to having only ice roads to the East and West Pads (see Chapter 2, Alternatives). Marine Coastal barges would make up to 420 round trips under Alternative E, and sealift barges would make up to 10 round trips during the construction and drilling phases.

Roadways

Alternative E proposes a seasonal tundra ice road between Endicott Spur and Point Thomson, with similar impacts to the Dalton Highway as those described for Alternative B. In the study area, up to approximately 15,580 round trips would be made on the ice road during construction and drilling. Over 8 years, that would average out to approximately 1,950 round trips each year. The average would be variable depending on the construction and drilling activity in each year.

Air Travel

Initial helicopter use and then fixed-wing aircraft to transport personnel to and from Point Thomson to Deadhorse would be similar to Alternative B. Up to 3,750 fixed-wing aircraft and 8,070 helicopter round trips would occur during construction and drilling. Over 8 years, the annual average would be 470 and 1,000 trips, respectively. Averages would be variable depending on the activities.

Helicopter operations are increased over the other alternatives due to their use in construction during roadless periods to move equipment and materials from one pad to another. Use of a helicopter to move equipment or materials would be expensive, dependent on weather, with multiple safety issues. Lack of gravel roads to provide year-round access would be a safety issue. In an emergency it would be impossible to take a person off the East or West Pad in bad weather and get the person to the airfield where planes have instrument flight rule (IFR) capabilities. Weather could easily delay the project because of the dependency on helicopters.

Pipelines

As in other action alternatives, the export pipeline would not impact existing transportation systems until condensate production began in operations.

5.17.6.2 Alternative E: Operation

Operations at Point Thomson would start by the last quarter of Year 6. Operational impacts to transportation systems would be similar to those described for Alternative B, with five additional coastal barge trips estimated annually.

Air Travel

Air travel would continue through operation for crew changes and transport of equipment, parts, and supplies, with around 300 operations annually. Helicopters would generate around five trips annually during operations between Deadhorse and Point Thomson, in part to cover any movement of equipment that might need to take place during operations. At the site, however, approximately 730 routine infield helicopter flights between pads would take place. There would be no impacts to other transportation services caused by air travel.

5.17.6.3 Alternative E: Impact Summary

Table 5.17-9 summarizes the impacts of Alternative E.

Table 5.17-9: Alternative E—Impacts Summary

Mode	Magnitude	Duration	Potential to Occur	Geographic Extent
Marine	Minor	Long term	Unlikely	Extensive
Roadways	Moderate	Medium term	Possible	Extensive
Aviation	Moderate	Long term	Possible	Extensive
Pipeline	Minor	Long term	Unlikely	Extensive

5.17.7 Mitigative Measures

As part of the project design, the Applicant would ensure that project workers attend appropriate training programs such as the Arctic Pass training, which includes driving/road rules and winter driving/ice road rules to avoid or minimize impacts on transportation safety. Measures that the Corps is considering to avoid or minimize impacts to human health (Section 5.23.7) would also apply to transportation impacts.

5.17.8 Climate Change and Cumulative Impacts

5.17.8.1 Climate Change

The impacts of global climate change are already manifesting themselves within the Arctic region. Projected warming of the atmosphere could combine with attendant rise in sea levels to impact the transportation infrastructure at Point Thomson and across the North Slope. Infrastructure that may experience impacts include gravel roads, seasonal ice infrastructure, barging facilities and use, and other coastal infrastructure.

The IPCC (2007) fourth assessment report projects an increase of global temperatures between 1.1 and 6.4°C (2.0 and 11.5°F) by 2100. This rate of change is anticipated to be exacerbated in the Arctic to a degree almost twice that of mid-latitude regions (ACIA 2005). In the Arctic, increases in the mean wintertime temperatures greatly affect freezing and thawing cycles. The seasonal use of sea ice and tundra ice roads across the North Slope and in the action alternatives could be diminished due to potential warming of the region, particularly wintertime warming, which could substantially reduce the winter ice road season. Ice roads depend heavily on a prolonged period of freezing temperatures during the autumn (October/November) to provide a solid basis for construction of the ice road to begin. The ACIA indicates that the critical factor influencing the start of the winter ice road season is the rate and amount of ice formation (2005). Any change in the starting date of the freezing period would change the period of normal usage for this means of travel.

Under modeled scenarios of climate change, sea ice cover is also expected to retreat farther into the Arctic Ocean, breaking up earlier, freezing later, and becoming thinner and more mobile (ACIA 2004). The longer periods of ice-free water could increase the length of the shipping season, thereby allowing greater access to industrial sites and communities on the North Slope by ships and coastal barges.

Surface air temperatures also have the potential to impact gravel roads on the North Slope. ACIA suggests there are structural design changes that could be implemented (such as increasing embankment thickness) that could slow the impact road instability within the permafrost zone. However, mean temperatures could warm to a point where these adjustments would no longer be sufficient to protect underlying permafrost from eventual failure as in failures seen in similar structures built in areas of discontinuous permafrost (2005). Similar impacts could occur to the airstrip and gravel pad infrastructure across the North Slope.

Predictions of changes to the hydrologic regime due to observed climatic changes could also impact gravel roads. Earlier breakup and flooding of rivers, and increases in precipitation as snow resulting in increased discharge in streams in the spring and summer (Frey and Smith 2003), could impact streamflow and stage. These potential hydrologic regime changes could result in increased stream velocity and erosive capacity of the streams being crossed by roadways if infrastructure were not properly designed to take these potential changes into consideration. Coastal transportation infrastructure is also at risk from storm surge flooding associated with rising sea levels and decreasing sea ice. According to community leaders, instances of flooding at the Barters Island Airport in Kaktovik have increased from flooding approximately every other year for the past 2 decades to flooding every year in the last 4 years and flooding twice in 2002 (NSB n.d.). Storms that cause the largest storm surges usually occur between late July and early September when shore fast and pack ice is not present to dampen the effects of wind and waves (NSB n.d.). A longer ice-free season increases the risk of damage to infrastructure by storms. Planning is already underway to evaluate potential sites for airport relocation (FAA 2009a, 2009b). Coastal erosion has also been an issue in Kaktovik, particularly in the vicinity of the airport (NSB n.d.).

Under Alternative B, the East, West, and Central Pads, as well as barge transportation, if not properly designed to account for these factors, could be at risk from storm surge flooding associated with rising sea levels. The infield gravel roads could be susceptible to rising surface air temperatures, including impacts from thermokarsting and subsidence. Storm surges could inundate land as a consequence of a larger water surface (fetch) resulting from a lengthening open-water season. Inundation could also influence changes in permafrost/soil conditions surrounding gravel infrastructure. Longer periods of open water, however, could provide a greater opportunity for the transportation of materials via both sealift and coastal barges.

The impacts of climate change to infrastructure in Alternative C would be similar to those described in Alternative B. There could be greater impacts of thermokarst from permafrost thaw and potential changes in hydrology because this alternative would rely heavily on the use of a 44-mile gravel road during operations as the primary access to Point Thomson. The impacts of climate change on Alternative D and E would be similar to those described for Alternative B, but with particular emphasis on potential impacts of a changing climate on tundra or sea ice roads from Badami and infield tundra ice roads, respectively. Changes in the timing of sea ice and tundra freeze-up and thaw could greatly reduce the time available for the use of ice roads to haul large equipment, material, and fuel to the site (Alternative D) and within the project area (Alternative E), and would substantially limit future logistics, operations and maintenance, and reasonably-foreseeable future drilling activities under this alternative.

5.17.8.2 Cumulative Impacts

The Point Thomson Project has the potential to add to the cumulative impacts of past and present projects and the potential impacts of RFFAs. Past and present projects such as oil and gas exploration and drilling, development of oil and gas production pads, and additional development (including military) on the North Slope, have included the construction and expansion of roads, airstrips, and docks to transport required materials to project sites across the North Slope. Dalton Highway truck traffic; low-pressure tundra-travel vehicle traffic, coastal and marine barge traffic; and fixed-wing and helicopter traffic have been generated due to construction and operation of these projects. Projects currently in operation and any reasonably foreseeable future oil and gas developments see (Section 4.2.1) on the North Slope are likely to require the construction of additional transportation facilities, and would add additional traffic and congestion to all of the transportation systems.

New project design and construction methods have reduced the need for gravel road infrastructure. These methods were incorporated into the design of the Alpine facilities, Badami facilities, and the Applicant's proposed Point Thomson facility and are now becoming more common on the North Slope (NRC 2003a). The design for these facilities often includes roads connecting clusters of remote production facilities to central processing facilities, but does not include gravel road access to the Prudhoe Bay area. Rather, transportation to the site is via ice roads in the winter and by aircraft year-round (BLM 2004). Thus, future development with limited gravel infrastructure is likely to result in higher levels of air traffic than is needed for existing facilities (BLM 2004).

Minor to moderate impacts to transportation infrastructure are possible under all action alternatives although impacts are likely to peak during construction and drop off once construction and drilling are complete. If construction of other projects occurred simultaneously with Point Thomson construction, then the existing transportation system could be affected, causing short-term congestion during the construction seasons.

Cumulative effects on air traffic should not adversely affect current aviation schedules, as the proposed project would create a small increase in the overall flights (2 to 3 trips per day during construction) compared to the approximately 50 flights that fly into the Prudhoe Bay/Deadhorse Airport each day (FAA 2011b). Similarly, an additional 20 tractor trailer trips per day during the winter season would be unlikely to create a cumulative impact on the Dalton Highway when compared to the current average use of 230 daily trips (DOT&PF 2010). The need for air and ground transportation would likely be less during the operations phase due to the decrease in personnel from construction and drilling to operations. Similar effects from other future projects would be expected but the combined total would be a minor change in capacity.

Overall barge transportation on the North Slope could also be cumulatively affected during the construction of the project if RFFAs such as Eastern Beaufort Outer Continental Shelf (OCS) exploration activities and construction of a Point Thomson sales gas pipeline were to occur in conjunction with aspects of the Point Thomson Project construction. An increase in smaller barges traveling in and out of Prudhoe Bay could potentially cause short-term congestion for the extent of the barge season. Barge traffic would cease during the winter as materials are trucked up the Dalton Highway, Spur Road, and the ice roads. Once the proposed project is in operation, barge traffic levels would likely decrease.

Cumulative impacts on transportation infrastructure associated with Alternative C would be similar to those described for the other action alternatives; however, installation of a gravel access road would add miles to the existing permanent roads and transportation facilities on the North Slope. The gravel access road could create additional cumulative impacts to transportation infrastructure as additional employees and materials would be needed during construction and could create additional congestion in Deadhorse. It would reduce the possibility of impacts on air traffic as it could be used, once completed, to transport people and materials to the Point

Thomson site. The gravel access road could also provide year-round access to the Arctic Refuge and other areas in between Prudhoe Bay and the Point Thomson area and could encourage other oil producers to develop areas to the west and south of Point Thomson. Depending on jurisdiction of the road, it could also open up additional areas for recreation, hunting, and subsistence activities.

In summary, no concerns related to adverse cumulative impacts have been identified. Some cumulative impacts may exist, if Point Thomson construction overlaps with the construction of another reasonably-foreseeable, large scale development. However, this cumulative impact would be of temporary duration and would be unlikely to have long term impacts on transportation North Slope infrastructure.

5.17.9 Alternatives Comparison and Environmental Consequences

The impacts of additional marine, roadway, aviation, and pipeline facilities have the same potential to occur for all of the alternatives. The potential for impacts to occur due to marine traffic and pipeline infrastructure is unlikely for all of the alternatives. The potential for impacts to occur due to construction and use of roadways and aviation facilities is possible for all alternatives. Because transportation infrastructure extends throughout and beyond the study area for all alternatives, the geographic extent of potential impacts for all modes and pipeline facilities is extensive. Impacts due to the aviation and pipeline facilities needed for all of the action alternatives are similar and resulted in the same intensity types for all impact categories.

The differentiating modes of transportation are marine and roadway. Because Alternatives B and E rely on the construction of a sealift barge facility and barging for year-round access to Point Thomson, marine impacts are long term compared to medium term for Alternatives C and D. The magnitude of the impacts for marine traffic is considered minor for all of the alternatives.

Alternatives C, D, and E resulted in a moderate magnitude of impacts compared to the minor impacts of Alternatives B on roadway traffic an infrastructure because Alternatives C and D rely more on land transportation and because Alternative E needs a longer drilling phase since there would only be ice roads to the East and West Pads. In addition, Alternatives C and D have long-term impacts due to roadway infrastructure compared to medium-term impacts to roadways for Alternatives B and E.