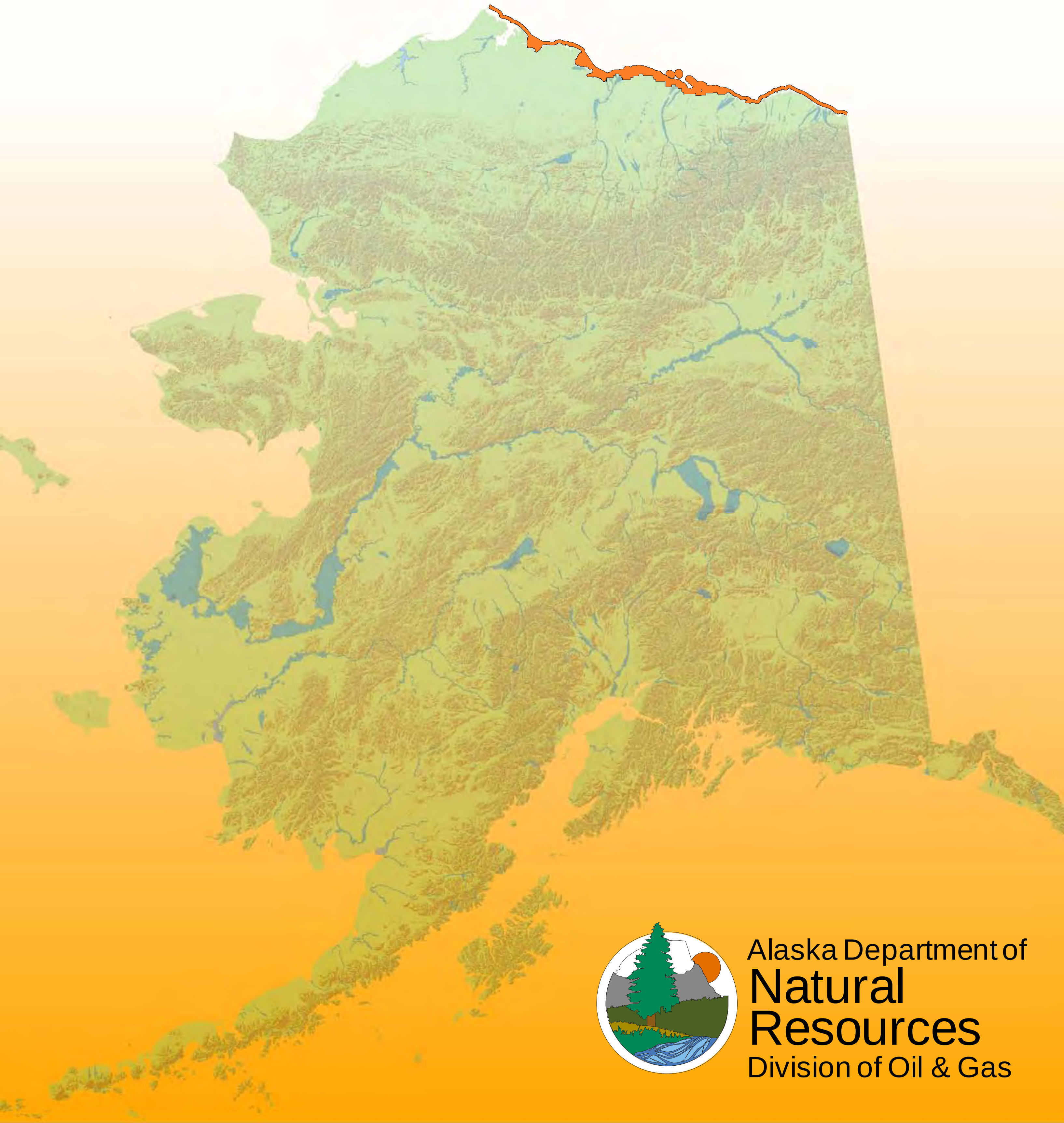
PROPOSED BEAUFORT SEA AREAWIDE OIL AND GAS LEASE SALE

Preliminary Finding of the Director

April 2, 2009



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PROPOSED
BEAUFORT SEA AREAWIDE
OIL AND GAS LEASE SALE

Preliminary Finding of the Director

Prepared by:
Alaska Department of Natural Resources
Division of Oil and Gas

April 2, 2009

List of Abbreviations

AAC Alaska Administrative Code
ACMP Alaska Coastal Management Plan
ADCED Alaska Department of Community and Economic Development
ADEC Alaska Department of Environmental Conservation
ADF&G Alaska Department of Fish and Game
ADNR Alaska Department of Natural Resources
ADOR Alaska Department of Revenue
AEIDC Arctic Environmental Information and Data Center
AHRS Alaska Heritage Resources Survey
ANCSA Alaska Native Claims Settlement Act
ANILCA Alaska National Interest Lands Conservation Act
ANWR Arctic National Wildlife Refuge
AOGCC Alaska Oil and Gas Conservation Commission
AS Alaska Statute
bbl Barrel(s) (42 gallons)
bcf Billion cubic feet
BIA U.S. Bureau of Indian Affairs
BLM U.S. Bureau of Land Management
bpd Barrels per day
CFR Code of Federal Regulations
DF Division of Forestry
DMLW Division of Mining, Land and Water
DO&G Division of Oil and Gas
DPOR Division of Parks and Outdoor Recreation
EIS Environmental Impact Statement
gal Gallon(s)
km Kilometer
LNG Liquefied Natural Gas
m Meter
MMS Minerals Management Service
NPR-A National Petroleum Reserve-Alaska
NSB North Slope Borough
OPMP Office of Project Management & Permitting
RCRA Resource Conservation and Recovery Act
SHPO State Historic Preservation Officer
SPCC Spill Prevention Control and Countermeasure
ft^2 Square feet
USACOE U.S. Army Corps of Engineers
USC United States Code
USDOI United States Department of the Interior
USFWS United States Fish and Wildlife Service

Metric and Standard Conversion Tables

To Metric		From Metric	
Feet	Meters	Meters	Feet
1	0.3	1	3.2
2	0.6	2	6.6
3	0.9	3	9.8
4	1.2	4	13.1
5	1.5	5	16.4
6	1.8	6	19.6
7	2.1	7	23
8	2.4	8	26.2
9	2.7	9	29.5
10	3	10	32.8
20	6	20	66
30	9	30	98
40	12	40	131
50	15	50	164
60	18	60	197
70	21	70	230
80	24	80	262
90	27	90	295
100	30	100	328
200	61	200	656
300	91	300	984
400	122	400	1312
500	152	500	1640
1000	305	1000	3281
1500	457	1500	4921

To Metric		From Metric	
Miles	Kilometers	Kilometers	Miles
1	1.6	1	0.6
2	3.2	2	1.2
3	4.8	3	1.9
4	6.4	4	2.5
5	8	5	3.1
6	9.7	6	3.7
7	11.3	7	4.3
8	12.9	8	5
9	14.5	9	5.6
10	16	10	6.2
20	32	20	12
30	48	30	19
40	64	40	25
50	80	50	31
60	97	60	37
70	113	70	43
80	129	80	50
90	145	90	56
100	161	100	62

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Chapter One: Executive Summary

The State of Alaska is proposing to offer for lease all available state-owned acreage in Beaufort Sea areawide oil and gas lease sales from 2009-2018 (see Map 1.1, Map 1.2, and Map 1.3). The director of the Department of Natural Resources, Division of Oil and Gas, has made a preliminary finding that holding these lease sales is in the best interest of the state. The director reviewed all facts and issues known or made known to him and limited the scope of the finding to the lease phase of oil and gas activities and the reasonably foreseeable significant effects of issuing leases (AS 38.05.035(e)(1)(A)). Conditions for phasing have been met under AS 38.05.035(e)(1)(C). The content of best interest findings is specified in AS 38.05.035(e), and topics that must be considered and discussed are prescribed in AS 38.05.035(g).

After weighing the facts and issues known to him at this time, considering applicable laws and regulations, and balancing the potential positive and negative effects given the proposed mitigation measures and other regulatory protections, the director has preliminarily concluded that the potential benefits of lease sales outweigh the possible negative effects, and that Beaufort Sea areawide oil and gas lease sales will be in the best interests of the state of Alaska.

A. Description of the Lease Sale Area

The area of the proposed Beaufort Sea lease sale contains approximately 2,000,000 acres in 573 tracts and consists of coastlands, nearshore, and submerged land, located along the Beaufort Sea coast from Barrow to the Canadian border. The proposed lease sale also includes numerous islands.

Evidence of human occupation and use of the Arctic Coastal Plain dates back to 10,000 BC. The environmental characteristics of the Arctic shaped Inupiat culture into a semi-nomadic society with a tradition of whaling and an emphasis on seasonal inland hunting. Sites across the North Slope contain sod houses, graves, storage pits, ice cellars, bones, and relics and attest to the historical use and presence of Arctic people in the area of the proposed lease sale; however, much of the archaeological record has been destroyed by erosion. There are 14 known historic and archaeological sites onshore within the area of the proposed lease sale. There are also several reported shipwreck sites within the area. It is very likely that there are additional sites that have not been previously documented.

The proposed lease sale is within the North Slope Borough and is adjacent to the communities of Barrow, Kaktovik, and Nuiqsut. The borough is a home rule borough, incorporated in 1972, which extends from the Chukchi Sea to the Canadian border. It has the powers of taxation, land management, and zoning, and is responsible for providing borough communities with public works, utilities, education, health, and other public services. In 2007, the population of the borough was 6,751. Approximately 70 percent of borough residents are Alaska Native or part Native.

Climate conditions in the Arctic vary dramatically. Summers are generally mild and the three-month ice-free season is critical to biological productivity. In contrast, winters are severe, forcing many species to migrate south. The amount of precipitation is so low along the Beaufort Sea coast that the region is classified as a desert.

The primary geologic hazards in or near the sale area include faults and earthquakes; sea ice; ice gouging; ice movement; sub-sea permafrost; onshore permafrost, frozen ground, and thermokarst; waves and erosion; coastal currents; flooding; overpressured sediments; unstable sediments; and shallow gas deposit and natural gas hydrates. Although geologic hazards could damage oil and gas infrastructure, proposed measures in this preliminary best interest finding, along with regulations imposed by state, federal, and local agencies, are expected to avoid, minimize, or mitigate those hazards.

The proposed lease sale is within Alaska's coastal zone and is subject to the Alaska Coastal Management Program (ACMP) and the local coastal district plan. Currently, there is no district plan in effect for the North Slope Borough. Future exploration, development, and production activities requiring additional authorizations will undergo separate coastal zone consistency analyses if and when they are actually proposed. Future activities must comply with the ACMP and, once its plan is in effect, the enforceable policies of the North Slope Borough Coastal Management Program.

B. Habitat, Fish, and Wildlife

The Beaufort Sea area includes terrestrial, freshwater, estuarine, and marine habitats. At least 17 species of marine fishes, 14 species of freshwater fishes, and 12 anadromous species may be found in the waters of the Beaufort Sea area. The area is seasonally inhabited by large numbers of migratory birds, especially sea ducks, which breed, molt, migrate, and forage in the area each summer. Terrestrial mammals inhabiting the area include caribou, moose, brown bears, muskoxen, arctic and red fox, wolf, and wolverine. Marine mammals inhabiting the area include polar bear, bowhead whale, beluga whale, ringed seal, spotted seal, and bearded seal. Walrus are occasionally seen in the proposed lease sale area. Some species, including the bowhead whale, spectacled eider, Steller's eider, and polar bear, have been listed as threatened or endangered under the federal Endangered Species Act.

The Arctic National Wildlife Refuge (ANWR) is a federal refuge adjacent to the proposed lease sale and is the primary area of northern Alaska set aside to protect habitat.

C. Current and Projected Uses

The Beaufort Sea area provides important habitat for freshwater and marine fishes, many species of birds, and terrestrial and marine mammals. The fish and wildlife of the area provide the resource base for subsistence fishing and hunting, and for several small sport fisheries and sport hunting. There are no commercial fisheries for marine species in the Beaufort Sea area although there is a very limited commercial whitefish fishery. To a small extent, the area is used for recreation and tourism. The primary industrial use of the area is for oil and gas development.

D. Oil and Gas in the Beaufort Sea

The Alaska Department of Natural Resources has determined that the proposed Beaufort Sea lease sale has moderate to high petroleum potential. This determination is based on a resource evaluation involving several factors including geology, seismic data, exploration history of the area, and proximity to known hydrocarbon accumulations. The area has all the geologic conditions favorable for a recoverable accumulation of hydrocarbons. Considering the exploration history of the area, the chances of finding undiscovered petroleum reservoirs are very good. However, under current market conditions, the remaining undiscovered reservoirs are expected to be non-economic to marginally economic accumulations. In light of this, the petroleum potential of this basin for the discovery of new fields is moderate.

Oil and gas activities proceed in phases with the activities of each subsequent phase depending on the completion or initiation of the preceding phase. The lease sale phase is the first step in the process of developing the state's oil and gas resources after the director issues a best interest finding. During the lease sale phase, the state conducts competitive areawide sales of oil and gas leases, offering for lease all available state acreage within the sale area. An oil and gas lease grants to the lessee the exclusive right to drill for, extract, remove, clean, process, and dispose of oil, gas, and associated substances; however, a plan of operations, subject to a myriad of regulatory authorities and permits, must be approved before any operations may be undertaken on or in the leased area. In the exploration phase, information is gathered about the area's petroleum potential by examining surface geology, researching data from existing wells, performing environmental assessments, conducting geophysical surveys, and drilling exploratory wells. During the development phase, operators evaluate the results of exploratory drilling and develop plans to bring the discovery into production. Production operations bring well fluids to the surface and prepare them for transport to the processing plant or refinery.

Since the first North Slope lease sale in December 1964, the State of Alaska has held 56 oil and gas lease sales involving North Slope and Beaufort Sea acreage. More than 11.5 million acres in 3,065 tracts have been leased. Of the leased tracts, 407 (about 13 percent) were drilled and only 292 tracts, or about 10 percent of those leased, have been commercially developed. About 81 percent of the state-leased acreage was onshore, and about 19 percent was offshore.

Directional drilling from onshore is the method generally most favored by the U.S. Army Corps of Engineers for bringing oil and gas discovered in offshore areas of Alaska's northern coast to shore. If directional drilling is not feasible, oil produced from offshore tracts in the Beaufort Sea could be brought onshore by a number of methods. While the location and nature of oil or gas deposits determine the type and extent of facilities necessary to develop and transport the resource, modern oil and gas transportation systems usually include: pipelines, marine terminals, and tank vessels. Shallow waters in the lease sale area will likely preclude the use of marine terminals or tankers to transport oil. Oil and gas produced in the lease sale area not brought to shore by directional drilling would most likely be transported by pipeline, depending on the type, size, and location of the discovery. If commercial quantities of oil are found in the lease sale area, the oil will go to market via the Trans-Alaska Pipeline System (TAPS). In-field gathering lines bring the oil from individual well sites to processing facilities for injection into TAPS.

The risk of a spill exists any time crude oil or petroleum products are handled. Accidental discharges into the sea from exploration and production account for two percent of the total releases of petroleum spilled into North American Seas. Oil consumption accounts for 32 percent and marine transportation three percent. The largest source of oil in the sea is natural seeps (63 percent of the total inputs). Since 1995, there have been nine spills of crude oil or process water in the North Slope subarea over 1,000 bbl (42,000 gal) and 80 spills over 23.81 bbl (1,000 gal). Most spills are smaller; about 85 percent of crude spills since 1995 have been less than 2.381 bbl (100 gal) and about 55 percent of process water spills are less than 2.381 bbl (100 gal). Companies do not store large volumes of crude at their facilities on the North Slope. Produced oil is processed and transported as quickly as possible reducing the possible size of a potential spill on the North Slope.

The oil and gas industry have been actively exploring and producing North Slope resources for more than three decades. In this time, the vast majority of oil, produced fluid, seawater, and other industry-related spills have been smaller than 10 gallons with very few larger than 100,000 gallons.

Some of the measures to prevent oil spills during the exploration, development, production, and transportation of crude oil are presented as mitigation measures in Chapter Nine. Some are discussed in Chapter Six. Prevention measures are also described in the oil discharge prevention and contingency plans that the industry must prepare before beginning operations. Plans must include measures designed to prevent spills and must have sufficient resources available to contain or control and clean up spills.

Cleanup plans, regardless of the location and nature of the spill, must balance the objectives of maximizing recovery and minimizing ecological damage. Plans must also address the complications of working in the Arctic. The North Slope/Beaufort Sea can present extremes that might make it difficult to effectively contain and clean up a major spill. Plans must address specific steps to accommodate these conditions.

Recognition of the difficulties of containment and cleanup of oil spills has encouraged innovative and effective methods of preventing possible problems and handling them if they arise. Oil spill prevention, response, and cleanup and remediation techniques are continually being researched by state and federal agencies and the oil industry. Risks of a spill can be avoided, minimized, and mitigated through preventive measures, monitoring, and rigorous response capability. Mitigation measures addressing the possibility of oil spills are included in this preliminary best interest finding. If exploration and development take place, additional site-specific and project-specific mitigation measures may be imposed as necessary.

E. Governmental Powers to Regulate Oil and Gas

All exploration lease activities are subject to numerous federal, state, and local laws and regulations with which the lessee is obligated to comply. These government agencies have a broad spectrum of authorities to regulate and condition activities related to oil and gas; their roles in the oversight and regulation of oil and gas activities differ, although some agencies may have overlapping authorities. These agencies include the Alaska Departments of Natural Resources, Environmental Conservation, and Fish and Game; the Alaska Oil and Gas Conservation Commission; the U.S. Environmental Protection Agency; the U.S. Army Corp of Engineers; the U.S. Fish and Wildlife Service; the National Marine Fisheries Service; and the North Slope Borough.

F. Reasonably Foreseeable Cumulative Effects of Leasing and Subsequent Activity

Potential effects of oil and gas lease sales can be both positive and negative. Most potentially negative effects on fish and wildlife species, habitats, and their uses, on subsistence uses, and on local communities and residents can be avoided, minimized, or mitigated through mitigation measures. A full listing of proposed mitigation measures can be found in Chapter Nine. Leasing activities alone are not expected to have any effects, other than to generate initial revenue to the state. Potential post-lease activities that could have cumulative effects on the area's habitats and fish and wildlife include seismic surveys, environmental and other studies, excavation of material sites, construction and use of support facilities, transportation of machinery and labor to the sites, and drilling and production activities. Unintended occurrences such as oil spills could have effects as well.

Air quality throughout the sale area is good. Although oil and gas exploration, development, and production activities may produce emissions that have the potential to affect air quality, federal and state air quality regulations, particularly the Clean Air Act (42 USC §§ 7401-7671), 18 AAC 50, and AS 46.14, are expected to avoid, minimize, and mitigate those potential effects.

Cumulative effects on marine water quality would be due primarily to three factors: discharges of drilling muds, cuttings, and produced waters; increased turbidity from construction of gravel islands and pipeline trenches; and oil spills. Drilling muds, cuttings, produced waters, and other effluents from oil and gas exploration, development, and production can have short- and long-term negative effects on aquatic life, including fish and benthic organisms. Cumulative impacts from exploration and development activities could adversely affect water quality; however, the impacts are expected to be local and temporary because of dilution, settling, and other natural altering and regenerative processes. The greatest effect on water quality from construction of gravel islands and pipelines and from pipeline repair would be additional turbidity caused by increases in suspended particles in the water column. The effects of discharges and offshore construction activities are expected to be short term, lasting as long as the individual activity, and have the greatest impact in the immediate vicinity of the activity. Impacts of oil spills are discussed in Chapter Six.

Although this is primarily an offshore sale, a very small amount of sale lands lie onshore between the Colville and Canning Rivers. During oil and gas development and production, various activities could impact vegetation in the sale area. Oil and gas activities subsequent to leasing could potentially have cumulative effects on land habitat. Measures in this preliminary best interest finding, along with regulations imposed by other state, federal, and local agencies, are expected to avoid, minimize, and mitigate those potential effects.

Potential effects include degradation of stream banks and erosion; reduction of or damage to overwintering areas; habitat loss due to gravel removal, facility siting, and water removal; impediments to migration; and fish kills due to oil spills. Oil and gas activities subsequent to leasing could potentially have cumulative effects on uses of fish populations and on wildlife. Most of these potential effects would likely occur as secondary effects from effects on habitat. Measures in this preliminary best interest finding, along with regulations imposed by other state, federal, and local agencies, are expected to avoid, minimize, and mitigate those potential effects.

Any activity that has the potential to affect habitat, fish, or wildlife has the potential to affect subsistence as a secondary effect. Proposed mitigation measures along with regulations imposed by other state, federal, and local agencies are expected to avoid, minimize, and mitigate biological alterations to the sale area. Reducing impacts to subsistence resources from oil and gas development is a primary goal in lease sale planning. While noise, traffic disturbance, and oil spills would produce chronic short-term impacts on subsistence species, none of these impacts would lead to the elimination of any subsistence resource. Most impacts to subsistence species associated with oil and gas exploration, development, and production would be localized and would not substantially affect subsistence species numbers, as long as the activities occurred outside of key habitat areas or migratory zones when animals are present.

Historic and cultural resources could be affected by oil and gas exploration, development, and production activities. For example, historic and cultural resources may be encountered during field-based activities, and these resources could be affected by accidents such as an oil spill. Cumulative effects on archaeological sites from oil and gas exploration, development, and production are expected to be low. In the event that an increased amount of ground-disturbing activity takes place, proposed mitigation measures along with regulations imposed by state, federal, and local agencies are expected to avoid, minimize, and mitigate effects to historic and cultural resources.

G. Fiscal Effects and Effects on Municipalities and Communities

Alaska's economy depends heavily on revenues related to oil and gas production and the government spending resulting from those revenues. Oil and gas lease sales generate income to state government through royalties (including bonuses, rents, and interest), production taxes, petroleum corporate income taxes, and petroleum property taxes. Unrestricted oil revenue totaled $10 billion in fiscal year (FY) 2008 and comprised approximately 90 percent of the state's general fund unrestricted revenue.

Alaska North Slope production peaked at 2.006 million barrels per day in FY 1988 and has declined steadily since then. The Alaska Department of Revenue (ADOR) anticipates volumes will decline by 3.8 percent in FY 2009 to about 0.689 million barrels per day. For FY 2010, ADOR projects a 3.5 percent decrease in North Slope production to 0.665 million barrels per day. The department of Revenue expects oil prices to average $57.78 a barrel in FY 2010 down from $90.46 in FY 2008.

The North Slope Borough (NSB) is host to the production center for the state's oil industry and no other borough is more influenced by the oil and gas industry. More than two thirds of all jobs in the NSB are directly linked to the oil industry or to its support industries. Although the borough relies on oil revenues, most local residents pursue a traditional and community-based economic life. The finances of the NSB government depend predominately on tax revenues from oil properties. Approximately 98 percent of all local property tax collections come from oil producers. For fiscal year 2008/2009, property tax receipts are anticipated to be $248 million.

Oil and gas property is exempt from local municipal taxation, but the state levies a 20-mill tax against this property. Each municipality with oil and gas property within its boundaries is reimbursed an amount equal to the taxes which would have been levied on the oil and gas property, up to the 20-mill limit. The 2005 property tax rate for the NSB was 19.03 mills. Since the 1980s, the NSB property tax base has consisted mainly of high-value property owned or leased by the oil industry in the Prudhoe Bay area.

Health status on the North Slope is determined by a wide array of factors, including genetic susceptibility, behavioral change, environmental factors, diet, and socio-cultural impacts. The state is currently developing a policy regarding Health Impact Assessments (HIA) for large resource extraction projects. HIA is a tool that seeks to identify potential lasting or significant changes, both positive and negative, of different actions on the health and social well-being of a defined population as a result of a program, project, or policy.

H. Mitigation Measures and Other Regulatory Protections

Mitigation measures address facilities and operations; habitat, fish, and wildlife; subsistence, commercial, and sport harvest activities; fuel, hazardous substances, and waste; access; prehistoric, historic, and archaeological sites; and local hire, communication, and training. Specific mitigation measures protect polar bears, hauled out seals and 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. Sets of mitigation measures protect brown bears, subsistence, and whale harvest. Other regulatory requirements (lessee advisories) address other regulatory, permitting, or management authorities including the Alaska Departments of Natural Resources, Environmental Conservation, Fish and Game, and Labor and Workforce Development; U.S. Army Corps of Engineers, Fish and Wildlife Service, and National Marine Fisheries Service; and the North Slope Borough.

I. Director's Preliminary Finding and Signature

The director of the Division of Oil and Gas has made a preliminary finding that, on balance, holding annual Beaufort Sea areawide oil and gas lease sales from 2009-2018 is in the best interests of the state. State law AS 38.05.035(e) and (g) requires that before an oil and gas lease sale, the director determine whether the lease sale is in the best interests of the state; state law also specifies what must be considered in making that determination. Annually, the Division of Oil and Gas (DO&G) issues a call for substantial new information that has become available since the most recent finding, and based on information received, the commissioner determines whether it is necessary to supplement the finding.

This preliminary determination is based upon a review of all facts and issues known, or made known, to the director. The director limited the scope of the finding to the lease sale phase of oil and gas activities and the reasonably foreseeable significant effects of a lease sale (AS 38.05.035(e)(1)(A)). Conditions for phasing were met under AS 38.05.035(e)(1)(C). At the lease sale phase, the type, location, duration, timing, or level of any exploration or development activity that might subsequently occur cannot be predicted precisely. Therefore, the director has not considered possible specific effects of unknown future exploration, development, and production activities that are outside the scope of the finding. The effects of future exploration, development, and production will be considered at each subsequent stage, when government agencies and the public review permit applications for the specific activities proposed at specific locations in the area. However, the director did consider, in general terms, the potential effects that may occur subsequent to leasing.

In making this preliminary finding, the director considered and discussed the property descriptions and locations; the petroleum potential of the lease sale area; the fish and wildlife species and their habitats; the current and projected uses in the area, including uses and value of fish and wildlife; the governmental powers to regulate oil and gas exploration, development, production, and transportation; the reasonably foreseeable cumulative effects of oil and gas exploration, development, production, and transportation on the lease sale area, including effects on subsistence uses, fish and wildlife habitats and populations and their uses, and historic and cultural resources; lease stipulations and mitigation measures, including any measures to prevent and mitigate release of oil and hazardous substances, to be included in the lease, and a discussion of the protections offered by these measures; the methods most likely to be used to transport oil or gas from the lease sale area and the advantages, disadvantages, and relative risks of each; the reasonably foreseeable fiscal effects of the lease sale and the subsequent activity on the state and affected municipalities and communities, including the explicit and implicit subsidies associated with the lease sale; the reasonably foreseeable effects of oil and gas exploration, development, production, and transportation on municipalities and communities within or adjacent to the lease sale area; and the bidding method or methods adopted by the commissioner (AS 38.05.035(g)).

Although the initial benefit to the state will be the primary effect of leasing itself, the director recognizes that oil and gas exploration, development, and production subsequent to leasing could result in effects such as habitat changes; behavior changes in fish, wildlife and birds; and contamination of terrestrial, freshwater, and marine habitats. Therefore, general mitigation measures are included that will avoid, minimize, and mitigate potential negative effects. These address facilities and operations; habitat, fish, and wildlife; harvest activities; fuel, hazardous substances, and waste; access; prehistoric, historic, and archaeological sites; and local hire, communications, and training.

Lessees must comply with all applicable local, state, and federal codes, statutes, and regulations. Lessee advisories notify lessees of other regulatory requirements, including those administered by the Alaska Departments of Natural Resources, Environmental Conservation, Fish and Game, and Labor and Workforce Development; the U.S. Army Corp of Engineers, Fish and Wildlife Service, and National Marine Fisheries Service; and the North Slope Borough. Additional project-specific and site-specific mitigation measures will be applied as appropriate to future authorizations.

The state has sufficient authority through general constitutional, statutory, and regulatory empowerments; the terms of the lease sale; the lease contract; and plans of operation to ensure that lessees conduct their activities safely and in a manner that protects the integrity of the environment and maintains opportunities for subsistence and other concurrent uses.

No activity may occur without further review and proper authorization from the appropriate permitting agency, and all activities must comply with the ACMP. When lessees propose specific activities, more detailed information, such as site, type, and size of facilities, will be known. In most cases, permit applications are public information, and most permitting processes include public comment periods. The department may impose additional terms during the permitting process if additional issues are identified.

After weighing the facts and issues known to him at this time, considering applicable laws and regulations, and balancing the potential positive and negative effects given the mitigation measures and other regulatory protections, the director preliminarily concludes that the potential benefits of the lease sale outweigh the possible negative effects, and that Beaufort Sea areawide oil and gas lease sales will best serve the interests of the state of Alaska.

This preliminary finding is subject to revision based on comments received by DO&G. Members of the public, government agencies, environmental organizations, industry, and other interested parties are invited to comment on any part of this preliminary finding. In commenting, please be as specific as possible. Comments must be received by June 1, 2009, in order to be considered and must be sent to the following address:

Division of Oil and Gas
550 W. 7th Avenue, Suite 800
Anchorage, AK 99501-3560
ATTN: Saree Timmons

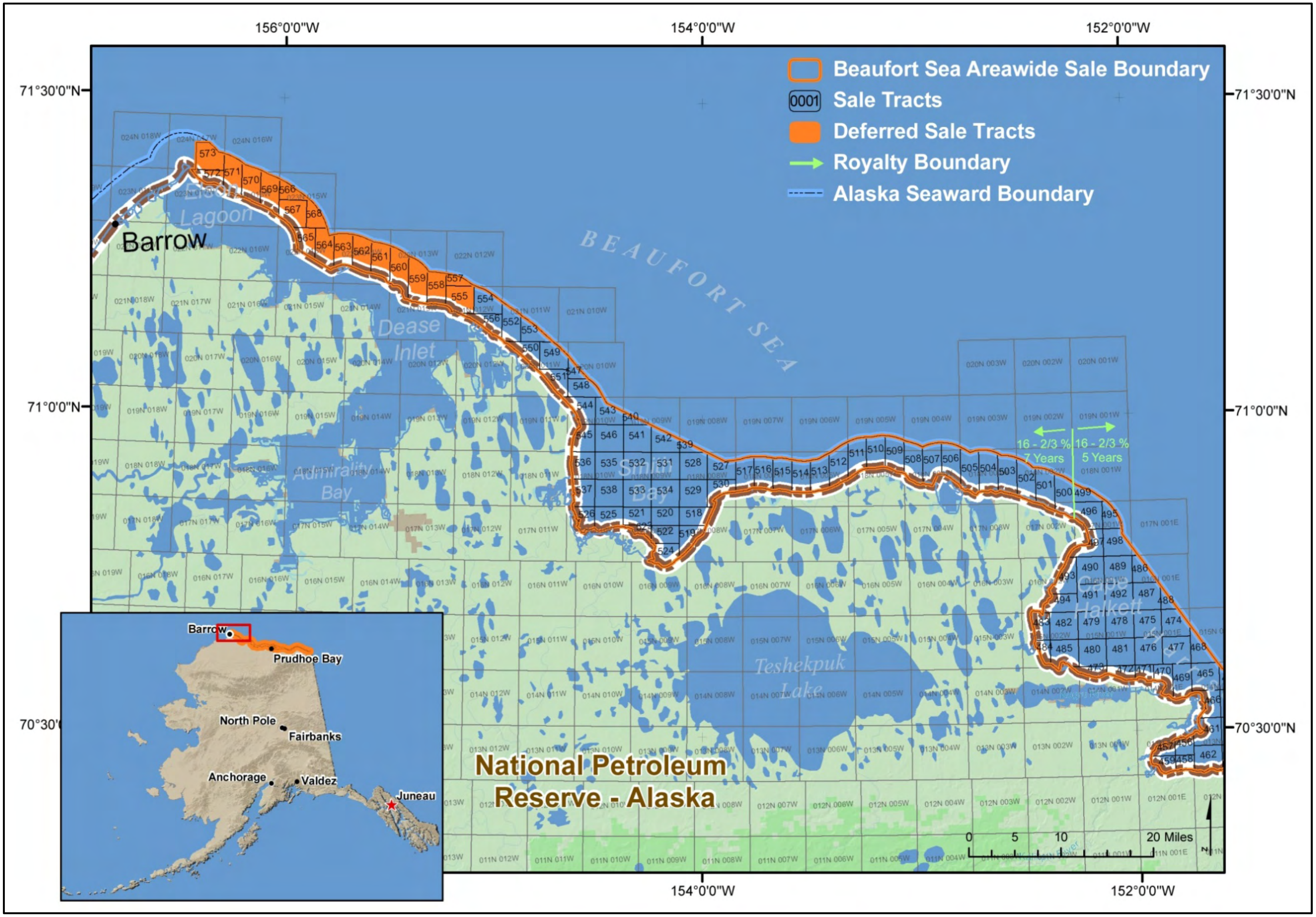
Comments may also be submitted via courier to the address above, by FAX (907-269-8938), or by email (saree.timmons@alaska.gov). Comments may also be submitted by testifying at a public hearing. Meeting for this purpose may be held in the Beaufort Sea area during the public comment period. Details regarding the date, time, and location of these meeting will be public noticed in the near future.

Following review of comments on this preliminary best interest finding and any additional available information, the director will make a final determination if the proposed lease sales are in the state's best interests, and will issue a final finding and decision. A final finding and decision is expected to be issued in July 2009.

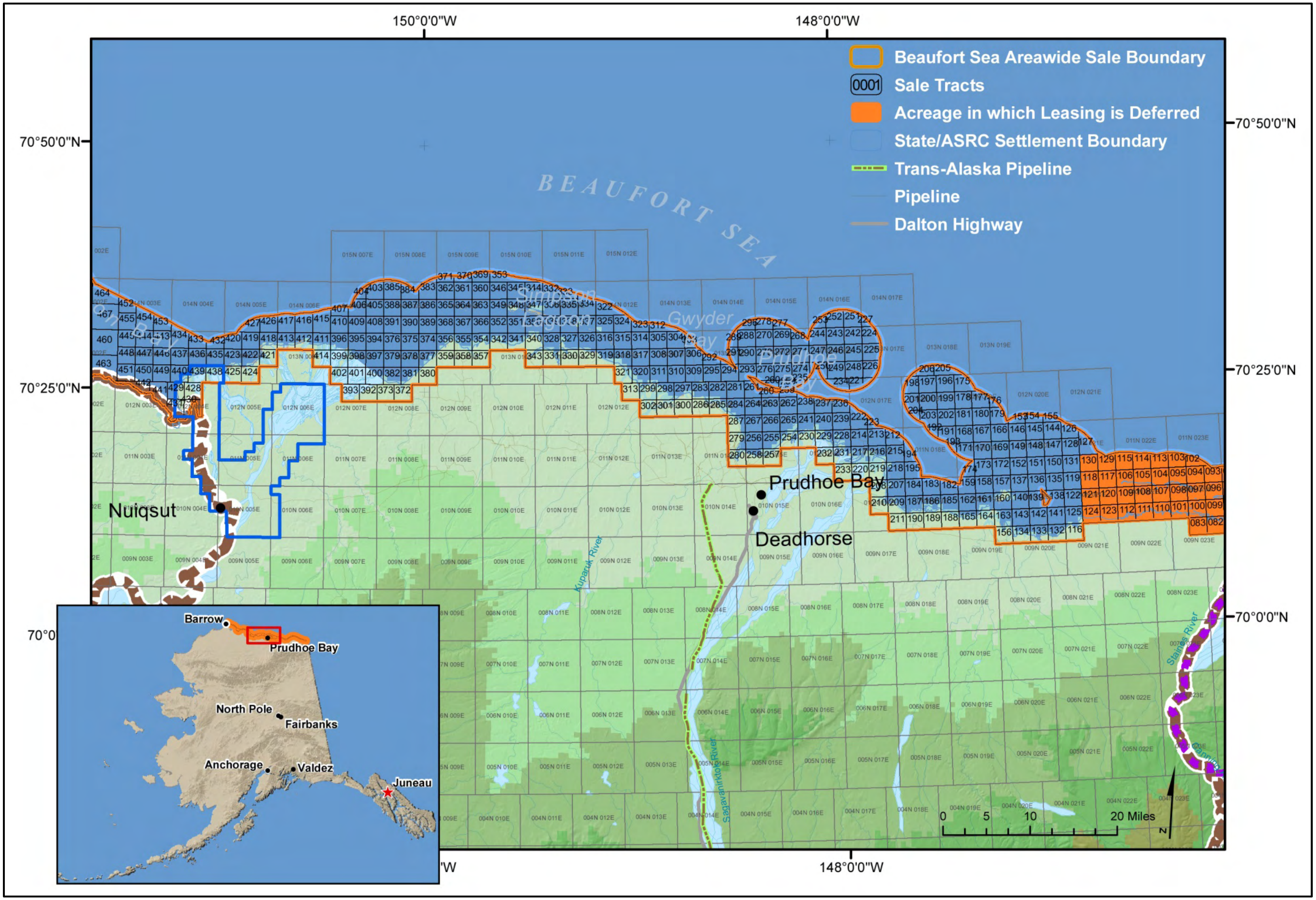
In accordance with AS 38.05.035, a person is eligible to file a request for reconsideration and subsequently an appeal to Superior Court of a best interest finding if they have meaningfully participated in the process by either submitting written comment during the public comment period or by testifying at a public hearing.

Kevin Banks, Director — April 2, 2009 (Date)

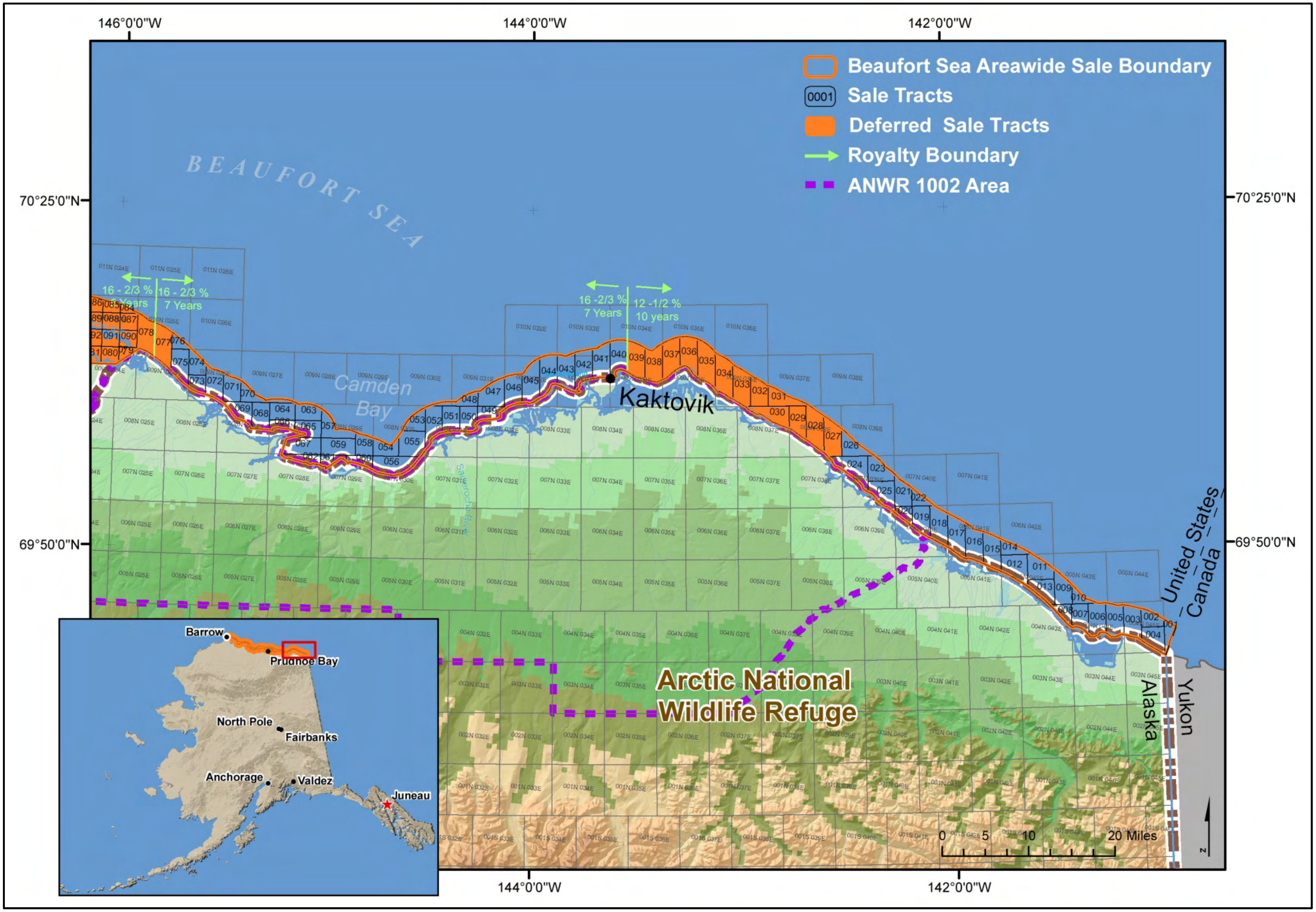
Maps



Map 1.1. Tract map of the Beaufort Sea areawide lease sale area (west).



Map 1.2. Tract map of the Beaufort Sea areawide lease sale area (central).



Map 1.3. Tract map of the Beaufort Sea areawide lease sale area (east).

Chapter Two: Introduction

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Chapter Two: Introduction

The Alaska Department of Natural Resources (ADNR) is proposing to offer for lease all available state-owned acreage in Beaufort Sea areawide oil and gas lease sales from 2009-2018 (see Maps 1.1-1.3). The proposed lease sale area is within the North Slope Borough and consists of state-owned tide and submerged land in the Beaufort Sea between the Canadian Border and Point Barrow. The area is adjacent to both the National Petroleum Reserve-Alaska (NPR-A) and the Arctic National Wildlife Refuge (ANWR). The southern fringe of the proposed lease sale area includes some state-owned uplands lying between the NPR-A and ANWR. The gross area is about 2 million acres and is divided into 573 tracts ranging in size from 640 to 5,760 acres.

A. Authorities

The Alaska Constitution provides that the state's policy is "to encourage…the development of its resources by making them available for maximum use consistent with the public interest" and that the "legislature shall provide for the utilization, development, and conservation of all natural resources belonging to the State…for the maximum benefit of its people" (Alaska Constitution, article VIII, §1 and 2). To comply with this provision, the legislature enacted Title 38 of the Alaska Statutes and directed ADNR to implement the statutes.

The legislature found that the people of Alaska have an interest in the development of the state's oil and gas resources to maximize the economic and physical recovery of the resources; maximize competition among parties seeking to explore and develop the resources; and maximize use of Alaska's human resources in the development of the resources (AS 38.05.180(a)(1)). The legislature also found that it is in the best interests of the state to encourage an assessment of its oil and gas resources and to allow the maximum flexibility in the methods of issuing leases and to offer acreage for oil and gas leases or for gas only leases (AS 38.05.180(a)(2).

B. Issues Addressed in Best Interest Findings ("g-list")

Alaska statutes govern the disposal of state-owned mineral interests. AS 38.05.035(e) states that upon a written finding that the interests of the state will be best served, the director may, with the consent of the ADNR commissioner (commissioner) approve contracts for the sale, lease, or disposal of available land, resources, property, or interests in them. The written finding is known as a best interest finding and describes the proposed lease sale area, analyzes the potential effects of the sales, describes measures to mitigate those effects, and constitutes the director's determination that the interests of the state will be best served by the disposal. ADNR, Division of Oil and Gas (DO&G) makes available both a preliminary and a final written finding and provides opportunity for public comment. The final written finding also discusses material issues that were raised during the public comment period.

AS 38.05.035(e) prescribes what, at minimum, must be in these findings. AS 38.05.035(g) lists the following matters that DO&G must consider and discuss in its written finding:

i. property descriptions and locations;
ii. the petroleum potential of the sale area, in general terms;
iii. fish and wildlife species and their habitats in the area;
iv. the current and projected uses in the area, including uses and value of fish and wildlife;
v. the governmental powers to regulate the exploration, development, production, and transportation of oil and gas or of gas only;
vi. the reasonably foreseeable cumulative effects of exploration, development, production, and transportation for oil and gas or for gas only on the sale area, including effects on subsistence

uses, fish and wildlife habitat and populations and their uses, and historic and cultural resources;

vii. lease stipulations and mitigation measures, including any measures to prevent and mitigate releases of oil and hazardous substances, to be included in the leases, and a discussion of the protections offered by these measures;

viii. the method or methods most likely to be used to transport oil or gas from the lease sale area and the advantages, disadvantages, and relative risks of each;

ix. the reasonably foreseeable fiscal effects of the lease sale and the subsequent activity on the state and affected municipalities and communities, including the explicit and implicit subsidies associated with the lease sale, if any;

x. the reasonably foreseeable effects of exploration, development, production, and transportation involving oil and gas or gas only on municipalities and communities within or adjacent to the lease sale area; and

xi. the bidding method or methods adopted by the commissioner under AS 38.05.180.

To aid those interested in reviewing and commenting on the preliminary best interest finding, this document is organized for ease of reading and reviewing, and therefore does not necessarily follow the order of the "g-list". Location of "g-list" items are listed in Table 2.1.

Table 2.1. Location of topics required by AS 38.05.035(g)(1)(B) – ("g-list") – in the preliminary best interest finding.

"g-list" Number	"g-list" Description	Location in Preliminary Best Interest Finding
i	Property descriptions and locations	Chapter Three
ii	Petroleum potential	Chapter Six
iii	Fish, wildlife, and habitat	Chapter Four
iv	Current and projected uses; uses and value of fish and wildlife	Chapter Five
v	Governmental powers	Chapter Seven
vi	Reasonably foreseeable effects on subsistence; fish, wildlife, and habitat and their uses; and historic and cultural resources	Chapter Eight
vii	Mitigation measures	Chapter Nine
viii	Oil or gas transport	Chapter Six
ix	Reasonably foreseeable fiscal effects	Chapter Eight
x	Reasonably foreseeable effects on municipalities and communities	Chapter Eight
xi	Bidding method	Chapter Ten

A compilation of other laws and regulations applicable to oil and gas activities in Alaska can be found in Appendix B. If the proposed activity occurs in the coastal zone, AS 46.40 requires that the activity be consistent with the Alaska Coastal Management Program (ACMP) and any approved coastal district plan in effect. An ACMP consistency analysis was released concurrently with the preliminary best interest finding. It will be followed by a proposed consistency determination and a final consistency determination

C. Areawide Lease Sales

Before 1996, ADNR evaluated noncontiguous patchwork portions of a region and then offered them for lease. For each subsequent lease sale, ADNR repeated this exercise for other patchwork portions of the region, often directly adjacent to those just evaluated. The public faced repeated requests to comment on areas with similar resources and issues or concerns. The state faced repeating costly analyses of resources and issues identical to those just analyzed.

As a result of 1996 amendments to AS 38.05.180(d), areawide oil and gas lease sales no longer require a new written finding under AS 38.05.035(e)(6)(F) provided that a best interest finding has been done for the area within the previous 10 years and, following a call for public comments, the commissioner annually determines whether substantial new information has become available that justifies a supplement to the most recent finding

Areawide leasing allows a thorough, region-wide analysis, eliminates repeated requests to the public, increases government efficiency, and allows ADNR to focus once a year on substantial new information that has become available. It also provides an established time each year that the state will offer for lease all available acreage within five geographical regions: the Alaska Peninsula, Cook Inlet, Beaufort Sea, North Slope, and North Slope Foothills. By conducting lease sales at a set time each year, ADNR provides industry with a stable, predictable leasing program, which allows companies to plan and develop their exploration strategies and budgets years in advance. The result is more efficient exploration and earlier development, which in turn benefits the State of Alaska and its residents. Areawide lease sales are also more efficient for the public and ADNR.

The last best interest finding for the Beaufort Sea was issued July 15, 1999. Supplements to the finding were issued on August 15, 2000, July 29, 2004, and July 15, 2008. The 1999 finding was valid for lease sales held through 2008. This preliminary best interest finding addresses proposed Beaufort Sea Areawide Oil and Gas Lease Sales from 2009-2018.

D. Process

The process of developing a best interest finding includes many opportunities for participation, from the public, government agencies, Native organizations, resource user groups, environmental organizations, and others (Figure 2.1).

1. Request For Agency Information

The process of developing a best interest finding begins with a request for information from agencies, local governments, and Native corporations. DO&G requests information and data about the region's property ownership status, peoples, economy, current uses, subsistence, historic and cultural resources, fish and wildlife, and other natural resource values. Using this information, as well as other relevant information that becomes available, DO&G develops a preliminary best interest finding and releases it for public comment.

On April 23, 2008, DO&G issued a *Request for Agency Information* to initiate the process of gathering information on the proposed lease sales. The division received responses from the Alaska Department of Environmental Conservation (ADEC); ADNR, Office of Habitat Management and Permitting (OHMP)[1]; ADNR, Division of Park and Outdoor Recreation (DPOR); ConocoPhillips Alaska, Inc. (CPAI); The Alaska Fisheries Science Center; and the North Slope Borough (NSB). ADEC, Air Quality Permits Program suggests requiring lessees to document the baseline air quality, prohibiting lessees from using simple cycle turbines, and requiring lessees to provide a plan for the

[1] The Office of Habitat Management and Permitting (OHMP) of the Alaska Department of Natural Resources became the Division of Habitat, a part of the Alaska Department of Fish and Game (ADF&G), effective July 1, 2008, as a result of Executive Order 114.

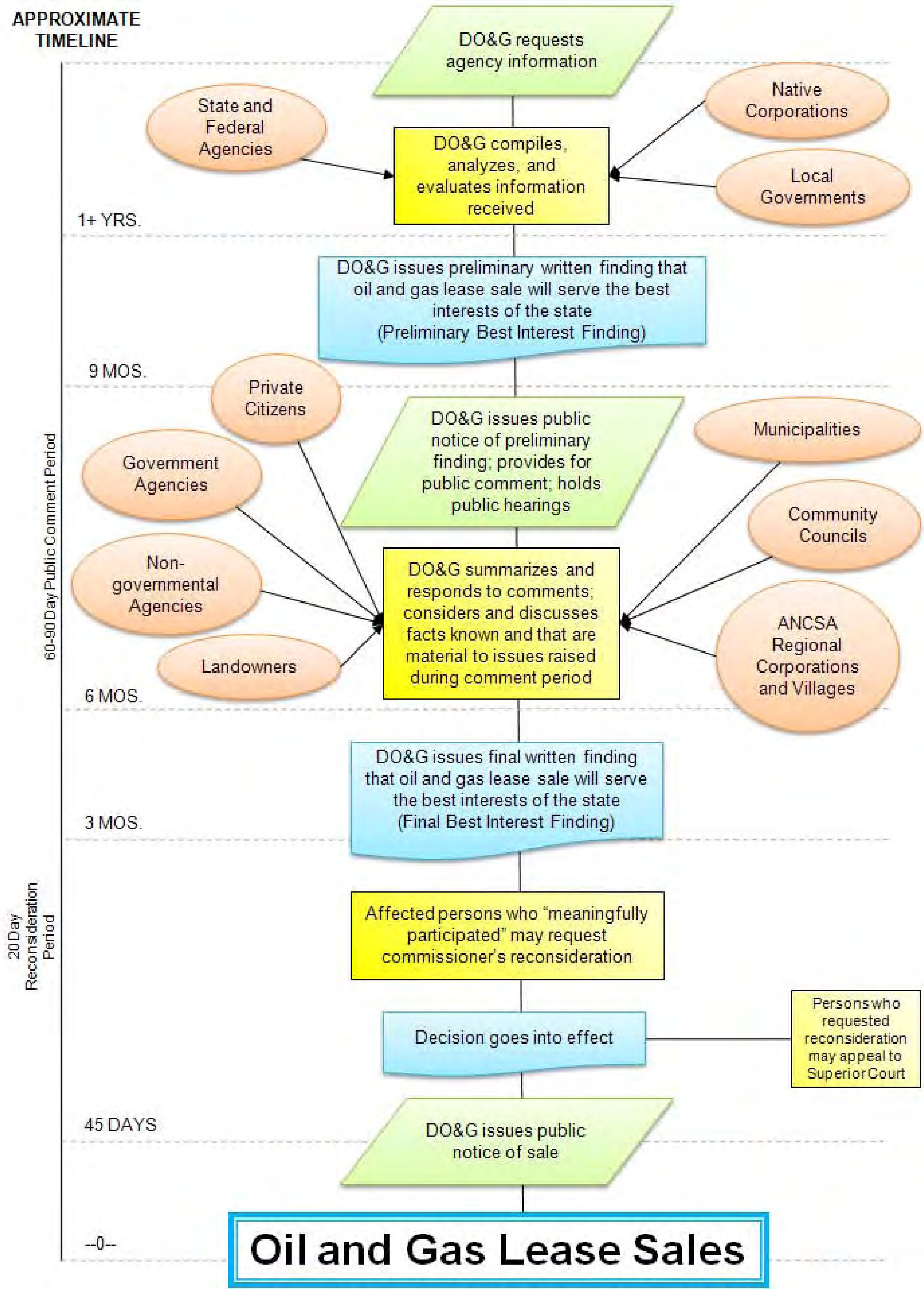

Figure 2.1. Public process for developing best interest findings for areawide oil and gas lease sales. Note that timeline is not to scale.

prevention/minimization of field souring. OHMP submitted additional information regarding subsistence fishery harvest information for Arctic cisco in the Colville River Delta. DPOR, Office of History and Archaeology reports several submerged shipwreck sites within the project area and requests that stipulations on submerged cultural resources be included in the finding. CPAI expressed serious concerns about operational restrictions, strongly encourages ADNR to resist delays in scheduled sales, and recommends that ADNR at no time decrease the current aerial surface extent of the sales. The Alaska Fisheries Science Center provided links to documents on the status of marine mammal and fish stocks.

Information provided by these agencies, as well as other relevant information, has been incorporated into this preliminary best interest finding.

The North Slope Borough (NSB) asks that ADNR consult closely with the borough and other stakeholders as the finding is being prepared, provided 18 sources of new information and events that it believes must be considered, says that areas deferred from past sales should be permanently removed from consideration, believes that potential impacts to human health must be analyzed as rigorously and comprehensively as the potential impact to wildlife resources, and believes that the goal of the cumulative effects analysis should be to capture all potential influences, whether from industrial sources or not.

ADNR carefully considered the borough's comments and incorporated much of the relevant new information into this preliminary best interest finding. The borough will have an opportunity to review the preliminary finding and suggest further changes during the public comment period. ADNR plans to continue to defer from this proposed lease sale all tracts from Pt. Barrow to Tangent Point (Tracts 555, 557-573) and from Barter Island to Pokok Bay (Tracts 27-39). Deferral means that these tracts will not be offered for lease in the proposed 2009 areawide sale, but may be included in future lease sales. Impacts to public health and cumulative effects are discussed in Chapter Eight. The goal of Chapter Eight is to satisfy the requirements of AS 38.05.035(g), that the director consider and discuss facts that are material to the reasonably foreseeable cumulative effects of exploration, development, production, and transportation for oil and gas on the sale area, not to capture all potential influences.

2. Preliminary Best Interest Finding and Request for Public Comments

To obtain public comments on the preliminary best interest finding, DO&G follows the public notice statute, AS 38.05.945. This statute includes specific provisions for noticing best interest findings, as required under AS 38.05.035(e). These include: publication of both a legal notice and a notice in display advertising in newspapers of statewide circulation and in newspapers of general circulation in the vicinity of the proposed action; public service announcements on the electronic media serving the area to be affected by the proposed action; and one or more of the following methods: posting in a conspicuous location in the vicinity of the proposed action; notification of parties known or likely to be affected by the action; or another method calculated to reach affected parties. Notice must also be given to a municipality if the land is within the boundaries of the municipality; to a coordinating body or a community council if requested in writing; to a regional corporation if the boundaries of the corporation established by the Alaska Native Claims Settlement Act (ANCSA) encompass the land and the land is outside a municipality; to a village corporation organized under ANCSA if the land is within 25 miles of the village for which the corporation was established and the land is located outside of a municipality; to the postmaster of a permanent settlement of more than 25 persons located within 25 miles of the land if the land is located outside a municipality, with a request that the notice be posted in a conspicuous location; and to a nonprofit community organization or a governing body that has requested notification in writing and provided a map of its boundaries, if the land is within the boundaries.

In addition, AS 38.05.946 provides that a municipality, an ANCSA corporation, or nonprofit community organization may hold a hearing within 30 days after receipt of the notice, which the commissioner or his/her representative shall attend. The commissioner has discretion to hold a public hearing.

Public comment assists in providing a body of information for the best interest finding review and analysis that is as complete as possible. Information provided by agencies and the public assists the director in reviewing all of the facts and issues; determining which facts and issues are material to the decision of whether the proposed lease sale is in the best interests of the state; and determining the reasonably foreseeable, significant effects of the proposed lease sale.

3. Final Best Interest Finding

After receiving public comments on the preliminary best interest finding, DO&G reviews all comments, revises the best interest finding as needed, and incorporates additional relevant information and issues brought up during the public comment period. The director strikes a balance of interests, determines if the proposed lease sale is in the best interest of the state, and makes a final finding.

The final best interest finding for the Beaufort Sea is expected to be issued in July 2009.

4. Request for Reconsideration and Appeal to Superior Court

A person who is eligible to file a request for reconsideration and who is or maybe adversely affected by the final written finding may, within 20 days after issuance of the final written finding, file a request for reconsideration of the decision by the commissioner. A person is eligible to file a request for reconsideration if the person “meaningfully participated” in the process set out for receipt of public comment and is affected by the final written finding. “Meaningfully participated” means submitting written comment during the period for receipt of public comment or presenting oral testimony at a public hearing, if a public hearing was held (AS 38.05.035(i)).

A person may appeal a final written finding to the superior court, but only if the person was eligible to request, and did request, reconsideration of that finding. The points on appeal are limited to those presented to the commissioner in the person’s request for reconsideration (AS 38.05.035(l)). By requiring a party to exhaust the administrative review and reconsideration process before appealing to the superior court, the agency is given full opportunity to review, analyze, and respond to concerns before litigation. For purposes of appeal, the burden is on the party seeking review to establish the invalidity of the finding (AS 38.05.035(m)).

E. Annual Lease Sales

After a final best interest finding has been issued, DO&G may proceed with oil and gas lease sales in the area. As noted above, a written finding is not required for a lease sale in an area subject to a best interest finding issued within the previous 10 years unless the commissioner determines that substantial new information has become available that justifies a supplement to the finding.

Approximately nine months before a proposed lease sale, DO&G issues a call for comments requesting substantial new information that has become available since the most recent finding for that lease sale area was issued (Figure 2.2). This request is sent to agencies and individuals on the division’s mailing list and posted on the DO&G website. The call for public comments provides opportunity for public comment for a period of not less than 30 days. Based on information received, the commissioner determines whether it is necessary to supplement the finding. Based on that determination, the commissioner either issues a supplement to the finding or a “Decision of No New Substantial Information” 90 days before the lease sale. The supplement has the status of a final written best interest finding for purposes of filing an administrative appeal or a request for reconsideration.

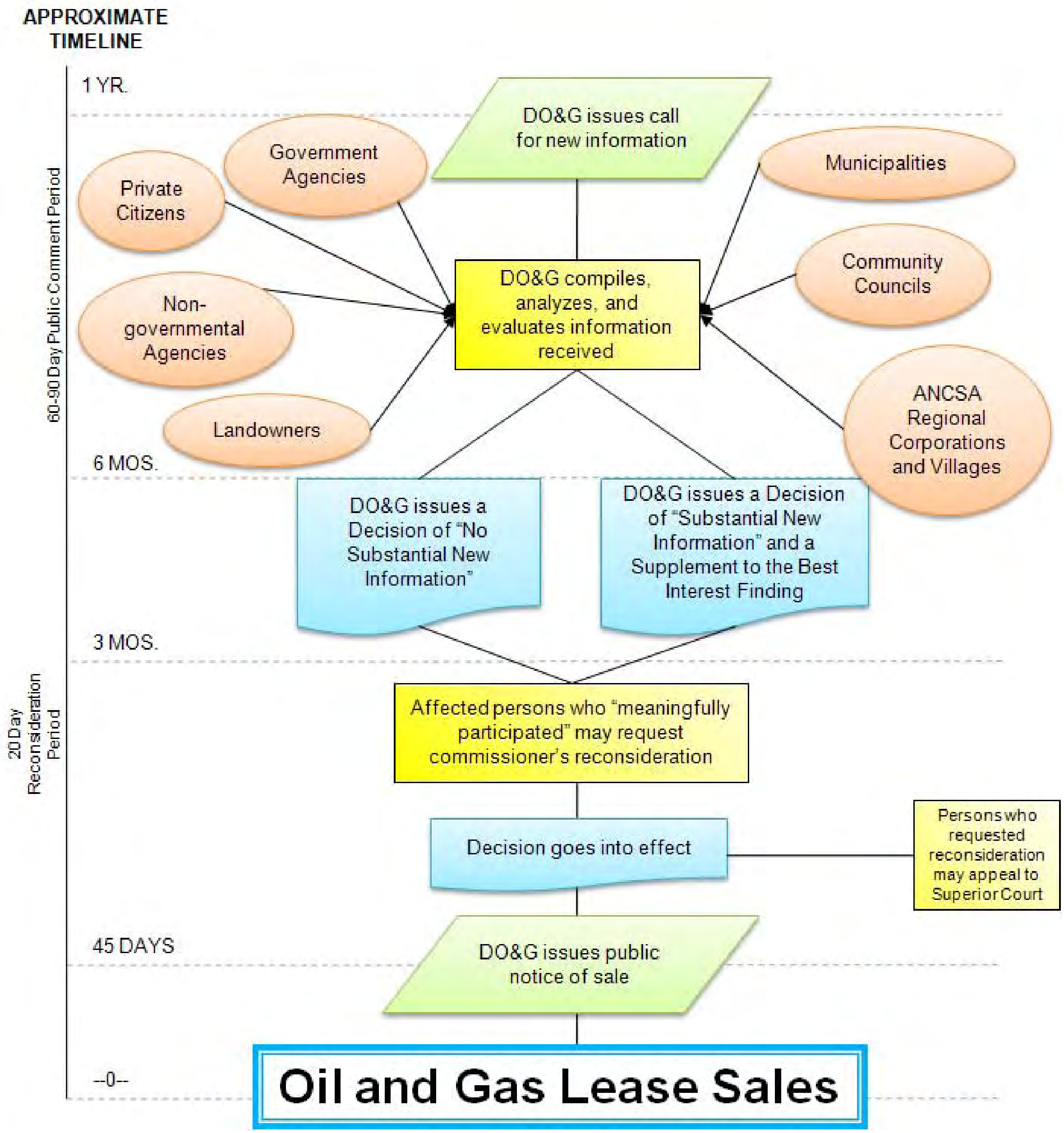

Figure 2.2. Annual public process for determining if a supplement to a best interest finding is necessary. Note that timeline is not to scale.

Any person that comments during the period for receipt of public comments has reconsideration and appeal rights as described in AS 38.05.035.

F. Scope of Review

The director, in the written finding, shall establish the scope of the administrative review on which the director's determination that the disposal will best serve the interest of the state is based and the scope of the written finding supporting that determination. The scope of the administrative review and finding may address only reasonably foreseeable, significant effects of the uses proposed to be authorized by the disposal (AS 38.05.035(e)(1)(A)). For an effect to be "reasonably foreseeable": (1) there must be some cause/result connection between the proposed disposal and the effect to be evaluated; (2) there is a reasonable probability that the effect will occur as a result of the disposal; and (3) the effect will occur within a predictable time after the disposal. Therefore, the finding does not speculate about potential but improbable future effects, but instead reviews reasonably foreseeable effects of the proposed disposal.

A reasonably foreseeable effect must also be "significant." Significant means a known and noticeable impact on or within a reasonable proximity to the area involved in the disposal.

Further, the director may limit the scope of an administrative review and finding for a proposed disposal to:

- (i) applicable statutes and regulations;
- (ii) the facts pertaining to the land, resources, or property, or interest in them, that the director finds are material to the determination and that are known to the director or knowledge of which is made available to the director during the administrative review; and
- (iii) issues that, based on the statutes and regulations, on the facts as described, and on the nature of the uses sought to be authorized by the disposal, the director finds are material to the determination of whether the proposed disposal will best serve the interests of the state. (AS 38.05.035(e)(1)(B).)

G. Phased Review

Phased review recognizes that some disposals of oil and gas, or of gas only, may result in future development that cannot be predicted or planned with any certainty or specificity at the initial lease sale phase, and that any future development will be subject to detailed review before it takes place. In the case of oil and gas, DO&G cannot determine with any specificity or definition at the lease sale phase if, when, where, how, or what kind of exploration, development or production might ultimately occur as the result of a lease sale. Although advances in technology, unpredictable market changes, and specific infrastructure requirements for possible production cannot be foreseen, new developments or improvements in any or all of these areas may yield answers to some of these questions in the future.

Phasing allows the analysis of leasing to focus only on the issues pertaining to the lease sale phase and reasonably foreseeable, significant effects a lease sale. Additional authorizations are required for exploration, development, and production phases. When a project is multi-phased, review of issues that would require speculation about future factors may be deferred until permit authorization is sought at the exploration, development, and production phases. A discussion of governmental and public involvement at these later phases can be found in Chapter Seven.

Under AS 38.05.035(e)(1)(C), the director may, if the project for which the proposed disposal is sought is a multiphased development, limit the scope of an administrative review and finding for the proposed disposal to the applicable statutes and regulations, facts, and issues identified above that pertain solely to the disposal phase of the project when:

(i) the only uses to be authorized by the disposal are part of that phase;
(ii) the disposal is a disposal of oil and gas, or of gas only, and, before the next phase of the project may proceed, public notice and the opportunity to comment are provided unless the project is subject to a consistency review under AS 46.40 and public notice and the opportunity to comment are provided under AS 46.40.096(c);
(iii) the department's approval is required before the next phase may proceed; and,
(iv) the department describes its reasons for a decision to phase.

The conditions under which phasing may occur have been addressed in this preliminary best interest finding for the proposed Beaufort Sea areawide oil and gas lease sales. Accordingly, the review of activities in the proposed lease sale area is of a multi-phased development. The director, in making this preliminary finding, has limited the scope of the finding to the applicable statutes and regulations, facts, and issues that pertain solely to the lease sale phase of oil and gas activities and the reasonably foreseeable significant effects of a lease sale.

Condition (i) is met because the only uses authorized are part of the lease sale phase. The lease gives the lessee, subject to the provisions of the lease, the right to conduct geological and geophysical exploration for oil, gas, and associated substances within the leased area and the right to drill for, extract, remove, clean, process, and dispose of any oil, gas, or associated substances that may underlie the lands described by the lease. While the lease gives the lessee the right to conduct these activities, the lease itself does not authorize any exploration or development activities by the lessee on leased tracts.

Condition (ii) is met because the proposed lease sale is of oil and gas or gas only, and before the next phase of the project may proceed, ADNR will provide public notice and the opportunity to comment for any proposed plan of operations in the lease sale area. Additionally, any plan of operations in the lease sale area that is within the coastal zone is subject to consistency with the ACMP standards, including public notice and opportunity to comment under AS 46.40.

Condition (iii) is met because ADNR's approval is required before the next phase (in this case exploration) may proceed. See Chapter Six for a discussion of post-leasing phases. Before exploration activities can occur on leased lands, the lessee must secure all applicable authorizations. Additional authorizations must also be secured for any subsequent development or production on the lease.

The plans of operation must identify the specific measures, design criteria, construction methods, and standards that will be employed to meet the provisions of the lease. A plan of operations is subject to extensive technical review by a number of local, state, and federal agencies. Oil and gas exploration, development, or production-related activities will be permitted only if proposed operations comply with all local, state, and federal laws and the provisions of the lease.

Condition (iv) is met because ADNR describes above the reasons for its decision to phase.

The effects of future exploration, development, and production will be considered at each subsequent phase, when various government agencies and the public review applications for specific proposed activities at specific locations. However, this finding does discuss, in general terms, the potential effects that may occur with oil and gas exploration, development, production, and transportation within the proposed lease area as well as proposed measures to be imposed as terms of the lease, subsequent permits, and plan of operations to mitigate possible adverse effects.

H. Post-sale Title Search

The proposed Beaufort Sea lease sale area has been divided into tracts that will remain fixed for future lease sales. The extent of the state's ownership interest in these lands will not be determined before the lease sales. Instead, following each lease sale, ADNR will verify title only for tracts receiving bids. Therefore, should a potential bidder require title or land status information for a particular tract before a lease sale, it will be the bidder’s responsibility to obtain that information from ADNR’s public records. It is possible that a tract included in a lease sale may contain land that the state cannot legally lease because it is subject to an existing oil and gas lease or because the mineral estate is not state owned. Depending on the number of tracts leased and the complexity of the ownership, it could take weeks to months following a lease sale to complete the title work and issue all of the leases.

Chapter Three: Description of the Proposed Beaufort Sea Lease Sale Area

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Chapter Three: Description of the Proposed Beaufort Sea Lease Sale Area

A. Property Description

The proposed lease sale area contains approximately 2,000,000 acres in 573 tracts ranging in size from 640 to 5,760 acres. The area consists of state-owned tide and submerged land, located along the Beaufort Sea coast, between Point Barrow and the Canadian border within the three-mile offshore boundary between state and federal waters. The proposed lease sale area is adjacent to the offshore boundaries of both the National Petroleum Reserve-Alaska (NPR-A) and the Arctic National Wildlife Refuge (ANWR). The southern fringe of the area includes some state-owned uplands lying between the NPR-A and ANWR between the Colville River and the Canning River. The proposed lease sale also includes numerous islands.

Prominent water bodies in the proposed lease sale include Smith Bay, Harrison Bay, Simpson Lagoon, Gwyder Bay, Prudhoe Bay, Stefansson Sound, Foggy Island Bay, Mikkelson Bay, and Camden Bay. Important island groups include Plover, Jones, Return, Midway, McLure, Stockton, Maguire, and Flaxman Islands.

The state owns most of the uplands within the proposed lease sale boundaries. Other landowners are the federal government, Native corporations, the North Slope Borough, and individuals. The mineral estate of seven onshore tracts within the Colville River Delta is owned jointly by the state and the Arctic Slope Regional Corporation (ASRC), with Kuukpik Village Corporation (Nuiqsut) as the owner of the land estate. There is one federal inholding, the DEW site at Bullen Point. Although surrounded by the proposed lease sale, this acreage is excluded from state oil and gas leasing because the state does not own the mineral estate. Kaktovik Inupiat Corporation, the village corporation for Kaktovik, has inholdings within ANWR.

The uplands from the Stains River easterly to the Canadian border lie within ANWR, which is owned by the federal government and therefore not available for inclusion in state oil and gas lease sales. The uplands from the Colville River westerly to Barrow are within the NPR-A, which is also owned by the federal government. Portions of NPR-A are available for oil and gas exploration and development.

There are several Native allotments and parcels owned by the North Slope Borough. The state, as the mineral estate owner, may lease these lands.

The U.S. Department of State has notified the State of Alaska that the tide and submerged land within Tract 001 of the proposed lease sale may be subject to a title dispute with the government of Canada. Potential bidders on Tract 001 should be prepared for possible delays in determining state title to lands within this tract.

The proposed lease sale is within the North Slope Borough. This home rule borough, incorporated in 1972, extends from the Chukchi Sea to the Canadian border. The borough has the powers of taxation, land management, and zoning, and is responsible for providing borough communities with public works, utilities, education, health, and other public services. The proposed lease sale is within Alaska’s coastal zone and is subject to the Alaska Coastal Management Program.

ADNR plans to continue to defer from this proposed lease sale all tracts from Pt. Barrow to Tangent Point (Tracts 555, 557-573) and from Barter Island to Pokok Bay (Tracts 27-39). Deferral means that these tracts will not be offered for lease in the proposed 2009 areawide sale, but may be included in future lease sales. Even though existing mitigation measures (Chapter Nine) provide the necessary protection for subsistence activities, ADNR is taking the extra precaution of continuing to defer these tracts from consideration at this time. It is possible that during the 10-year period covered by this finding, the prospects for developing these tracts will increase. ADNR will annually review the available information for these tracts to determine whether to offer them in a future lease sale.

1. Land and Mineral Ownership

The Alaska Statehood Act granted to the state of Alaska the right to select from the federal public domain 102.5 million acres of land to serve as an economic base for the new state. The Act also granted to Alaska the right to all minerals underlying these selections and specifically required the state to retain this mineral interest when conveying its interests in the land (AS 38.05.125). Therefore, when state land is conveyed to an individual citizen, local government, or other entity, state law requires that the deed reserve the mineral rights for the state. Furthermore, state law reserves to the state the right to reasonable access to the surface for purposes of exploring for, developing and producing the reserved mineral. Surface owners are entitled to damages under AS 38.05.130, but may not deny reasonable access. Mineral closing orders, which are commonly associated with surface land disposals, do not apply to oil and gas leasing.

The Alaska Native Claims Settlement Act (ANCSA), passed by Congress in 1971, also granted newly created regional Native corporations the right to select and obtain from the federal domain lands the land and mineral estates within the regional Native corporation boundaries. It also allowed Native village corporations and individual Native Alaskans to receive land estate interests. However, overlapping selections created conflicts and delays in conveying the land from the federal government, and some selected lands have yet to be conveyed.

In 1991 the State and Arctic Slope Regional Corporation (ASRC) executed a Settlement Agreement. In that agreement, the State and ASRC agreed to joint ownership of the land within the settlement area for the purposes of oil and gas leasing. The mineral estate of seven onshore tracts within the Colville River Delta is now owned jointly by the state and ASRC in various percentages, with Kuukpik Village Corporation (Nuiqsut) as the owner of the land estate. In accordance with the agreement, sections that are not “fully conveyed” from the federal government are not available for leasing. The State is the designated authority to offer the jointly owned lands for leasing, and issues leases on behalf of ASRC for their various ownership percentages.

There is one federal inholding, the DEW site at Bullen Point. The state has a selection topfiling on the parcel and is expected to receive title after the federal withdrawal has been lifted. However, there are contamination issues with the parcel that may need to be resolved before conveyance.

There are several parcels of which the surface estate was conveyed from the state through the federal government to Native allottees. The North Slope Borough also owns land as a result of the state’s municipal entitlement program. Additional municipal conveyances are pending within the proposed lease sale area. For the most part, the State, as the owner of the retained mineral estate, may lease these lands for oil and gas development.

B. Historical Background

Evidence of human occupation and use of the Arctic Coastal Plain dates back to 10,000 B.C. Marine mammal harvesting on winter sea ice has occurred for at least four thousand years, and evidence of whaling is 3,400 years old (Langdon 1995). The record of human existence on the North Slope is characterized by several distinct cultural periods marked by changes in tool style (NSBCMP 1984). The environmental characteristics of the Arctic shaped Inupiat culture into a semi-nomadic society with a tradition of whaling and an emphasis on seasonal inland hunting. This pattern of land use remained unchanged until the second half of the 19th century with the arrival of westerners, new tools, and due to natural events, such as caribou population decline (NSBCMP 1984; NSB 1979).

Numerous sites across the North Slope containing sod houses, graves, storage pits, ice cellars, bones and relics attest to the historical use and presence of Arctic people in the proposed lease sale area, however, much of the archaeological record has been destroyed by erosion (Hoffman et al. 1988). For centuries, trading centers, such as Barter Island and Nigalik, at the mouth of the Colville River, were used by Canadian and Alaskan Eskimos (Jacobson and Wentworth 1982). Eskimos of the North Slope also traded with Asia across the Bering Strait as early as the mid-1700's (Langdon 1995) (NSBCMP 1984).

European explorers and fur traders began arriving in the proposed lease sale area during the 1820s and 30s. This contact introduced metal tools, traps, and guns to support trading and hunting. Russian trading posts were established from Norton Sound southward. After bowhead whale migration paths were discovered, commercial whaling increased dramatically in the Arctic after 1850 and into the 1880s. Several whaling stations were built along the coast, providing for regular contact and trading with Natives. Steamships, later replaced sailing vessels, facilitating year round access. Increased hunting pressure and a natural decline reduced the population of the western caribou herd. This, coupled with western diseases, such as measles and influenza, resulted in an increase in the death rate of the inland Eskimo. Coastal Inupiat also suffered population decline from foreign diseases (NSBCMP 1984)

By World War I, declining whale populations and a decreased demand for whale oil and baleen brought an end to the commercial whaling period. However, demand for fur, particularly Arctic fox, resulted in the continued presence of westerners along the Beaufort Coast and North Slope. Native residents who were engaged in trapping provided income for non-subsistence resources. By 1914, trapping camps used in the thriving fur trade were established from Barrow to the Canadian border (NSBCMP 1984). In the 1930s, however, the price of fur plummeted, forcing many traders to leave the region near the lower Colville River. Many residents moved to other settlements in Alaska (Hoffman et al. 1988).

World War II brought an influx of military personnel into Alaska and the petroleum exploration period began. Inupiat were hired to work on construction projects, including the Naval Arctic Research Laboratory near Barrow in 1947, and the Distant Early Warning (DEW) line defense sites in the early 1950s (NSBCMP 1984). Before 1950, the lower Colville River supported many families, until the Bureau of Indian Affairs required that children attend schools, and most residents relocated to Barrow (NSB 1979).

The contemporary period of modernization and change began in the 1960s. The discovery of the Prudhoe Bay oil field in 1967 prompted a renewed interest in petroleum exploration and development, but before oil reserves could be developed, Native land claims had to be settled. "In response to rapid change that threatened Native land rights through land transfers, biological resource limitations, and natural resource leasing (primarily oil and gas), Inupiat political groups formed regional organizations to protect their rights and culture." The Alaska Native Claims Settlement Act, passed in 1971, created village and regional Native corporations and provided a mechanism for the transfer of land ownership to Native Alaskans (NSBCMP 1984).

Before the building period of the late 1970s and 1980s, few services were provided to residents, few jobs were available, and living conditions were austere across the Arctic Slope of Alaska. All communities lacked sanitation services, running water, telephones in homes, community centers and modern recreation facilities. The incorporation of the North Slope Borough (NSB) in 1972 provided residents with local government powers and a mechanism to assess and tax oil and gas infrastructure. Incorporation also created responsibilities of planning, zoning, education and utilities. Petroleum revenues and other funding have provided the borough with resources to pay for schools, fire

Community of Barrow.

stations, medical clinics, health care services, utilities, public safety facilities, family assistance programs, workforce development programs, community centers, public housing, administrative facilities, and jobs for borough residents.

C. Communities

1. North Slope Borough

The North Slope Borough, incorporated in 1972, is Alaska's largest borough, covering more than 15 percent of the state's total land area. The area encompasses 88,817.1 mi^2 of land and 5,945.5 mi^2 of water. Communities located within the borough include: Anaktuvuk Pass, Atqasuk, Barrow, Deadhorse/Prudhoe Bay, Kaktovik, Nuiqsut, Point Hope, Point Lay, and Wainwright (DCCED 2006). The borough is located within the Barrow Recording District.

In 2007, the population of the North Slope Borough was 6,751. Approximately 70 percent of borough residents are Alaska Native or part Native. The majority of permanent residents are Inupiat Eskimos (DCCED 2008a).

Air travel provides the only year-round access, while land transportation provides seasonal access. The Dalton Highway provides road access to Deadhorse/Prudhoe Bay, though it is restricted during winter months. "Cat-trains" are sometimes used to transport freight overland from Barrow during the winter (DCCED 2008a).

2. Barrow

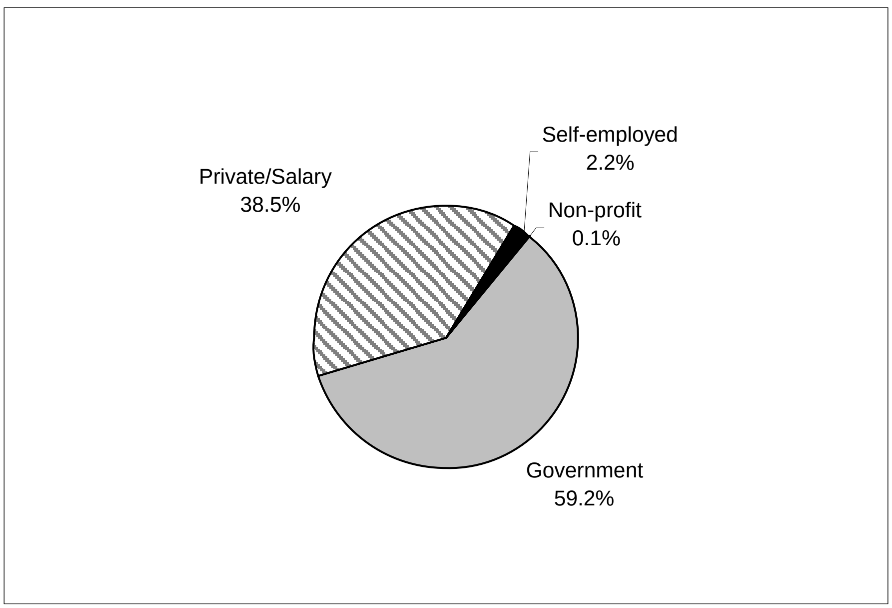
Barrow, which was incorporated in 1958, is located 10 miles south of Point Barrow on the Chukchi Sea coast. The area encompasses 18.4 mi^2 of land and 2.9 mi^2 of water. Formation of the North Slope

Borough in 1972, the Arctic Slope Regional Corporation, and construction of the Prudhoe Bay oil fields and the Trans-Alaska Pipeline have contributed to Barrow's development.

The population of Barrow is 4,054 (DCCED 2008a). The majority of the population is Inupiat, who practice a traditional subsistence lifestyle dependent on marine mammal hunting and supplemented by inland hunting and fishing. The North Slope Borough is Barrow's primary employer; however employment is also provided by state and federal agencies and numerous other businesses that provide support services to oil and gas field operations. The median household income in 1999 was $76,200 (City-Data.com 2008). Figure 3.1 and Figure 3.2 display Barrow's employment classes and employment rates from the year 2000.

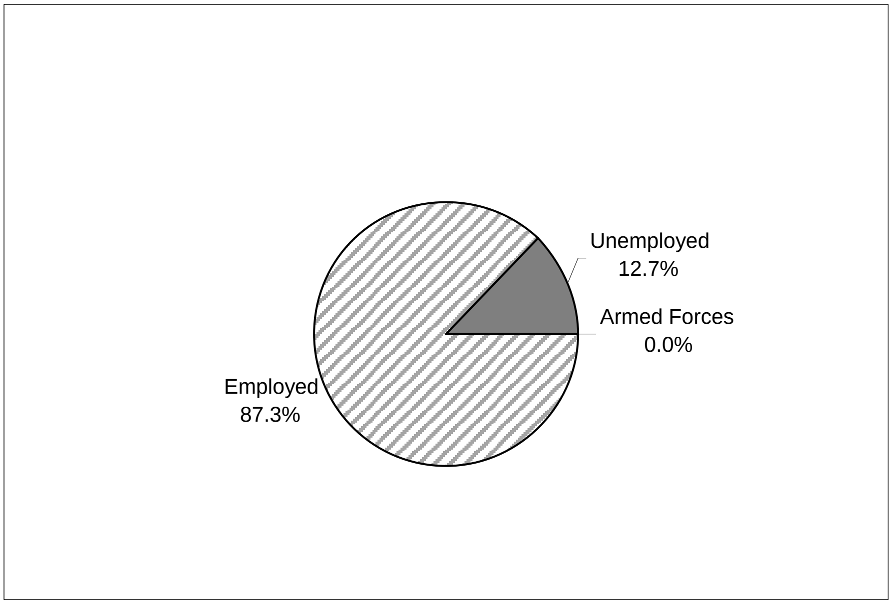
The North Slope Borough provides utilities to Barrow. Water is derived from a dam on Isatkoak Lagoon and is stored in a holding tank. The Barrow Utilities & Electric Cooperative operates the water and sewage treatment plants, generates and distributes electric power, and distributes piped natural gas for home heating. The local power plant is fueled by natural gas (DCCED 2006).

Year-round access is provided by air travel. The state owns the Wiley Post-Will Rogers Memorial Airport, which serves as the regional transportation center for the borough. The airport has a 6,500-foot-long asphalt runway. Marine and land transportation also provide seasonal access (DCCED 2006).



Source: (USCB 2000a)

Figure 3.1. Barrow employment classes, 2000.



Source: (USCB 2000a)

Figure 3.2. Barrow employment rate, 2000.

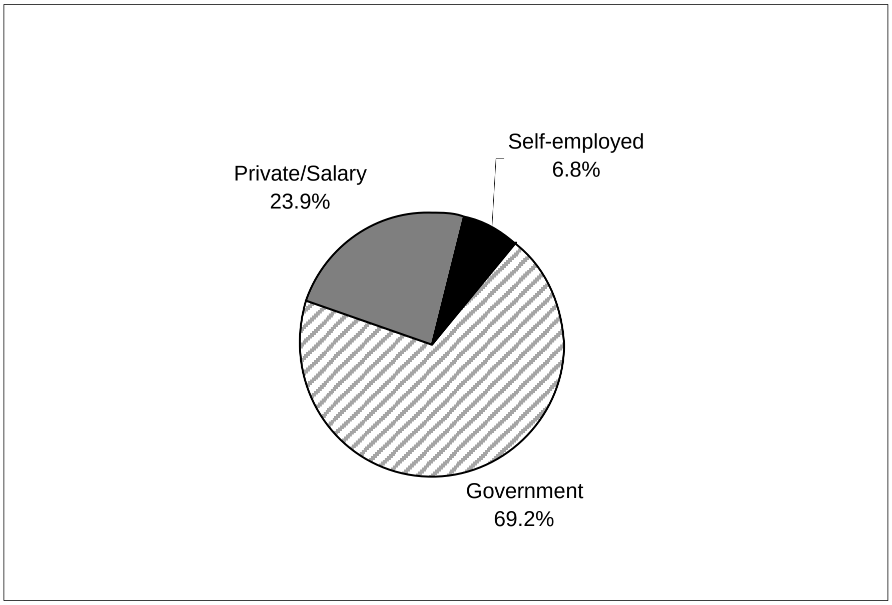
3. Kaktovik

Kaktovik, which was incorporated in 1971, is located on the north shore of Barter Island, between the Okpilak and Jago Rivers. The village encompasses 0.8 mi^2 of land and 0.2 mi^2 of water and lies within the Arctic National Wildlife Refuge. The island served as a major trade center for the Inupiat, particularly as a bartering place for Alaska Inupiat and Canadian Inuit (DCCED 2006).

The population of Kaktovik is 287 (DCCED 2008b). The isolated village has maintained traditions and its subsistence is mainly dependent upon caribou (DCCED 2006). Unemployment is high in Kaktovik and economic opportunities are limited due to the isolation of the community. The median household income in 1999 was $55,625. The North Slope Borough and school provide most of the year-round employment; however, part-time seasonal jobs, such as construction, also provide income (USCB 2000b). Figure 3.3 and Figure 3.4 display Kaktovik's employment classes and employment rates from the year 2000.

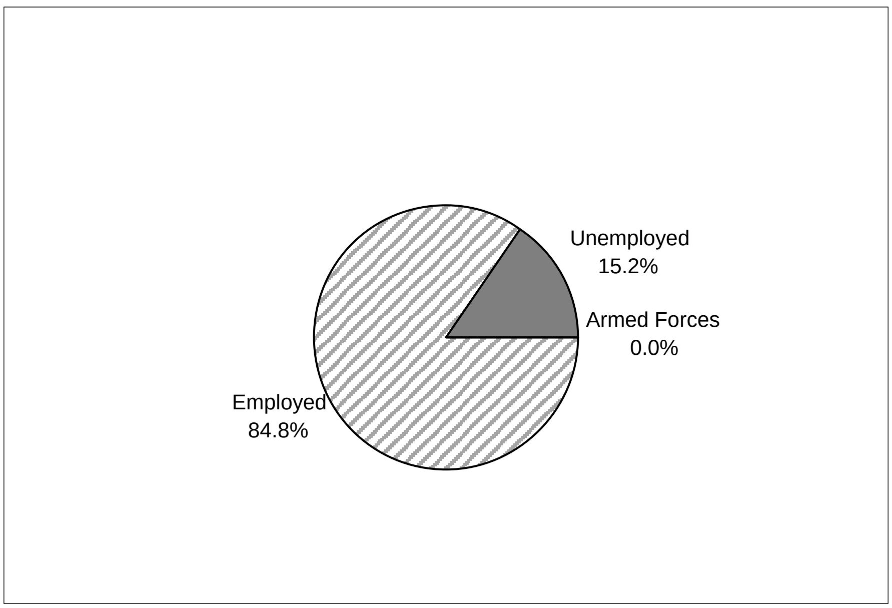
The North Slope Borough provides utilities to Kaktovik. Water is derived from a surface source, treated and stored in a 680,000-gallon water tank, and delivered by truck to home holding tanks. Approximately 80 percent of homes have running water in the kitchen. Homes that are not connected to the water and sewer system utilize holding tanks that are pumped and hauled on a regular basis (USCB 2000b).

Year-round access is provided by air travel. The Barter Island Airport is owned by the U.S. Air Force and operated by the borough. Marine and land transportation also provide seasonal access (DCCED 2006).



Source: (USCB 2000b)

Figure 3.3. Kaktovik employment classes, 2000.



Source: (USCB 2000b)

Figure 3.4. Kaktovik employment rate, 2000.

Aerial view of Kaktovik.

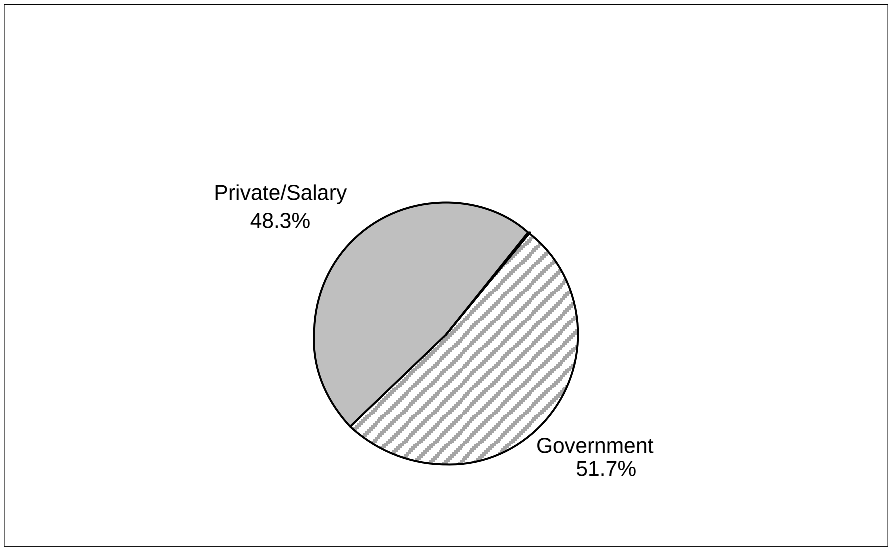
4. Nuiqsut

Nuiqsut, population 403 (DCCED 2008a) is located approximately 35 miles from the Beaufort Sea on the west bank of the Nechelik Channel of the Colville River delta. It encompasses 9.2 mi^2 of land. The Colville delta has traditionally been a gathering and trading place for the Inupiat and offers good hunting and fishing. The old village of Nuiqsut was abandoned in the late 1940s for lack of a school. In 1973, the village was resettled by 27 families from Barrow. In 1973 and 1974, a school, housing, and other facilities were constructed by federal agencies. The City of Nuiqsut was incorporated in 1975 (DCCED 2006). The majority of the population is Inupiat, who practice a traditional subsistence lifestyle.

The median household income in 2000 was $48,036 (USCB 2000c). The Kuukpik Native Corporation, school, borough, and store provide most of the year-round employment in the village. Trapping and craft-making also provide some income. Caribou, bowhead and beluga whale, seal, moose, and fish are staples of the diet. Polar bears are also hunted (DCCED 2006). Figure 3.5 and Figure 3.6 display Nuiqsut’s employment classes and employment rates from the 2000 census.

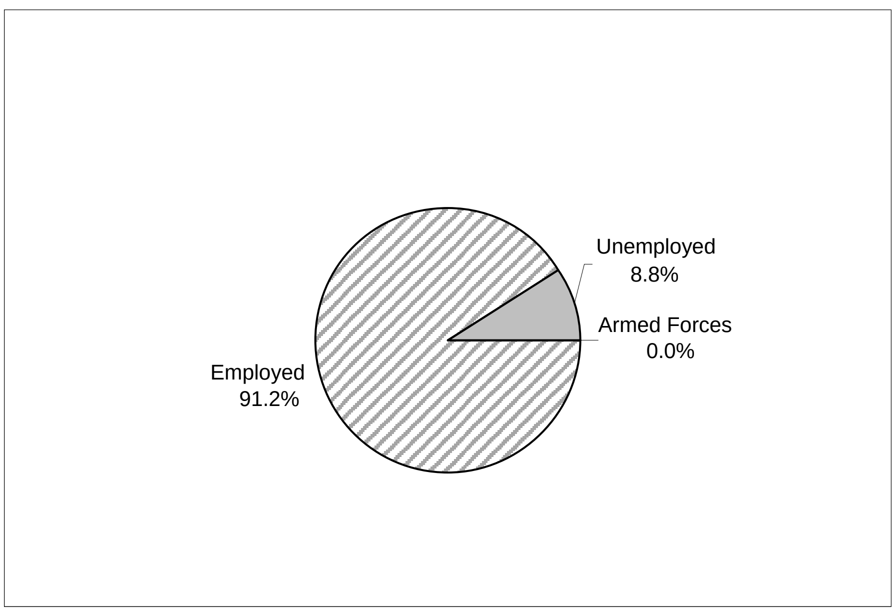
The North Slope Borough provides utilities to Nuiqsut. Water is derived from a lake, treated and delivered to individual resident’s water tanks. Most homes have running water to the kitchen. The Alpine oil field will soon provide piped natural gas to Nuiqsut, which will lower the cost of running diesel electric generators for heating homes and other facilities (DCCED 2006).

The borough owns and operates a gravel airstrip and year-round access is provided by air travel. Marine and land transportation also provide local seasonal access and snowmachines are used for local transportation in winter months (DCCED 2006).



Source: (USCB 2000c)

Figure 3.5. Nuiqsut employment classes, 2000.



Source: (USCB 2000c)

Figure 3.6. Nuiqsut employment rate, 2000.

5. Prudhoe Bay/Deadhorse

Extensive development of the Prudhoe Bay/Deadhorse area for oil drilling operations began in the 1970s. Despite the low census figures—the population in 2007 was three—Prudhoe Bay is a very busy place and serves as a hub for oil and gas field workers. Population figures reflect only permanent residents of Deadhorse and Prudhoe Bay—most oil field workers travel home to Anchorage or the lower 48 states when off duty. The airport, lodging, a general store, and other facilities are clustered in Deadhorse (DCCED 2008a).

The Prudhoe Bay oil fields provide approximately 20 percent of the nation's domestic oil supply. More than 5,000 individuals are employed in drilling, pipeline operations, cargo transportation, and a variety of support positions (DCCED 2006).

The airport at Deadhorse is the primary means of public transportation. The state owns a 6,500-foot-long asphalt airstrip and a heliport. The Dalton Highway is used year-round by trucks to haul cargo to the North Slope (DCCED 2006).

D. Cultural Resources

Historic use and archaeological sites: The ADNR, Office of History and Archaeology has researched the available sources and found 14 known historic and archaeological sites onshore within the proposed lease sale area. There are several reported shipwreck sites within the proposed lease sale area. It is very likely that there may be additional sites that have not been previously reported (DPOR 2008).

Cultural and historic resources are those sites and artifacts having significance to the culture of Arctic people. Historic and cultural sites are those identified by the National Register of Historic Sites, and include those identified in the NSB Traditional Land Use Inventory (TLUI), by the Commission on Inupiat History, Language and Culture, and sites identified in other published studies. Many places, such as ancient village locations along the tributaries of the Colville River, which contain archaeologically important relics, continue to be used today.

E. Climate

Surface conditions in the Arctic vary dramatically. In summer, the climate is generally mild. The three-month ice-free season is critical to biological productivity. In contrast, winters are severe, forcing many species to migrate south.

Since the late 19th century, average global temperatures have increased 0.5°F to 1.0°F (BLM 2005). Temperature increase in Alaska over the last 50 years averages 3.4°F, although the temperature changes vary greatly across the state and most of the change has occurred in winter and spring months. Little additional warming has occurred since 1977, with the exception of a few locations. Regional climatic change is difficult to quantify and much less reliable than global estimations (BLM 2005; ACRC 2008).

Changes that could accompany warming trends include melting glaciers, reduction in seasonal sea ice cover resulting in increased storm effects and higher coastal erosion rates, increased permafrost melting, shifting vegetation zones, increased fires, insect outbreaks, changing animal migration paths, and changing subsistence patterns (DGGS 2008a).

In 2006, the Alaska Climate Impact Assessment Commission was formed to assess the effects of climate change on citizens, resources, economy, and assets of the state of Alaska (ACIAC 2008). In September 14, 2007, Administrative Order 238 was signed, creating the Climate Sub-Cabinet to develop an Alaska Climate Change Strategy. The strategy will serve as a guide for responding to climate change and will identify immediate priorities as well as long-term strategies, including recommendations for saving energy and reducing greenhouse gas emissions (SOA 2008). On April 17, 2008, the Governor's subcabinet released its final report of recommended actions including emergency planning and training, erosion control, and village relocation planning (IAW 2008).

1. Precipitation

Along the Beaufort Sea coast, the amount of precipitation is low. Air temperature controls how much moisture the air holds as a vapor. Extremely cold air can contain only very small amounts of water vapor. The result is low precipitation. Therefore, the region is classified as a desert—a desert of frozen land. Precipitation ranges from 13 centimeters (cm) at Barrow to 18 cm at Barter Island. Oliktok Point, adjacent to the proposed lease sale area, has an average of 18.8 cm per year. Most precipitation occurs during summer as rain. Average annual snowfall is only 12 inches along the coast (AEIDC 1975).

2. Temperature

The Arctic receives most of its heat energy during the short summer months. The decrease of heat energy in fall and winter is rapid at extreme northern latitudes. Areas of extensive cloud cover receive much less heat energy. The length of the day is also a factor, since longer days produce more radiation. The sun angle in the Arctic is low even during long days. As a result, the sun's rays pass through a greater depth of atmosphere which absorbs some of the energy before it reaches the surface. Although the Arctic Ocean and Beaufort Sea are frozen for 10 months of the year they have a modifying effect on coastal temperatures. February is the coldest month. The average minimum temperature is approximately -25° F along the coast. July is the warmest month with an average maximum temperature of 45° F (AEIDC 1975).

The freezing and thawing of tundra, watery marshes, and lakes affect all outdoor activity in the Arctic. Surface transportation in summer is limited to where gravel roads have been constructed. In winter when the tundra, marshes, and lakes freeze sufficiently, almost any kind of equipment can travel with little or no damage to the tundra (AEIDC 1975).

3. Winds

Surface wind conditions affect nearshore currents, the movement of ice floes and oil spills, and the formation and break-up of sea ice. Winds also influence the timing of migratory activity in animals, and the relative safety of subsistence harvesting and oil and gas activities in the Arctic (Kozo 1984). Surface wind speeds along the coast are persistent and strong compared to those in more interior regions. Arctic coastal wind speeds of 30 to 50 knots (kts) are common during winter months. The average annual wind speed is 10.6 kts. at Barrow and 11.5 kts at Barter Island (AEIDC 1975). A semi permanent area of high pressure is centered approximately 600 miles north of the Alaska Arctic coast. Air continually flows south from this area of higher pressure as a north wind. By the time it reaches the Beaufort sea coast its direction is between northeast and east because of the rotation of the earth (AEIDC, 1975). Wind direction is predominately easterly but shifts to westerly from January to April. Part of this shift is due to piling up of air against the Brooks Range. Sea breezes (air moving inland in response to unequal heating across the coastline) control at least 25 percent of the summer surface wind direction and extend to at least 20 kilometer (km) offshore III-A-3)(MMS 1996; Kozo 1984).

F. Oceanography, Sea Ice, and Permafrost

Life, both residential and migratory in the proposed lease sale area, is supported by the coastal habitat. The productivity and extent of coastal habitats are dependent on physical processes that shape and move the coast and barrier islands, and influence the circulation of marine waters. These coastal processes are driven by the changing seasons and the ever-present polar ice cap.

1. Oceanography

Marine waters overlying the proposed lease sale area are generally shallow; most of the area is within the 33-foot isobath. The continental shelf along Alaska's north coast is relatively narrow. The distance from the shore to the shelf break ranges from approximately 30 to 60 miles. Barrier Islands and shoals comprised of gravel or tundra lie within the area and include the Eskimo, Jones, Spy, Midway, McClure, Return, Stockton, and Maguire island chains as well as Thetis, Leavitt, Pingok, and Flaxman islands. Due to longshore drift (a prevailing current parallel to the coastline), some barrier islands are shifting westward at rates of 60 to 100 ft per year and landward 10 to 20 ft per year (MMS 1987).

Tides in the Beaufort Sea are very small with mean ranges from 10 to 30 centimeters. Summer and fall storms frequently generate storm surges along the coast. Sea level increase of one to three meters have been observed (MMS 1987, Vol. III). The rates of coastal erosion vary from year to year depending on the timing of sea ice breakup, the timing of summer and autumn storms, the composition of the coastal bluffs, beach width, and the morphology of the adjacent sea floor. Most erosion occurs in late summer and autumn. Annual coastal erosion rates range from approximately 10.3 m at Harrison Bay to 1.5 m at Flaxman Island. In some areas, like the Colville River Delta, the shoreline may be advancing (MMS 1996).

Sea temperatures are cold throughout the year, ranging from -1º to -2º C in winter under the ice to just above freezing in summer. Sea temperatures off all pack-ice zones are markedly cooler (AEIDC 1975).

Seasonal freezing and melting are the major influences affecting surface water characteristics in the arctic seas (AEIDC 1975). Nearshore Beaufort Sea waters are relatively warm, turbid, brackish, and shallow. This zone of brackish water is formed each spring when coastal plain rivers discharge warm freshwater into the Beaufort Sea. The width and depth of this zone varies depending on freshwater input, water currents, winds, and topography (Craig et al. 1985). The mixing of these water masses results in a great diversity and abundance of zooplankton; these zooplankton and arctic cod support large numbers and species of fish and wildlife within the proposed lease sale area.

The salinity of the Beaufort Sea varies both geographically and seasonally from 28 to 32 parts per thousand. The relatively warmer water of low salinity from large rivers affects the salinity in the vicinity of the deltas. Salinity is much higher in these areas in winter as river flow decreases or increases. Seawater samples from under the ice in spring show salinity values of 30 to 33 parts per thousand (ppt) in Harrison Bay and up to 40 ppt under the ice in the Colville River delta. Less saline waters exist behind barrier islands, in lagoons, and in river deltas. These estuarine type waters are enriched by terrestrial nutrients and support a productive biological community (AEIDC 1975).

Conversely, salinity for nearshore waters may be lower. During one summer, salinity for Mikkelsen Bay measured uniformly throughout the bay, and averaged between 16.9 and 23 ppt. During the 1994 study year, average salinity was lowered by 2 to 5 ppt after a rain storm. Historical data indicate that salinity levels, for example in Prudhoe Bay, vary considerably from year to year (Fechhelm and Griffiths 1990)

Sediments in the Beaufort Sea waters come from river runoff at spring breakup and the rains of late summer, coastal erosion, scour of the sea bottom by moving ice, and from freezing of bottom sediments into fast ice. The surficial sediments consist predominately of clay and silt-size particles underlain by ice-bonded sandy gravel in some areas (MMS 1996). The concentration and size of sediments vary greatly with local geological conditions and season. Largest sediment concentrations and coarsest sizes are carried during spring ice breakup and in severe storms. Coarse materials are often carried offshore by ice-rafting (AEIDC 1975).

The surface circulation of the Beaufort Sea is dominated by a clockwise gyre in the Arctic basin, centered midway between Alaska and the North Pole. This prevailing current moves both water and ice shoreward throughout most of the year. However, over short periods of time nearshore surface currents are extremely variable. In late summer and fall easterly and offshore winds produce surface currents countering the prevailing Arctic gyre. This results in a variable period of relatively ice-free waters (AEIDC 1975).

The speed, direction, and persistence of summer winds determine whether freshwater river runoff accumulates or dissipates in the nearshore Beaufort Sea. The temperature, turbidity, and salinity of nearshore waters are also influenced by the level of mixing of nearshore water with colder offshore water in the shallow bays and lagoons; a process driven by summer winds. The presence or absence of prevailing winds in a given year has been correlated with anadromous fish migration (into the proposed lease sale area) success in subsequent years (Griffiths et al. 1995). For more detail on the effects of coastal processes on Arctic fish, see Chapter Four.

2. Sea Ice

For nine months of the year, typically from November through July, marine waters are covered with ice. Within the proposed lease sale area, most ice is landfast ice which is anchored to shore and is relatively stable in comparison to the shear zone and pack ice further offshore. Landfast ice freezes to the bottom in shallow waters near land, and by the end of winter may extend outward to the 30- to 60-foot depth contour where it may reach a maximum thickness of about 6 ft (AEIDC 1975). Wind and water stresses during freeze-up and breakup may result in deformations that take the shape of pileups and rideups on the coastal and island beaches. These frequently extend up to 20 m inland from the shoreline (MMS 1996).

Seaward of the landfast ice is the shear zone or stamukhi. Shear zone ice forces are extremely dynamic and constantly produce open water ridges or leads that freeze and form new ice which in turn is deformed by pressure. The region of most intense ridging occurs in Beaufort Sea waters that are 15 to 45 m deep. As shear zone ice moves, it may gouge the sea bottom. The number and appearance of ice gouges depend on sediment type and age, the shape of the ice and depth of the water (AEIDC 1975; MMS 1996).

The pack ice zone lies beyond the shear zone and consists predominantly of multiyear ice floes from 6 to 12 ft thick that are constantly in motion. Multi-year ice is that which has survived more than one melt season. In summer they are surrounded by open water, thin ice or bits and fragments and in winter by first-year ice. The long-term ice movement is from east to west in response to the Beaufort Gyre. Often, the Beaufort Sea pack ice contains large ice floes or ice islands that originated from the Ellesmere Ice Shelf. They vary in size from a few thousand square yards to 300 square miles. When subjected to pack ice pressures in shallow waters, their keels extensively gouge the sea bottom (AEIDC 1975; MMS 1996).

3. Permafrost

Permafrost consists of any soil or other superficial deposit, including bedrock, that has been colder that 0º C for two or more years. Permafrost soils may be nearly ice free in coarse, unsaturated materials and may contain more than 50 percent water in finer grain saturated soils. Alaska has two types of permafrost classified as continuous or discontinuous. Continuous permafrost implies that the ground is frozen over nearly all the landscape and is colder than -5º C at the depth below annual seasonal temperature changes (depth varies based on rock type and water content but is about 15 m). Discontinuous permafrost is ground that is between 0º C and -5º C and as the term suggests, is not continuous. In discontinuous zones of permafrost, ground on south facing slopes and under large bodies of water are usually not frozen. Generally north of Atigun Pass (crest of the Brooks Range), the permafrost is continuous (Brown and Kreig 1983). Heading offshore the permafrost becomes progressively more discontinuous (MMS 1996).

Near Prudhoe Bay, permafrost extends to a depth of about 600 m which is the probable case for most all of the onshore portion of the proposed lease sale area (Brown and Kreig 1983) (DGGS 1994, citing to Collett and others 1989). The depth of the active layer, or the layer of seasonal thaw is generally less than 0.9 m and 1.8 m beneath active stream channels. Ice content varies from minor segregated ice to massive ice in the form of ice wedges and pingos. Offshore, a large area of permafrost occurs off the Sagavanirktok River and possibly near Harrison Bay. Other areas of offshore permafrost include the 2-meter isobath zone, which is overlain by bottomfast ice in the winter; areas between the barrier islands and the shoreline; and on some of the barrier islands. However, permafrost may exist in other isolated places offshore to depths several hundred meters beneath the seafloor (MMS 1996). It is generally accepted that permafrost does not extend offshore beyond the 90-meter isobath.

G. Geologic Hazards

The primary geologic hazards in or near the proposed lease sale area include faults and earthquakes; sea ice; ice gouging; ice movement; sub-sea permafrost; onshore permafrost, frozen ground, and Thermokarst; waves and erosion; coastal currents; flooding; overpressured sediments; unstable sediments; and shallow gas deposits and natural gas hydrates. These geologic hazards could impose constraints to exploration, production, and transportation activities associated with possible petroleum development, and should be considered before any siting, design, and construction of facilities.

1. Faults and Earthquakes

Surface faults[1] have been mapped throughout the Central Beaufort including high-angle faults, basement-involved[2] normal faults, listric growth faults[3], and north-dipping gravity faults[4]. Locally, two or more types may occur in close proximity to each other.

High-angle faults occur along the Barrow Arch extending into Harrison Bay. Along the Barrow Arch they are related to the basement tectonics of the Arctic Platform, while in Harrison Bay they offset the Tertiary and older units (Table 3.1). There has been little evidence of any Quaternary movement with no evidence of displacement in Pleistocene or Holocene sediments and there has been no recent seismicity associated with these faults. Thus, differential movement along these faults seems to have ended before the beginning of the Quaternary Period (DGGS 2008b, 2008 citing to Craig and Thrasher, 1982).

A number of shallow faults have been mapped north of the Arctic Platform. Included in these faults are the upper extensions of detached listric growth faults that exist deep in the Brookian section. These faults have been mapped in the greatest detail in the Camden Bay area where some of these faults may have been reactivated in the late Cenozoic and can have several tens of meters of offset. Shallow faults have also been mapped beneath the outer shelf, west of Cape Halkett and 15-50 km

[1] A fault is a surface or zone of rock fracture along which there has been displacement, from a few centimeters to a few kilometers in scale (American Geological Institute, Glossary of Geology, 1973).

[2] The term “basement” refers to the surface beneath which sedimentary rocks are not found (Encyclopedic Dictionary of Exploration Geophysics, 1991).

[3] A “listric” surface is a curvilinear, usually concave-upward surface of fracture that curves, at first gently and then more steeply, from a horizontal position. Listric surfaces form wedge-shaped masses, appearing to be thrust against or along each other (American Geological Institute, Glossary of Geology, 1973).

[4] A gravity fault is a normal fault in which movement is downward.

north of the proposed lease sale area, and are reported to show from 3 to 10 m of Quaternary offset (DGGS 2008b, 2008 citing to Grantz and others, 1983).

In contrast to the western Beaufort shelf off Alaska, the Camden Bay area is still seismically active. This region is located at the northern end of a north-northeast trending band of seismicity that extends north from east-central Alaska (DGGS 2008b citing to Biswas and Gedney, 1979). Since monitoring began in 1978, a large number of earthquakes, ranging from magnitude one to over five, have been recorded in this area, with the majority of events clustering along the axis of the Camden anticline[5]. The largest earthquake recorded in the area was a magnitude 5.3 event 30 km north of Barter Island in 1968. In this region, the Tertiary and Quaternary strata dip away from and are truncated at the top of the Camden anticline, indicating that it has been growing in recent geologic time. The faults in this region trend northwest-southeast, parallel to the hinge line[6] and as they approach and intersect the axis of the Camden anticline, they offset progressively younger strata. This suggests that these faults are older hinge line-related structures that were reactivated in late Tertiary and Quaternary by the uplift of the Camden anticline.

Table 3.1. Geologic time and formations.

Eras	Periods	Epochs	Began Approximate Number of Years Ago
Cenozoic	Quaternary	Holocene (Recent) Pleistocene (Glacial)	10,000 1.8 million
	Tertiary	Pliocene Miocene Oligocene Eocene Paleocene	5.3 million 23.8 million 33.7 million 54.8 million 65 million
Mesozoic	Cretaceous Jurassic Triassic	Early and Late Early, Middle and Late	144 million 206 million 248 million
Paleozoic	Permian Pennsylvanian Mississippian Devonian Silurian Ordovician Cambrian		290 million 323 million 354 million 417 million 443 million 490 million 543 million

Source: http://www.geosociety.org/science/timescale/timescl.htm (accessed November 2008).

[5] An "anticline" is a fold, the core of which contains the stratigraphically older rocks; it is convex upward. The opposite is called a syncline (American Geological Institute, Glossary of Geology, 1973).

[6] Generally, a hinge line refers to a line or boundary between a stable region and a region undergoing upward or downward movement (American Geological Institute, Glossary of Geology, 1973).

On the outer Beaufort shelf and upper slope, seaward of the 50-65 m isobaths, are gravity faults that are related to large rotational slump blocks[7] (DGGS 2008b citing to Grantz and Dinter, 1980; Grantz and others, 1982b). South of these slumps, which bound the seaward edge of the Beaufort Ramp, these faults have surface offsets ranging from 15 m to as high as 70 m (DGGS 2008b citing to Grantz and others, 1982b). Grantz and others (1982b) have inferred that these faults have been active in recent geologic time on the basis of the age of the faults and therefore pose a hazard to bottom-founded structures in this area. Large-scale gravity slumping of the blocks here could be triggered by shallow-focus earthquakes centered in Camden Bay or in the Brooks Range.

Throughout the region approximately 59 earthquakes of magnitude 4 and larger have been recorded between January 1968 and July 2008 (Map 3.1). Most of the seismicity in the region is shallow (less than 30 km deep), indicating near-surface faulting.

Wesson and others estimate a 10 percent probability of exceeding 0.07 g[8] earthquake-generated peak ground acceleration in bedrock during a 50-year period in the proposed lease sale area (DGGS 2008b citing to Wesson and others2007). For comparison, peak ground acceleration in Anchorage during the great 1964 earthquake was estimated at 0.16 g (DGGS 2008b, citing to Algemissen and others, 1991). In areas throughout the area underlain by thick, soft sediments, ground accelerations are likely to be higher than in bedrock due to amplification. However, thick localized permafrost may cause the earthquake response of sediments to be more like bedrock, which would limit amplification effects and would also tend to prevent earthquake-induced ground failure, such as liquefaction. Because of the periodic presence of sea ice along the Beaufort Sea Coast, consideration should be given to the combined effects of sea ice–earthquake interactions on any potential infrastructure in this region. Kato and Toyama suggest that earthquake load may be magnified by ice-structure interaction during a seismic event (DGGS 2008b, citing to Kato and Toyama 2004).

The USGS (U.S. Geological Survey) has a series of seismic hazard maps for Alaska, which are available on the USGS website at http://earthquake.usgs.gov/research/hazmaps/ . These maps depict earthquake hazard by showing, with contour values, the earthquake ground motions that have a given probability of being exceeded in 50 years. The ground motions being considered at a given location are those from all future possible earthquake magnitudes at all possible distances from that location. The ground motion coming from a particular magnitude and distance is assigned a probability based on the annual probability of occurrence of the causative magnitude and distance from the source. The method is based on historical earthquake occurrences and geological information on the recurrence rate of fault ruptures. To prepare these maps, the USGS analyzed all known seismic sources (surface faults, subduction zone and volcanic sources). Included in the computations are all historical and instrumental recordings of ground motions, gathered using a grid of 1-km^2 polygons. It is therefore possible to see the probabilistic ground motion for any location. The USGS seismic hazard maps are incorporated into the International Building Code for establishing the seismic design values for a selected location.

2. Sea Ice

The Beaufort Shelf is covered with ice most of the year, with a typical ice-free period during August and September only. The sea ice first forms in late September to early October and becomes continuous nearshore by mid-October. This ice will remain through the winter and start breaking up in July. It is not until early August that the nearshore region is largely ice free (DGGS 2008b, citing to Barry 1979). In recent years, breakup occurred earlier with a difference of 6 and 21 days along the

[7] A "slump block" is the mass of material torn away as a coherent unit during a block slump. The rotation refers to the apparent fault-block displacement in which the blocks have rotated relative to one another, so that alignment of formerly parallel features is disturbed (American Geological Institute, Glossary of Geology, 1973).

[8] Gravitational acceleration. One g equals an acceleration rate of 9.806 m per second per second.

Chukchi and Beaufort Sea coasts, respectively. Ice-free coastlines now occur over a month earlier along the Beaufort Sea coast (DGGS 2008b, citing to Mahoney, et al. 2007). During the winter months, the offshore ice can be divided into three main zones: the landfast zone, the shear zone (or Stamukhi zone), and the pack ice zone (DGGS 2008b, citing to Reimnitz and Barnes 1974). The landfast ice forms along the shore and develops seaward in the early fall. Small movements of this ice can be related to storm fronts which cause narrow leads and rubble fields in this zone. In late winter, the fast ice can extend out to the 25-meter to 30-meter isobath.

The shear zone, or Stamukhi zone, is between the landfast ice and the pack ice zone. It is a transition zone between the relatively stationary landfast ice and the highly mobile pack ice. Fragments of seasonal ice, multi-year ice and ice ridges up to tens of meters high exist in this zone. It is here where there is an intense interaction between the ice and the seabed, where the ice can gouge the seabed to depths of several meters (DGGS 2008b, citing to Reimnitz and Barnes 1974).

The pack ice zone, seaward of the Stamukhi zone, is the shoreward edge of the permanent polar ice cap. It consists of multi-year ice, ice ridges, and ice island fragments that migrate westward in response to the clockwise circumpolar gyre (DGGS 2008b, citing to Reimnitz and Barnes 1974). During summer, the ice can move up to 20 km/day. Summer pack ice usually occurs tens to hundreds of kilometers offshore and so will not affect the proposed lease sale area.

The National Ice Center currently monitors, analyzes, publishes current conditions and forecasts the ice conditions along the Beaufort coastline. They use visual, infrared, passive microwave and Synthetic Aperture Radar imagery, as well as ship reports and aerial reconnaissance to produce these data (DGGS 2008b, citing to Andrews and Benner 1996). Since the central Beaufort is characterized by significant, rapid changes in ice conditions, mathematical modeling of the evolution of the sea ice cover has been developed to help predict the ice conditions more precisely. By using these data it is possible to determine different ice characteristics such as: ice concentration, thickness distribution, edge configuration, drift velocity, zones of divergence and compacting, distribution of ice floe sizes, and their strength and motion (DGGS 2008b, citing to Appel 1996).

A massive iceberg or ice island could present a danger to structures beyond state territorial waters where depths are great enough to allow for large ice masses to approach the coastal zone. Ice islands are produced by the break-up of portions of the Ellesmere Ice Shelf and are the tabular icebergs of the Arctic Ocean. They are usually 40 to 50 m thick with lateral dimensions that range from tens of meters to tens of kilometers. If an ice island became imbedded in the arctic ice pack and hit an offshore production facility, the facility would likely be destroyed. This geologic hazard poses no threat to exploration or development in the proposed lease sale area because of the shallow water depth.

Sea ice poses a potential hazard to offshore and coastal structures if they are not properly designed; a concrete island drilling structure could be pushed off location, ice could override a fixed structure, or a marine pipeline could be damaged where it comes ashore. Facilities exposed to the potential risks of each sea ice zone must be designed to accommodate ice forces.

Structures exposed to ice forces are fortified with sheet piling, concrete armor, and large bags filled with dense material placed in the path of moving sheets of ice. Existing steel and concrete island drilling structures placed in multi-year ice are durable and can accommodate closely spaced well designs. Gravel islands are designed with 10:1 slopes above sea level, and 5:1 slopes as deep as 20 ft below sea level. They are also constructed with a sheet pile retaining ring. Slopes are protected by fabricated blocks and filter fabric anchored to sheet pile.

All offshore structures in state waters must be bottom-founded (NSBMC 19.70.040(A) (NSB 2008), which considerably reduces the risk of damage to oil and gas facilities from sea ice movements. Exploratory drilling in winter is conducted with ice pads frozen to the sea bottom. This method of exploratory drilling is expected to be used throughout the proposed lease sale area. Most of the area, and the entire region shoreward of the barrier islands, are seasonally covered by stable fast ice, generally ridge free. Thus, the risk of damage to facilities is reasonably predictable, and can be accounted for in the design. Sea ice remains stable throughout the drilling period. However, severe winter storms, such as one in November 1978, have been known to break-up landfast ice and create large pressure ridges (DGGS 2008b, citing to Thomas 1984:447). Therefore, contingency plans must be in place to demobilize a drill rig in a short period of time if weather becomes adverse.

All operations must comply with NSB municipal Code offshore development policies (NSBMC 19.70.040) (NSB 2008) which include measures to prevent an uncontrolled release of oil. Drilling below threshold depth must be conducted during winter (November 1 through April 15) and be completed as early in this period as practicable (NSBMC 19.70.040(C) (NSB 2008) to minimize the risk of an oil spill caused by ice movements.

NSB municipal code requires plans for offshore drilling activities to include a relief well drilling plan and an emergency countermeasures plan. The emergency countermeasures plan must identify the steps that will be taken to protect human life and minimize environmental damage in the event of loss of a drilling rig; ice override; or loss or disablement of support craft or other transportation systems (NSBMC 19.70.050(I)(6)(NSB 2008).

“Offshore structures must be able to withstand geological hazards and forces which may occur while at the drill site. Design criteria must be based on actual measurements or conservative estimates of geological forces. In addition, structures must have monitoring programs and safety systems capable of securing wells in case unexpected geophysical hazards or forces are encountered” (NSBMC 19.70.050(I)(2) and NSBCMP Policy 2.4.4(b)(NSB 2008).

3. Ice Gouging

Nearshore areas of the Beaufort Sea bed can potentially come in direct contact with icebergs, potentially resulting in ice gouging of the seafloor and infrastructure damage. Based in part on a USGS study in the mid 1980’s suggest that ice gouge characteristics (density, depth and width) are related to water depth and shelf bottom morphology (DGGS 2008b, citing to Rearick and Ticken1988). Density, width and depth of ice gouges tend to increase with increasing water depth away from shore, attaining their maximum values in the Stamukhi zone, generally between the 18-meter and 30 meter isobaths, and then decreasing toward the shelf edge. Ice gouging is primarily active at mid-shelf and inner-shelf water depths although gouges can be found across the entire shelf. On the mid-shelf, ice ridges can scour the seafloor to depths of several meters. Reimnitz and Barnes found gouges as deep as 5.5 m, with ridges up to 2.7 m high just west of the proposed lease sale area in Smith Bay (DGGS 2008b, citing to Reimnitz and Barnes 1974). Barnes has measured the average ice gouge on the Beaufort shelf at 50 cm deep, ridges 40 cm high, and 7.5 m wide. Ice gouges have been found to range between 1 and 10 m of relief (DGGS 2008b, citing to Barnes 1981).

At water depths less than 18 m, inshore of the Stamukhi zone, the ice gouging is much less severe. In this region, any ice gouges which form are rapidly buried by sand waves or sediment sheets. Since the nearshore sediments tend to be coarser grained than those farther offshore, any ice gouges in this region will degrade more rapidly than in the more cohesive, fine-grained sediments farther offshore (DGGS 2008b, citing to Barnes and Reimnitz 1979).

As the water depth increases offshore of the Stamukhi zone, the number of ice keels large enough to reach the bottom decreases, although ice gouges have been reported in water as deep as 58 m. Closer to the outer shelf edge, strong geostrophic currents exist which smooth the older ice gouges by eroding and filling them (DGGS 2008b, citing to Reimnitz and others, 1982).

Shoals and islands often show little or no evidence of ice gouging on their down-drift side with the highest intensity of gouging occurring on the up-drift side (DGGS 2008b, citing to Reimnitz and others, 1982; Rearic and Ticken 1988). In the Prudhoe Bay area, there is very little ice gouging due to the location of the barrier islands, while in Harrison Bay, where there are no barrier islands, high-intensity ice gouging occurs.

In general, the ice gouges throughout the central Beaufort shelf are oriented east-west, although they vary considerably more on the inner shelf where the shoals and other bottom features can deflect the ice. This east-west orientation reflects the directions of the surface current as well as the prevailing wind throughout the region.

Ice gouging poses little hazard to offshore exploration or production structures but does pose a significant risk to oil and gas transportation, particularly sub-sea pipelines (DGGS 2008b, citing to Younan 2007). Potential for damage to pipelines and offshore facilities depends on structural configuration; structural resistance of the pipe as well as the physical dimensions of and frequency of gouges (DGGS 2008b, citing to McKenna and others, 2003). Pipelines should be trenched deep beneath the deepest predicted scour depth, and covered with protective material. This could constitute backfill of in-situ or other material. Protective armament at all locations is not necessarily warranted, but could be a site-specific requirement. Additionally, pipelines should be designed to withstand both the horizontal and vertical forces associated with the gouging process which may cause significant soil displacement (DGGS 2008b, citing to McKenna 2003).

4. Ice Movement

Ice movement (ice ride-up and override) can result from wind, current, waves or temperature changes. Continuous, large scale ice movements are caused by major current systems (e.g., the Beaufort Gyre in the Arctic Ocean), tidal currents, or geostrophic winds. Major contributions to local, short term movements are wind, wave, and current action during storms. Ice movements during a single ice season create zones of landfast and pack ice. Zone boundaries are not static, but change with seasonal ice growth and movement. Ice movements at a given site may have a predominant direction due to geography and environmental conditions (DGGS 2008b, citing to API 1995).

Throughout the Beaufort Sea, both ice ride-up and ice override can transport and erode significant amounts of sediment. Ice ride-up is the process whereby ice blocks are forced onshore by strong wind or currents and push the sediment from the coast into the ridges farther inland. It is most important on the outer barrier islands where ice ride-up ridges up to 2.5 m high, extending 100 m inshore from the beach have been identified (DGGS 2008b, citing to Hopkins and Hartz 1978). Over most of the Arctic coast, ice ride-up rubble is found at least 20 m inland with boulders in excess of 1.5 m in diameter (DGGS 2008b, citing to Kovacs 1984). A number of accounts of ice ride-up events have been documented where man-made structures have been damaged along the Beaufort coast. In January of 1984, ice over-topped the Kadluck, an 8 m-high caisson-retained drilling island located in Mackenzie Bay (DGGS 2008b, citing to Kovacs 1984). Ice ride-up has the potential to alter shorelines and nearshore bathymetry, which in the longer term may pose a threat to nearshore facilities with increased erosion.

Ice override can occur offshore or onshore. Ice can override itself, rafted ice, or can override the coastline and ride-up onto a shore. Ice override onshore will add an additional dead load (ice on top of a buried pipeline) to a buried pipeline in the transition area from offshore to onshore beginning where the ice contacts the sea floor. This dead load, along with the force being exerted by the ice and the strength of soil, should be considered in pipeline design (DGGS 2008b, citing to Rice 1999; Younan 2007).

5. Sub-Sea Permafrost

Numerous refraction, borehole and conductivity surveys indicate that permafrost is widespread beneath the Beaufort inner shelf. A number of seismic refraction surveys have been run (DGGS 2008b, citing to Rogers and Morack ,1981, Neave and Sellmann, 1983, and Morack and others, 1983). Additional data have been obtained from boreholes (DGGS 2008b, citing to Harding-Lawson 1979) and thermal probes (DGGS 2008b, citing to Hopkins and Hartz 1978b; Rogers and Morack 1981; Harrison and Osterkamp 1981). The depth to the surface of the subsea permafrost is highly variable, which reflects the varying degrees of ice-bonding before the Holocene marine transgression as well as the degree of subsequent thawing due to the advection of saline groundwater. A study in the Laptev Sea region, (DGGS 2008b, citing to Grigoriev and Rachold 2005) concludes that evolution of upper layers of sub-sea permafrost depends on near bottom water temperature and salinity, coastal retreat rate (or accumulation/accretion rate), bathymetric features and shoreline inclination, general coastal morphology and shoreline configuration, coastal and shore-face sediment composition, ice content of deposits submerged below sea level, and near-shore hydrodynamics and sea ice regime.

The Beaufort shelf has been subaerially exposed to the Arctic climate during several Pleistocene lowstands of sea level followed by subsequent highstands (DGGS 2008b, citing to Wang and others, 1982). During these episodes, the permafrost formed to depths of several hundred meters during the lowstands followed by highstand periods where it was partially melted by saline advection from the seawater into the underlying sediment and by geothermal heating. In a study by Harding-Lawson (DGGS 2008b, citing to Harding Lawson 1979), boreholes encountered ice at depths shallower than 9 m to more than 30 m over a distance of less than 12 km. Hopkins and Hartz estimate that well-bonded permafrost (permafrost having a greater ice crystal matrix) will form in a subaerial Arctic environment in only 40 to 50 years (DGGS 2008b, citing to Hopkins and Hartz 1978a).

Permafrost can therefore be expected to occur in the core of some of the barrier islands and artificial islands. On Reindeer Island, the Humble Oil C-1 well encountered two layers of permafrost at depths of 0 to 18.9 m and 91 to 128 m. The shallower layer may have formed under modern Arctic conditions while the deeper layer was probably formed during the Pleistocene (DGGS 2008b, citing to Sellmann and Chamberlain 1979).

Sub-sea permafrost can pose a hazard to bottom-founded drilling structures via thaw and subsidence, if its presence is not considered in design and construction. Geophysical data acquired before development can reveal the presence and distribution of sub-sea permafrost. Structures placed on top of permafrost must be designed to prevent heat loss into the substrate. The presence of sub-sea permafrost is a major consideration in the siting and design of sub-sea pipelines. The effect of heat loss to the surrounding substrate can be minimized by trenching and backfilling along the pipeline corridor, and by insulating the pipe. Chilling the oil or gas in pipelines may also reduce the potential effects posed by the presence of sub-sea permafrost.

6. Onshore Permafrost, Frozen Ground, and Thermokarst

Permafrost exists throughout most of the onshore portion of the sale and is, for the most part, overlain by an active layer[9] of unconsolidated sediment. The thickness of permafrost has been measured from numerous onshore wells indicating that it thins from east to west. East of Oliktok Point, it has been measured to be 500 m thick, whereas west of the Colville River it has been measured to be 300 to 400 m thick (DGGS 2008b, citing to Osterkamp and Payne 1981). The depth of seasonal thaw is generally less than 1 m below the surface and 2 m beneath most active stream

[9] An “active layer” refers to a surface layer of ground or soil above permafrost that is alternately frozen each winter and completely thawed each summer. It represents the seasonally frozen ground (American Geological Institute, Glossary of Geology, 1972).

channels and is dependent on site-specific hydrological and geotechnical water crossing conditions. Borings along the Colville River, for example, show it remains thawed year-round. The ice content varies throughout the region from segregated ice to massive ice in the form of wedges and pingos, and is the highest in the fine-grained, organic-rich deposits and the lowest in the coarse granular deposits and bedrock (DGGS 2008b, citing to Collett and others, 1989).

Ground settlement, due to thawing, occurs whenever a heated structure is placed on ground underlain by shallow, ice-rich permafrost, and proper engineering measures are not taken to adequately support the structure and prevent the structure's heat from melting the ground ice. Settlement is a function of the original thickness of the active layer, the increase in the active layer as it adjusts to the surface disturbance and the thaw strain of the underlying permafrost. In general the magnitude of settlement depends on the nature and abundance of ice and the severity of the disturbance. The potential for thaw settlement is least in areas of active river deposits and eolian sand and can be greater than 1 meter in areas of alluvial marine deposits (DGGS 2008b, citing to Pullman and others, 2007).

In addition to settlement, seasonal freeze-thaw processes will cause frost jacking of nonheated structures placed on any frost-susceptible soils unless the structures are firmly anchored into the frozen ground with pilings or supported by non-frost-susceptible fill (DGGS 2008b, citing to Combellick 1994). The frost susceptibility of the ground is highest in fine-grained alluvium, colluvium, thaw-lake deposits, and coastal-plain silts and sands; moderate in alluvial-fan deposits and till; and lowest in coarse-grained flood-plain deposits, alluvial terrace deposits and gravely bedrock (DGGS 2008b, citing to Carter and others, 1986; Ferrians, 1971; Yeend, 1973a, b). Thermokarst is caused by the disturbance or removal of vegetation resulting in local melting of ground ice. This causes development of uneven topography in the form of mounds and sink holes. Even small disturbances such as a vehicle driven across the tundra can create thermokarst features. In the past off-road and seismic trail disturbances associated with oil development activities have led to the development of thermokarst (DGGS 2008b, citing to Pullman and others, 2007).This can be mitigated through seasonal and area restrictions on vehicles.

Increased thawing of permafrost is commonly initiated by both natural (forest fire, floods, and erosion) and manmade ground disturbances (DGGS 2008b, citing to Richter-Menge et al. 2006). Surface response to permafrost melting is not uniform and is related to the interactions of slope position, soil texture, hydrology and vegetation over time. Arctic lowland areas are particularly at risk for thaw subsidence because of the high volume of ground ice at the top of the permafrost (DGGS 2008b, citing to Jorgenson and others, 2008).

Other potential impacts from thawing permafrost include liquefaction and the development of slides, flows, slumps and increased erosion along rivers and coasts (DGGS 2008b, citing to Nelson and others, 2001; Hobson 2006; ACIA 2006). Additionally, Lilly and others suggest that changes in the distribution of ice in soil pore space can impact sediment strength on both seasonal and long term scales. Generally, soil strength is greater during the winter when soil water is frozen than during summer months when melting occurs (DGGS 2008b, citing to Lilly and others, 2008).

Many geologic processes in areas of permafrost and seasonally frozen ground are related to seasonal and long term variability of climate, and long-term records indicate that permafrost temperatures at the depth of zero seasonal temperature variations in permafrost (20 m) are warming on the North Slope (DGGS 2008b, citing to Richter-Menge et al. 2006; Pavlov and Malkova 2008). Ground subsidence, increased erosion, change in the hydrologic regime, and the other potential impacts of permafrost degradation described above will negatively impact infrastructure as climate warms unless new mitigation techniques are adopted (Report of the Alaska Regional Assessment Group, 1999). As a result, continued monitoring of permafrost stability, including water content and temperature variability of soils, and continued assessment of mitigation techniques are necessary. Frozen-ground problems can be successfully mitigated through proper siting, design, and

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Erosion along the coastline of Barrow.

construction, as demonstrated at Prudhoe Bay and elsewhere. Structures such as drill rigs and permanent processing facilities should be insulated to prevent heat loss into the substrate. Pipelines can be trenched, back-filled, and chilled (if buried) or elevated to prevent undesirable thawing of permafrost. In addition, ADNR regulates winter travel across the tundra and authorizes travel only after determining that the tundra is sufficiently frozen and protected by ample snow cover so that the travel will not have major environmental effects such as permafrost degradation (DGGS 2008b, citing to Bader and Guimond 2004).

7. Waves and Erosion

Wave heights along the Beaufort coastline are low throughout most of the year because of the short fetch resulting from the pervasive ice cover. However, in the fall open-water season, a considerable fetch can develop both seaward and shoreward of the barrier islands. During this time, storm waves can reach up to 7 to 9 m when the fetch is equal to 800 km and can become effective erosive agents both onshore and along the exposed faces of the barrier islands (DGGS 2008b, citing to Appel 1996). Also, wind-induced storm surges can force the ice and water onshore and can raise sea level as much as 3 m, with an additional meter added to this due to low atmospheric pressures associated with the storms (DGGS 2008b, citing to Barnes and Reimnitz 1974). During the most extreme surges, the coastal islands can become completely flooded, and major changes in the size and shape of these islands can occur during a very short time period (DGGS 2008b, citing to Reimnitz and Maurer 1978b).

Even with the short open-water season along the Beaufort coastline, the wave action, in combination with melting of coastal permafrost and gravity induced mechanisms, can cause dramatic rates of coastal erosion (DGGS 2008b, citing to Walker 1988; Hoque and Pollard 2008; Aguirre and others, 2008). The highest rates of erosion occur along coastal promontories where the bluffs are composed of fine-grained sediments and ice lenses, and where thermal erosion, a dynamic process involving the wearing away by thermal means (melting ice) and by mechanical means (hydraulic transport), are the dominant processes. In some areas, beaches have been formed from the gravel eroded from bluffs composed of coarse-grained deposits and act to partially protect those bluffs from further wave action. In other areas, where the bluffs are composed of fine sediment, the sand eroded from the bluffs does not form protective beaches and the bluffs erode more rapidly. In the Harrison Bay area, where the bluffs are composed primarily of coarser-grained sediments, the average retreat rates are between 1.5 and 2.5 meters per year (DGGS 2008b, citing to Craig et al. 1985).

Average rates of erosion across the Beaufort coastline range from 1.5 to 4.7 meters per year, although short term rates can be higher. In one case, near Oliktok Point, the coastline eroded 11 meters during one two-week period (DGGS 2008b, citing to Hopkins and Hartz 1978a). West of Harrison Bay, erosion occurred at a rate of 1.08 kilometers per year during the period 1985-2005, compared to 0.48 kilometers per year from 1955-1985. In this area, removal of offshore islands and spits left coastal bluffs exposed to direct wave impact. Thermokarst lakes along the coast were subsequently breached, leading to accelerated rates of erosion (DGGS 2008b, citing to Mars and Houseknecht 2007).

The only prograding (advancing) shoreline areas along the Beaufort coastline occur off the deltas of major rivers. In those areas, the rate of progradation is very slow. The progradation rate of the Colville River delta was estimated to be 0.4 meters per year (DGGS 2008b, citing to Reimnitz et al. 1985).

Factors influencing erosion along the North Slope coastline also affect erosion along the region's rivers, although the driving forces (currents, waves with a short fetch) are somewhat different. Sediment cohesiveness, influenced by the degree and depth of seasonal frost, and permafrost, are important factors in determining river bank erodibility (DGGS 2008b, citing to Veldman and Ferrell 2002).High erosion rates occur along braided channels, which usually develop in areas composed of noncohesive sediment (DGGS 2008b, citing to Scott 1978). In a study along the Sagavanirktok River, aerial photographs showed a maximum erosion rate of 4.5 meters per year during a 20-year period. In this area, most of the erosion appeared to occur in small increments during breakup flooding and was concentrated in specific areas where conditions were favorable for thermo-erosional niching (DGGS 2008b, citing to Combellick 1994).

Erosion rates, river bank and shoreline stability, and the potential impacts of waves and storm surge must all be considered in determining facility siting, design, construction, and operation especially with recent studies indicating that the extent of seasonal ice-free seas in the arctic has been increasing and could potentially result in increased rates of erosion along Arctic coastlines (DGGS 2008b, citing to Aguirre and others, 2008; Mahoney and others, 2007) Facility siting, design, construction and operation must also be considered in determining the optimum oil and gas transportation mode. Structural failure can be avoided by proper facility setbacks from coasts and river banks. Docks and road or pipeline crossings can be fortified with concrete armor, and by placing retainer blocks and concrete-filled bags in areas subject to high erosion rates, such as at the Endicott causeway breaches.

8. Coastal Currents

Marine currents along the central Beaufort shelf are primarily wind driven and are strongly regulated by the presence or absence of ice. Sediment is transported by these currents along the barrier islands and the coastal promontories, although, due to the short open-water season, the annual rate of longshore sediment transport is relatively low. The currents along the inner shelf generally flow to the west in response to the prevailing northeast wind, with current reversals occurring close to shore during storms. Further from the shoreline, on the open shelf, the currents average between 7 and 10 cm/sec (DGGS 2008b, citing to Matthews 1981). During storms, east-flowing currents have been measured with velocities of up to 95 cm/sec, although typical storm current velocities are an order of magnitude lower (DGGS 2008b, citing to Kozo 1981). Under the ice, in the winter, the currents are usually less than 2 cm/sec, although some currents have been measured at up to 25 cm/sec in areas around grounded ice blocks (DGGS 2008b, citing to Matthews 1981).

Geostrophic currents can occur north of the proposed lease sale area on the outer shelf, flowing parallel to the shelf-slope break. These currents have been measured at up to 50 cm/sec and can occur in both easterly and westerly directions (DGGS 2008b, citing to Craig and others, 1985). Since the tidal range on the central Beaufort shelf is small, approximately 15 to 30 cm, the tidal currents exert only minor influences on the sedimentary regime (DGGS 2008b, citing to Matthews 1981). When the water flow on the shelf is restricted by bottomfast ice, these currents can act as important scouring agents (DGGS 2008b, citing to Reimnitz and Kempema 1982b).

Offshore structures are designed to withstand variable marine currents in the Beaufort Sea. Additionally, all drilling structures are bottom founded and fortified to counteract any current-induced scouring. Artificial or natural gravel islands must be fortified and built to withstand coastal currents as well as the forces of moving sea ice for the life span of the producing field. To this end, they may require periodic maintenance in response to heavy storms.

9. Flooding

Floods occur annually along most of the rivers and many of the adjacent low terraces due to seasonal snowmelt and ice jams (DGGS 2008b, citing to Rawlinson 1993; Walker and Hudson 2003). Spring ice breakup on rivers in the region often occurs over the first few days of a three-week period of flooding in late May through early June. Up to 80 percent of the flow occurs during this period (DGGS 2008b, citing to Walker 1973). The geologic impact of flooding is in large part related to the magnitude and timing of seasonal ice breakup. The formation of ice jams is especially associated with catastrophic flooding (DGGS 2008b, citing to Walker and Hudson 2003). Some of the most damaging floods are associated with an above-average snowpack that is melted by rainstorms and sudden warming.

During flooding, small changes in river flow can be caused by changes in sediment bars. Consequently, areas of significant bank erosion can be variable. The amount of erosion depends on factors such as sediment character, amount of water and its level with respect to the river bank (DGGS 2008b, citing to Veldman and Ferrell 2002). Ice carried along by rivers can also produce significant erosion, especially if breakup occurs during lowering river stage, allowing the ice to erode stream banks (DGGS 2008b, citing to Walker and Hudson 2003).

Spring floodwaters inundate large areas of the deltas, and on reaching the coast spread over stable ground and floating ice up to 30 km from shore (DGGS 2008b, citing to Arnborg et al. 1967; Barnes et al. 1988; Reimnitz et al. 1974; Walker 1974). When floodwater reaches openings in the ice often associated with tidal cracks, thermal cracks and seal breathing holes), it rushes through with enough force to scour the bottom to depths of several meters by a process called strudel scouring (DGGS 2008b, citing to Reimnitz and others, 1974; Leidersdorf and others, 2001; Reimnitz 2002).

Along the Beaufort shelf, strudel scour craters have formed up to 6 m deep and 20 m across, as mapped by shallow bathymetric surveys and scuba diving observations (DGGS 2008b citing to Reimnitz and others, 1974). In a study for the Northstar Pipeline, strudel scours were found in water depths of 2.2-5.4 meters with the greatest scour occurring at depths of 3-4 meters (DGGS 2008b, citing to Leidersdorf and others, 2001). Sheltered coastal areas and bays adjacent to major rivers such as the Colville, Sagavanirktok, and Canning are particularly susceptible to this type of scouring. In these areas deltas can be totally reworked by strudel scouring in several thousand years, although the scours can be infilled very rapidly (DGGS 2008b, citing to Reimnitz 2002; Reimnitz and Kempema 1982a). Areas of strudel scour that have been measured along the Beaufort shelf are shown in Map 3.2.

Strudel scouring has the potential to undermine substrate upon which a nearshore structure is placed, such as an artificial island placed in a river mouth or delta. It is unlikely that such a structure would be permitted as it may violate NSBCMP Best Effort Policies regarding alteration of shoreline dynamics by mining, and placing of structures subject to a 50-year recurrence level (NSBCMP 2.4.5(i) and (j) (NSB 2008).

In addition to seasonal flooding, many rivers along the coast are subject to seasonal icing before spring thaw. This is due to overflow of the stream or groundwater under pressure, often where frozen or impermeable bed sections force the winter flow to the surface to freeze in a series of thin overflows, or where spring-fed tributaries overflow wide braided rivers (DGGS 2008b citing to Veldman and Ferrell, 2002). In areas of repeated overflow, residual ice sheets often become thick enough to extend beyond the flood-plain margin. These large overflows and residual ice sheets have been documented on the Sagavanirktok, Shaviovik, Kavik, and Canning Rivers (DGGS 2008b citing to Dean, 1984; Combellick, 1994).

Storm surges along the Beaufort coast frequently occur in the summer and fall. Sea level increases of 1 to 3 m have been observed, with the largest increases occurring on westward-facing shores. Storm surges can also occur from December through February, although sea level elevation changes are generally less than in summer and fall. Winter storm surges of as much as 1.4 m amplitude have been recorded for the period of complete ice cover in the Beaufort Sea (DGGS 2008b citing to Reimnitz, 2002). Decreases in the elevation of sea level can occur, and these occur more frequently during the winter months.

Seasonal flooding of lowlands and river channels is extensive along major rivers that drain into the proposed lease sale area. Thus, measures must be taken before facility construction and field development to prevent losses and environmental damage. Pre-development planning should include hydrologic and hydraulic surveys of spring break-up activity as well as flood-frequency analyses. Data should be collected on water levels, ice floe direction and thickness, discharge volume and velocity, and suspended and bedload sediment measurements for analysis. Also, historical flooding observations should be incorporated into a geologic hazard risk assessment. All inactive channels of a river must be analyzed for their potential for reflooding. Containment dikes and berms may be necessary to reduce the risk of flood waters that may undermine facility integrity.

10. Overpressured Sediments

Along the central Beaufort region, extremely high pore pressures can be expected to be found where Cenozoic strata (sedimentary layers) are very thick, such as in the Kaktovik, Camden, and Nuwuk Basins. Onshore, in the Camden Basin, high pore pressures have been measured in both the Tertiary and Cretaceous formations where the burial depths of the Tertiary strata exceeded 3 km (DGGS 2008b citing to Craig and others, 1985).

In the Point Thomson area, the pore pressure gradients were measured as high as 0.8 pounds per square inch per foot (psi/ft) in sediments at burial depths of 4 km. In this area a pore pressure gradient of 0.433 psi/ft is considered normal (DGGS 2008b citing to Hawkings and others, 1976). High pore pressures have also been measured throughout the Cenozoic strata of the Mackenzie Delta in the Canadian Beaufort. Here, the pore-pressure gradients were measured as high as 0.76 psi/ft and have been observed at depths as shallow as 1.9 km (DGGS 2008b citing to Hawkings and others, 1976).

Drilling mud in the well-bore is mixed to a specific density that will equal or slightly exceed the pressure in the formation. When formation pressures exceed the weight of the drill mud in the wellbore, the result can be a kick[10] or blow-out. Thus, encountering over-pressured sediments while drilling can result in a blow-out or uncontrolled flow. The risk of a blow-out is reduced by identifying locations of overpressured sediments via seismic data analysis, and then adjusting the mud mixture accordingly as the well is drilled. If a kick occurs, secondary well control methods are employed. The well is shut-in using the blow-out prevention (BOP) equipment installed on the wellhead after surface casing is set. The BOP equipment closes off and contains fluid pressures in the annulus and the drillpipe. BOP equipment is required for all wells and surface and sub-surface safety valves are required to automatically shut off flow to the surface.

11. Unstable Sediments

The distribution of unconsolidated sediments on the central Beaufort is greatly affected by the density of ice gouging, wave and current activity, and the composition of sediment delivered from rivers and coastal bluffs. The ability of these sediments to support the weight of bottom-founded structures and to resist sliding when sea ice interacts with the structure can vary greatly. The sediments consist predominantly of coarser grained material (sand and gravel sized particles) in nearshore areas, near offshore barrier islands and on shoals and along the shelf break. Further offshore, at depths of 20 m and greater, the sediments consist primarily of mud (clay and silt sized particles) (DGGS 2008b citing to Craig and others, 1985).

Overconsolidated surface sediments are widespread on the Beaufort shelf (Map 3.3)(DGGS 2008b, citing to Chamberlain 1978; Reimnitz and others, 1982; Watt 1984). This type of sediment is one that is consolidated beyond what is expected from the present overburden pressure, and is produced by freeze-thaw action (DGGS 2008b, citing to Chamberlain 1978) and compaction by ice gouging (DGGS 2008b citing to Reimnitz and others, 1980). The freeze-thaw action requires the sediment be frozen after deposition, which for the central Beaufort has been measured at depths greater than 1 to 2 m (DGGS 2008b, citing to Hunter and Hobson 1974).

Unstable sediments can move unexpectedly and pose a risk to improperly sited and constructed facilities. Shallow seismic data can reveal some information about the stability of sediments, and shallow core samples profiling sediment type can be taken for geotechnical analysis in an area where a facility is to be sited, such as along a proposed pipeline route.

Potential instability and mass movements of sediment in the area are also related to the seafloor gradient, low sediment strength where fine-grained sediments retain high amounts of water, sediment loading from waves during storms, and ground motion during earthquakes. Along the shelf, inshore of the 50-meter isobath, the seafloor slope is generally low and, except in the vicinity of Camden Bay, ground motions associated with earthquakes are very low. Thus, except for Camden Bay, the mass movements in water less than 50 m are generally not considered to be a significant hazard to offshore operations (DGGS 2008b, citing to MMS 1995).

12. Shallow Gas Deposits and Natural Gas Hydrates

Shallow pockets of natural gas have been encountered in boreholes both onshore and offshore throughout the Arctic. This gas usually exists in association with faults that cut Brookian (Aptian through Miocene) strata, and as isolated concentrations in the Pleistocene coastal plain sediments (DGGS 2008b citing to Grantz and others, 1982b). The presence of shallow gas has been inferred from studies. Sediments in which gas has accumulated are a potential hazard if penetrated during drilling, as well as for any man-made structures on top of them. The presence of gas may lower the

[10] A kick is a condition where the formation fluid pressure (pressure exerted by fluids in a formation) exceeds the hydrostatic pressure (pressure exerted by mud in the borehole) resulting in a ‘kick’; formation fluids enter the borehole.

shear strength of the sediments and reduce their ability to support structures (DGGS 2008b citing to MMS, 1995).

Natural gas hydrates are unique compounds consisting of ice-like substances composed of gas trapped within water molecules (DGGS 2008b, citing to Nixon and Grozic 2007). They commonly occur offshore under low-temperature, high-pressure conditions (DGGS 2008b, citing to Macleod 1982), as well as at shallower depths associated with permafrost (DGGS 2008b, citing to Kvenvolden and McMenamin 1980). Within the proposed lease sale area, gas hydrates have been found at shallow depths under permafrost along the inner shelf (DGGS 2008b citing to Sellmann and others, 1981) and onshore at Prudhoe Bay (DGGS 2008b, citing to Kvenvolden and McMenamin 1980) and at the Mount Elbert well in Milne Point where downhole coring and logging operations were recently completed (DGGS 2008b, citing to Collett 2008).

One of the main problems associated with gas hydrates is dissociation, which occurs when the compound becomes unstable. Dissociation occurs by both natural and man-made activity and can lead to an increase in fluid pressure and reduction of effective stress of sediment as volume increases (DGGS 2008b, citing to Nixon and Grozic 2007). Potential for dissociation in marine environments is a function of water depth, sea floor temperature, availability of gas and availability of water in adequate quantities. Natural mechanisms leading to gas hydrate dissociation include sea level decrease and sediment temperature increase. Man-made mechanisms include heat transfer during petroleum production leading to melting of hydrates. During drilling, rapid decomposition of gas hydrates can cause a rapid increase in pressure in the wellbore, gasification of the drilling mud, and the possible loss of well control. If the release of the hydrate gas is too rapid, a blowout can occur, and the escaping gas could be ignited. In addition, the flow of hot hydrocarbons past a hydrate layer could result in hydrate decomposition around the wellbore and loss of strength of the affected sediments (DGGS 2008b, citing to Nixon and Grozic 2007). If this happened and the well was shut-in for a period, the reformation of the hydrates could induce high pressures on the casing string (DGGS 2008b, citing to MMS 1995).

An additional geologic hazard associated with gas hydrates is the potential for submarine slope failures associated with decreased sediment strength occurring during dissociation (DGGS 2008b, citing to Nixon and Grozic 2007). Acoustic records indicate a stretch of slumps in the Beaufort Sea along the shelf-edge break. The slumps extend for at least 500 km in an area of known gas hydrates and should be considered during exploration and development activities.

Because gas hydrates and shallow gas deposits pose risks similar to overpressured sediments, the same mechanisms for blow-out prevention and well control are employed to reduce the danger of loss of life or damage to the environment. For a discussion of oil spill prevention and response, see Section F of Chapter Six.

13. Mitigation Measures and Other Regulatory Protections

Several geologic hazards exist in the Beaufort Sea area that could pose potential risks to oil and gas installations both onshore and offshore. As discussed above, these potential hazards include earthquakes, sea ice, shore-ice movement, permafrost and frozen-ground phenomena, waves, coastal and river erosion, offshore currents, flooding, strudel scour, overpressured and unstable sediments, and shallow gas deposits and hydrates.

The risks from earthquake damage can be minimized by siting onshore facilities away from potentially active faults and unstable areas, and by designing them to meet or exceed national standards and International Building Code seismic specifications specific for Alaska. National industry standards help assure the safe design, construction, operation, maintenance, and repair of pipelines and other oil and gas facilities. Sometimes referred to as “technical standards” they establish standard practices, methods, or procedures that have been evaluated, tested, and proven by analysis and/or application. These standards are intended to assure the safe design, construction, operation, maintenance, and repair of infrastructure. National consensus standards, such as the American Petroleum Institute (API), American Society of Mechanical Engineers (ASME), National Fire Protection Association (NFPA), and National Association of Corrosion Engineers (NACE), can carry the equivalent weight of law. In fact, many of them are codified by incorporation of all or parts of them into regulations by reference. They are constantly reviewed and upgraded by select committees of engineers and other technical experts (PHMSA 2008).

Design for offshore drilling and production platforms should consider all environmental events which influence the design of an arctic structure (API Recommended Practice 2N). Design conditions are those environmental conditions to which the structure is designed. Additional precautions should be taken to identify and accommodate site-specific conditions or events that can act on a structure such as unstable ground, flooding, and other localized hazards. Proper siting and engineering will minimize the detrimental effects of these natural processes.

Safe design of offshore drilling and production platforms use design codes and recommended practices that assist the engineer by setting out procedures for achieving acceptable levels of safety. Recommended practices provide guidance for the design of arctic structures and pipelines considering the environment, sea ice, and permafrost. Once the design conditions have been established for each process, they become the basis for that system's design. The primary goal of codes is safety, which is accomplished by providing a minimum set of rules which must be incorporated into a sound engineering design concerning materials, fabrication, testing, and examination practices used in the construction of these systems. All of these are intended to achieve a set of engineering requirements deemed necessary for safe design and construction of these structures and their associated piping systems.

Although geologic hazards could damage oil and gas infrastructure, proposed measures in this preliminary best interest finding, along with regulations imposed by state, federal, and local agencies, in addition to design and construction standards discussed above, are expected to avoid, minimize, or mitigate those hazards. Mitigation measures address siting of facilities, design and construction of pipelines, and oil discharge prevention and contingency plans. A complete listing of mitigation measures is found in Chapter Nine.

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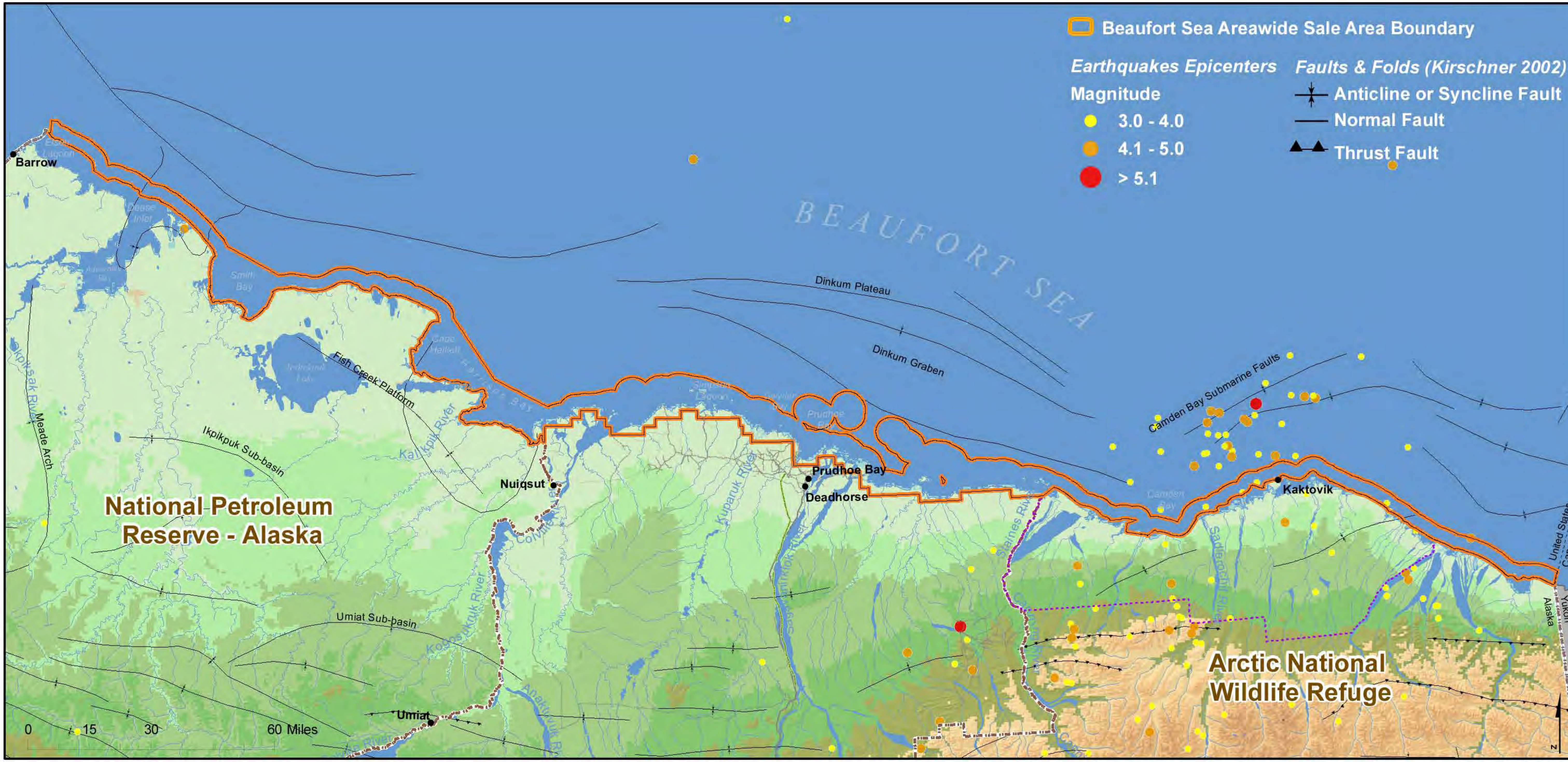
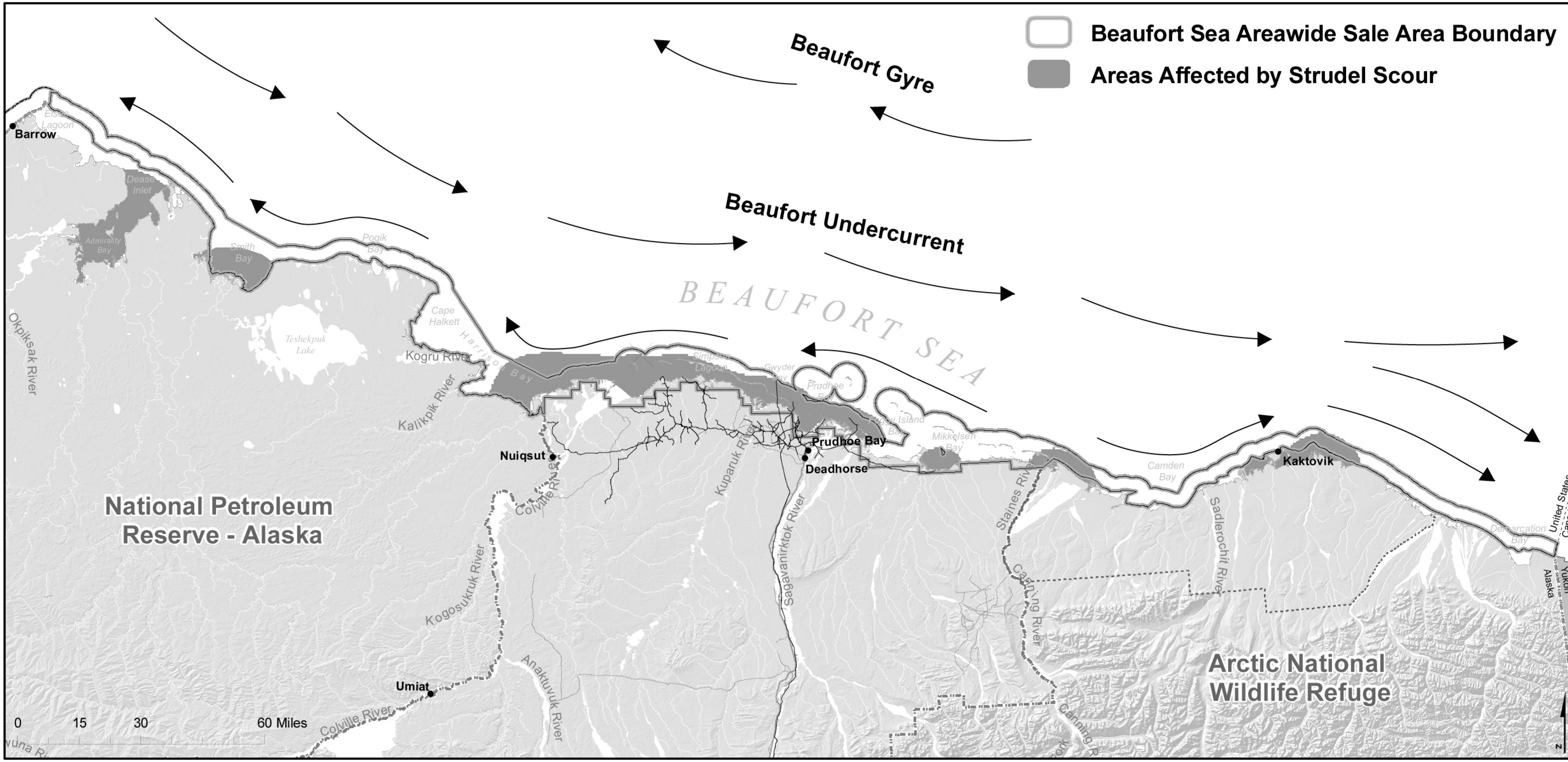
Maps



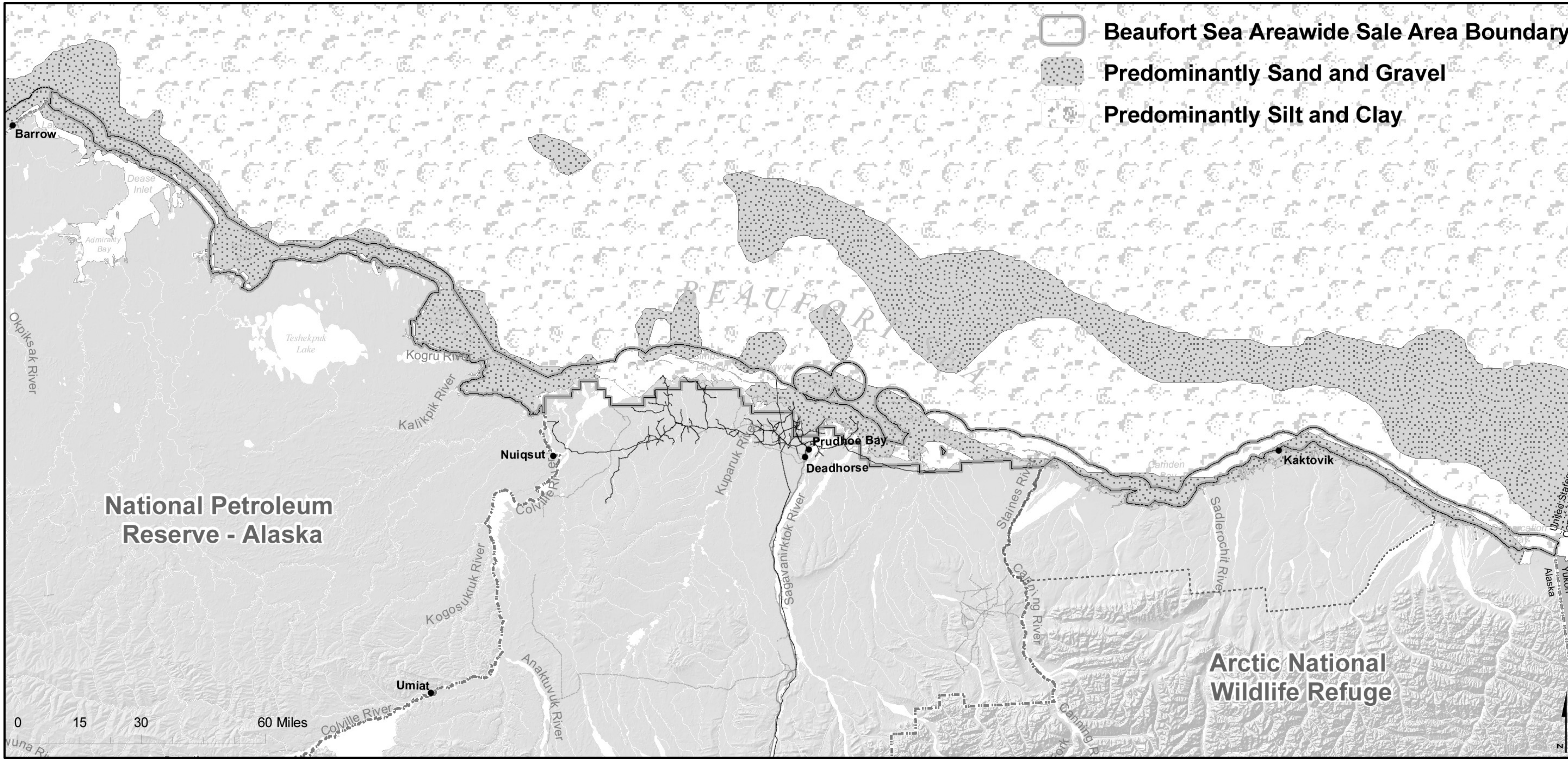
Notes: Information on this map is depicted only at a township or section level resolution. For detailed information regarding any specific area, interested individuals may consult the land records of one or more of t he following agencies: ADNR, BLM, MMS, NOAA, Alaska Earthquake Information Center, or C. E. Kirschner 2003. Sedimentary basins and faults. Discrepancies in boundary alignments are the result of merging multiple data sets from these various sources.

Map 3.1. Major earthquake epicenters in the Beaufort Sea area.



Notes: Information on this map is depicted only at a township or section level resolution. For detailed information regarding any specific area, interested individuals may consult the land records of one or more of the following agencies: ADNR, BLM, MMS, and NOAA. Discrepancies in boundary alignments are the result of merging multiple data sets from these various sources.

Map 3.2. Currents and scour distributions of the Beaufort Sea.



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Map 3.3. Generalized distribution of surface sediments, Beaufort Sea area.

Chapter Four: Habitat, Fish, and Wildlife

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Chapter Four: Habitat, Fish, and Wildlife

AS 38.05.035(g) directs that best interest findings consider and discuss the fish and wildlife species and their habitats in the proposed lease sale area. The proposed Beaufort Sea lease sale area includes important habitats and many fish and wildlife species that support subsistence activities for residents. Most habitats and populations of fish and wildlife in the area are healthy because of careful management, conservative laws governing importation and introduction of exotic animals, regulatory mechanisms in place for development, and relatively slow population growth (ADF&G 2008a). Only a four species found in the proposed lease sale area are listed as threatened or endangered under the federal Endangered Species Act: polar bear (threatened), spectacled eider (threatened), Steller's eider (threatened), and bowhead whale (endangered).

A. Habitats

The proposed Beaufort Sea lease sale area includes terrestrial, freshwater, estuarine, and marine habitats. A large onshore area immediately adjacent to the proposed lease sale area, the Arctic National Wildlife Refuge, has been set aside for habitat protection.

1. Terrestrial Habitats

Terrestrial habitats of the proposed lease sale area lie within the polar Arctic tundra, Beaufort Sea coastal plain ecoregion (ADF&G 2006). The terrestrial portion of the proposed lease sale area is part of the Arctic coastal plain, of which over 90 percent of the habitat is considered to be intact (WWF 2001). The area is dominated by tundra and is mostly treeless.

Several types of tundra are found in the Beaufort Sea area. These include wet sedge tundra, found in drained lake basins, swales, and floodplains; and tussock tundra and sedge-dryas tundra found on

NOAA At The Ends of the Earth Collection, corp1014

Winter sea ice terrain of the Beaufort Sea.

ridges. Low willow thickets, dwarf birch, various heath species, and herbs and lichens also grow in the area (Table 4.1; CEC 1997; ADF&G 2006).

Plant species of the tundra are few, their growth is minimal, and most of their biomass is concentrated in the root system. They often reproduce by division because of the short growing season (ADF&G 2006). Trees are generally absent because of the impermeable permafrost layer and thin soils. The short period of thawing during the summer and persistence of permafrost near the surface limit diversity of plant and animal species. Despite the low precipitation, much of the area remains marshy throughout the summer (Truett 2000).

2. Freshwater Habitats

Freshwater habitats of the Beaufort Sea area include several large rivers; an abundance of lakes, streams, and wetlands; and numerous seasonal ponds and creeks. The thousands of shallow, thaw lakes cover up to 50 percent of the Arctic coastal plain, and over 82 percent of the ecoregion is considered wetland (ADF&G 2006).

a. Lakes and Rivers

The freshwater lakes and rivers in and near the proposed Beaufort Sea lease sale area provide important habitat for fish, wildlife, and birds of the area. Although these water bodies are abundant, many freeze to the bottom during the winter, making them unavailable as overwintering habitat for fishes (Moulton and George 2000). Available freshwater habitats are decreased by 97 percent by late winter (Gallaway and Fechhelm 2000, citing to Craig 1989).

Table 4.1. Some terrestrial plants found in the Beaufort Sea area.

Common Name	Scientific Name
Sedges and Grasses	
water sedge	*Carex aquatilus*
tussock cottongrass	*Eriophorum vaginatum*
tall cottongrass	*Eriophorum angustifolium*
bigelow sedge	*Carex bigelowii*
tundra grass	*Dupontia fischeri*
alpine foxtail	*Alopecurus alpinus*
pendent grass	*Arctophila fulva*
Mosses	
	Scorpidium spp.
	Drepallodadus spp.
	Tomenthypnum nitens
	Distichium capillaceum
	Drepanocladus spp.
	Campylium stellatum
feather mosses	*Hylocomium splendens, Sphagnum spp*
lichens	*Cetraria cucullata, C. islandica*
	Cladonia spp.
reindeer lichen	*Cladina rangiferina*
reindeer mosses	*Cladonia rangeiferina, C. stellaris*
distichium moss	*Distichium capillaceum, Hypnum bambergeri*
ditrichum moss	*Ditrichum flexicaule*

-continued-

Table 4.1. Page 2 of 2.

Common Name	Scientific Name
Shrubs	
dwarf arctic birch	*Betula nana*
crowberry	*Empetrum nigrum*
narrow-leaf Labrador tea	*Ledum decumbens*
mountain-cranberry	*Vaccinium vitis-idaea*
entire-leaf mountain-avens	*Dryas integrifolia*
white mountain-avens	*Dryas octopetala*
mountain cranberry	*Vaccinium vitis-idaea*
four-angled cassiope	*Cassiope tetragona*
alpine bearberry	*Arctostaphylos alpine*
red-fruit bearberry	*Arctostaphylos rubra*
blueberry	*Vaccininium spp.*
four-angled cassiope	*Cassiope tetragona*
American green alder	*Alllus crispa*
Richardson willow	*Salix lanata*
diamond leaf willow	*Salix planifoli*
gray leaf willow	*Salix glauca*
netleaf willow	*Salix reticulata*
skeleton leaf willow	*Salix phlebophylla*
least willow	*Salix rotundifolia*
arctic willow	*Salix arctica*
polar willow	*Salix Polaris*

Source: ADF&G 2006.

Lakes and ponds of the area are sustained by the thick layer of permafrost that prevents downward percolation of water (Howard et al. 2000). During the winter, ponds and lakes freeze to a depth of about 1.7 m, during June and July they thaw, and they begin freezing again in September. Ponds and lakes provide important habitat for invertebrates, which are the principal prey for many of the fish and birds of the area. As it decomposes, peat underlying the tundra contributes to the detritus of tundra ponds and provides phosphorous and other nutrients to invertebrate food webs (Howard et al. 2000).

Teshekpuk Lake, the largest lake on the Arctic Coastal Plain, is located adjacent to the proposed Beaufort Sea lease sale area. The lake covers over 320 mi^2, and adjoining interconnected channels, lakes, and nearshore regions cover an additional 12,600 mi^2. Studies of habitat use by fishes indicate that the lake provides over 200 mi^2 of important habitat deeper than 7 ft for fishes, and an additional 21.5 mi^2 is available as potential overwintering habitat at the lake outlet (Moulton et al. 2007). The numerous small tundra streams and lakes of the area are used extensively by both anadromous and resident fish species for summer rearing (Morris and Winters 2008).

Principal rivers flowing through or into the proposed lease sale area include the Kogru, Kalikpik, Tingmeachsiovik, Colville, Kachemach, Miluveach, Unguravik, Sakonowyak, Kuparuk, Putuligayuk, Sagavanirktok, Kadleroshilik, Shaviovik, Staines, and Canning rivers. Warm shallow areas of these rivers are important habitat for fishes in the summer, and deep areas are important for overwintering areas (Moulton and George 2000). Riparian zones along rivers and stream provide important habitat for brown bears. Habitats that support the preferred forage plants and prey species of brown bears are limited on the arctic coastal plain, and riparian zones are some of the few areas that do (Shideler and Hechtel 2000).

The freshwater rivers of the Beaufort Sea area are also important for estuarine and marine habitats. The Colville River and Mackenzie River (located outside the proposed lease sale area in Canada), and numerous other rivers and streams along the Beaufort Sea coast, discharge massive amounts of freshwater and sediment into the Beaufort Sea. The Colville and Mackenzie rivers discharge about 350 km^3 of runoff and 130 x 10^6 tons of sediment into the Beaufort Sea shelf region (Dunton et al. 2006, citing to Macdonald et al. 2004). These freshwater discharges create a definite estuarine environment along the coast. High concentrations of suspended sediment from upland regions are swept into the nearshore waters of the Beaufort Sea by coastal erosion and river discharge. As a result, terrestrial organic matter is assimilated into marine food webs. Carbon from terrestrial sources may contribute as much as 30-50 percent of the total dietary requirements of some fishes inhabiting lagoons of the Beaufort Sea, and Arctic cod may derive as much as 70 percent of their carbon from terrestrial sources (Dunton et al. 2006).

b. Wetlands

Wetlands are transitional zones between aquatic and terrestrial habitats that are characterized by poor soil drainage, and are primarily of four types in Alaska: bogs, grass wetlands, sedge wetlands, and marshes (ADF&G 2006). The water contained in bogs comes primarily from rainfall rather than from runoff, streams, or groundwater. Bogs are characterized by nearly complete plant cover, including up to 100 percent moss. Over 50 percent of the plant species in grass wetlands are water-tolerant grasses. This habitat is important for recharging ground water, and for maintaining baseflows for aquatic resources downstream by storing storm and floodwaters. Sedge wetlands are found in very wet areas of floodplains, slow-flowing margins of ponds, lakes, streams, and sloughs, and in depressions of upland areas. Salt marshes are intertidal wetlands composed of salt-tolerant plants, usually located at river mouths; behind barrier islands, coves, and spits; and on tide flats (ADF&G 2006).

The U.S. Army Corps of Engineers has developed criteria for defining wetlands. Those criteria do not constitute a classification system but only provide a basis for determining whether a given area is a wetland for purposes of Section 404, without attempting to classify it by wetland type. The U.S. Army Corps of Engineers defines wetlands as (Environmental Laboratory 1987):

> a. **Definition**. Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.
>
> b. **Diagnostic environmental characteristics**. Wetlands have the following general diagnostic environmental characteristics:
>
>> (1) ***Vegetation***. The prevalent vegetation consists of macrophytes that are typically adapted to areas having hydrologic and soil conditions described in “a” above. Hydrophytic species, due to morphological, physiological, and/or reproductive adaptation(s), have the ability to grow, effectively compete, reproduce, and/or persist in anaerobic soil conditions[1]. Indicators of vegetation associated with wetlands are listed [elsewhere in Environmental Laboratory 1987].
>>
>> (2) ***Soil***. Soils are present and have been classified as hydric, or they possess characteristics that are associated with reducing soil conditions.

[1] Species (e.g., *Acer rubrum*) having broad ecological tolerances occur in both wetlands and non-wetlands.

Indicators of soils developed under reducing conditions are listed [elsewhere in Environmental Laboratory 1987].

(3) ***Hydrology***. The area is inundated either permanently or periodically at mean water depths ≤6.6 ft, or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation[2]. Indicators of hydrologic conditions that occur in wetlands are listed [elsewhere in Environmental Laboratory 1987].

c. **Technical approach for the identification and delineation of wetlands**. Except in certain situations defined in [Environmental Laboratory 1987], evidence of a minimum of one positive wetland indicator from each parameter (hydrology, soil, and vegetation) must be found in order to make a positive wetland determination.

Delineation of wetlands is further refined for Alaska in USACOE (2007), addressing regional wetland characteristics and differences such as climate, geology, soils, hydrology, plant and animal communities, and other factors important to the identification and functioning of wetlands.

Bergman et al. (1977) developed a system of eight water body classifications, all of which occur within the uplands adjacent to the proposed lease sale area.

Class I — Flooded tundra is composed of shallow waters formed during spring thaw when melt water overflows stream basins or is trapped in vegetated tundra depressions. Such pools formed in low centers of polygonal ground often produce a mosaic pattern of ridges and flooded sedge.

Class II — Shallow-*Carex* water bodies are shallow ponds with a gently sloping shore zone surrounded by and usually containing emergent Carex aquatilis with a central open water zone.

Class III — Shallow-*Arctophilia* ponds are shallow ponds or pools containing pendent grass (*Arctophilia*) in the center and shoreward stands of pendent grass or sedge (*Carex*). Shallow water and extensive stands of pendent grass provide feeding and nesting habitat and cover for birds. Most species use these wetlands, but key species include red-throated loons, king eider, tundra swans, and pintails.

Class IV — Deep-*Arctophilia* ponds or lakes are second generation basins resulting from melting of ice-rich zones in drained basins. Identified by shoreward stands of pendent grass (*Arctophilia*) and a lack of emergent vegetation in their center, these ponds or lakes have distinct shores and flat or gently rolling bottoms. These lakes are principal aquatic habitats for all waterfowl, especially tundra swan, king and spectacled eider, oldsquaw, brant, and pacific and red-throated loons.

Class V — Deep open lakes are large, deep lakes that have abrupt shores, sublittoral shelves, and a deep central zone.

Class VI — Basin-complex water bodies are large, partially drained basins; they may contain water continuously in the spring, but as summer progresses, water levels recede. Since water levels vary, vegetation is diverse and prolific. Non-breeding pintails feed in these basins, and emergent vegetation stands provide cover during their wing molt in July. King eiders and loons use lakes within basin-complexes for feeding and staging, principally during the early summer before deeper wetlands have thawed.

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[2] The period of inundation or soil saturation varies according to the hydrologic/soil moisture regime and occurs in both tidal and nontidal situations.

Class VII Beaded streams are small, often intermittent streams consisting of a series of channels formed in ice-wedges and linked to pools that develop at ice-wedge intersections. Beaded Streams are common throughout the coastal plain, and they are often the only class of wetlands in large areas of well drained regions of the interior coastal plain.

Class VIII Coastal wetlands are aquatic habitats bordering the Beaufort Sea within a zone directly influenced by seawater. Periodic saltwater flooding, the presence of brackish water, and unique vegetation of sedge and grass distinguish coastal wetlands from other types. Nesting and feeding black brant use coastal wetlands. Coastal wetlands are primarily used by snow geese for brood-rearing and staging. These wetlands may be found in most river deltas and adjacent to coastal lagoons.

Four water bodies types are generally used by birds more than others: shallow-*Arctophilia*, deep-*Arctophilia*, basin-complexes, and coastal wetlands (ADF&G 1997). In a study at Storkersen Point near the mouth of the Kuparuk River, Bergman et al. (1977) reported that these four types represented 35 percent of the area's wetlands, but received more than 68 percent of the study area's use by loons and other waterfowl. These wetlands support significant numbers of waterbirds, such as geese, ducks, and loons, and are used more intensively than other types of water bodies. Although limited in aerial extent, these wetlands are used more extensively by waterbirds than other wetland types.[3]

Meehan and Jennings (1988) studied the distribution and behavior of birds on the Colville Delta, and derived nine habitat classes for large waterbirds (tundra swan, greater white-fronted goose, Pacific loon, yellow-billed loon, and brant):

- **Discrete Lake** habitat includes lakes and estuarine water bodies, similar to Bergman's Class V.
- **Tapped Lake** habitat includes lakes that are hydrologically connected to a river system. In spring, flooded channels breach these lakes, allowing sediments and salt water to infiltrate. This class is also similar to Bergman's Class V.
- **Wet-Moist Flooded Tundra** includes wet sedge polygonal ground (Bergman's Class I) and moist sedge willow (Bergman's Class II).
- **Wet Graminoid** habitat is found along lake shores and polygonal ponds. Similar to Bergman Classes III and IV, the largest stands on the Colville Delta are located in its south central portion (located within the proposed lease sale area). This habitat includes dominant species, *Arctophila fulva* and *Carex aquatalis*.
- **Wet-Moist Polygons** include moist to wet low tundra meadows; near lake ponds and margins, flooded basins, and polygonal ground. Similar to Bergman Classes I and II, this habitat is the most abundant vegetation cover on the Colville Delta. This vegetation type was used by Pacific and Yellow-billed loon nesting and Tundra swan and white fronted geese.
- **Brackish Flats**, similar to Bergman's Class VIII, is found along the fringe of the delta, river channels, and tapped lakes. This habitat type has been associated with high brant use.
- **Shrub Dominant Areas** consist of low willow communities on river banks, terraces and dunes. Most bird use was low, and there was no equivalent Bergman class.

[3] Lessees are advised that the state may adopt, or approve the use of, an alternate wetlands classification system in the future. However, the protective nature of the wetlands mitigation measures developed for this and other oil and gas lease sales will remain consistent regardless of the wetlands classification system ultimately selected.

- **Barrens** include partially vegetated dunes, grass-forb lake shore, and partially vegetated and unvegetated floodplain. Similar to Bergman's Class VIII, this habitat is of low use by most birds and covers about 30 percent of the Colville Delta's total area.
- **Sedge-Tussock Tundra**, found in the western part of the delta, has no comparable Bergman class.

Meehan and Jennings (1988) ranked the importance of habitat classes relative to usage by key bird species. Discrete lakes were used the most, followed by wet-moist polygons, brackish flats, wet graminoid, and wet-moist flooded tundra. Tapped lakes and shrub dominant areas received an equal amount of use after the top six, followed by sedge-tussock tundra and barrens which were used the least. The authors cautioned that although the classes may apply to habitats across the North Slope, the ranking should only be applied to the Colville River Delta.

3. Nearshore Estuarine and Marine Habitats

The Beaufort Sea provides important habitat for fishes, marine mammals, and birds, and especially provides habitat for the marine invertebrates that make up the base of the food webs for the area. However, relative to the Bering and Chukchi seas, the Beaufort Sea has relatively low productivity and biomass of benthic fauna (Dunton et al. 2006, citing to Dunton et al. 2005). The Beaufort Sea shelf region, which includes three distinct shelf environments, varies in width from 80 km in Alaska to 150 km in Canada (Dunton et al. 2006, citing to Macdonald et al. 2004). Nearshore waters of the Beaufort Sea are characterized by physical and biological extremes (Dunton et al. 2006). Surface waters of the Beaufort Sea are frozen from October-May, and ice cover reaches a thickness of 2 m by late winter (Gallaway and Fechhelm 2000). By mid-July, nearshore waters are usually ice-free from shore to the edge of the pack ice. By late summer, the pack ice is from 10 to 100 km offshore.

Nearshore waters of the Beaufort Sea have estuarine characteristics because of the high input of freshwater from the Colville and Mackenzie rivers (Dunton et al. 2006). Melting coastal ice also contributes to the brackish conditions of nearshore areas (Gallaway and Fechhelm 2000). The relatively warm river discharges combined with increased solar radiation to elevate nearshore water temperatures provide the physical environment to support the intense biological activity that sustains the area's fish, birds, and marine mammals (Gallaway and Fechhelm 2000). Brackish waters form a relatively narrow band that becomes discontinuous by late summer (Thorsteinson et al. 1991).

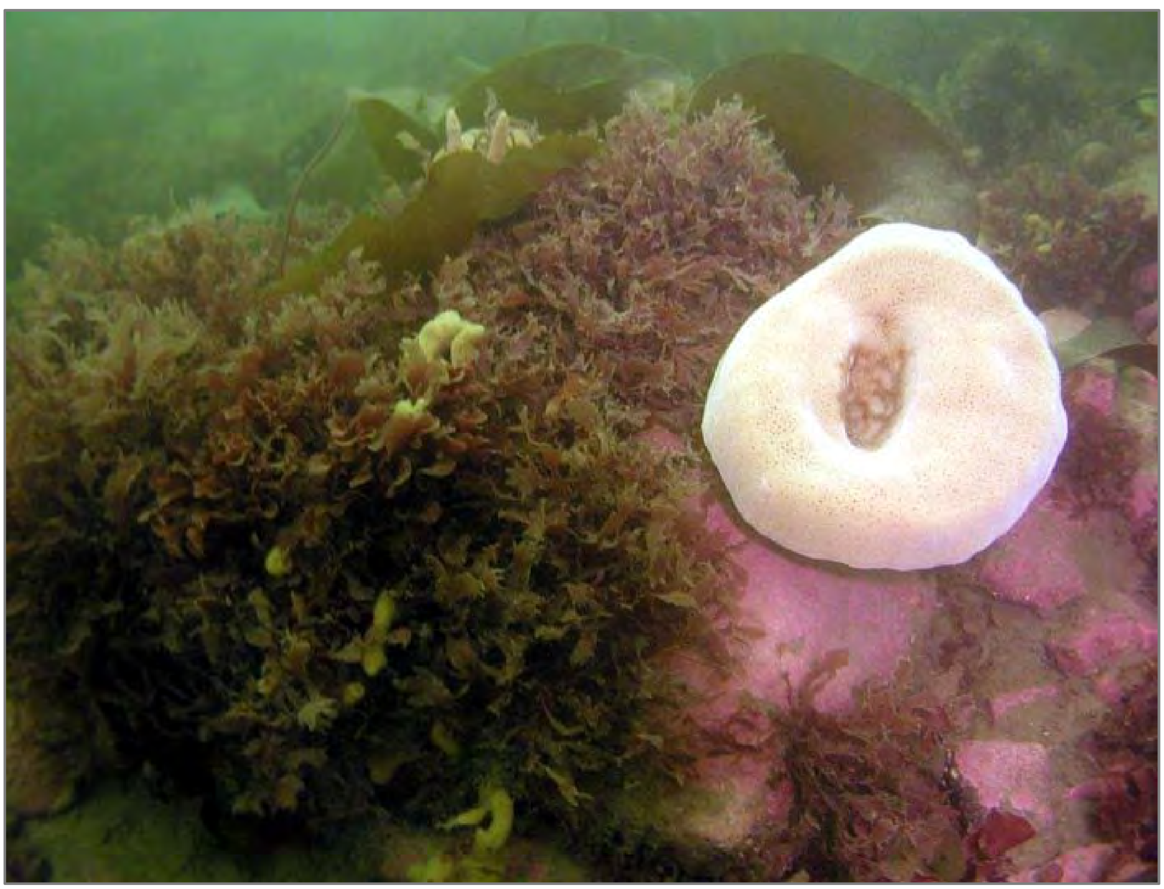
This is the prime feeding area diadromous fishes of the North Slope. Marine invertebrates are prolific, thriving in the warm, detritus-laden shallows. Marine mysids and amphipods are most abundant, but freshwater chironomids washed downstream are also important. Studies have estimated that "of all the marine and freshwater habitat available to diadromous fishes during summer, coastal waters hold 90% of the exploitable prey biomass" (Gallaway and Fechhelm 2000 [pg. 351], citing to Craig 1989).

Phytoplankton in the Beaufort Sea includes diatoms, dinoflagellates, and flagellates with the diatom *Chaetoceros spp*. being the most abundant. Studies conducted in Harrison and Prudhoe bays found that flagellates were most numerous at the surface with diatoms most numerous in the water column. Primary productivity was highest in the water column where diatoms were the most abundant organism, rather than at the surface. The horizontal distribution of diatoms in waters close to shore and river mouths suggest that light levels, rather than salinity or temperature, determine diatom distribution (Horner 1984). Phytoplankton production gradually increases after ice break-up, when light becomes increasingly available. Production declines after September when light availability limits photosynthesis. During the bloom period from spring through summer, the phytoplankton community on which zooplankton graze changes (Horner 1984). Productivity in Harrison Bay and Simpson Lagoon was measured at 10 to 23 g, and less than 10 g per m^2 in Prudhoe Bay. Primary productivity values can fluctuate as much as three-fold from year to year (Horner 1984), which may affect population dynamics for other species in the food web.

Zooplankton abundance and species diversity appear to increase with increasing distance from shore. One species group prefers deeper, more saline oceanic water offshore and includes *Mysis litoralis, Parathemisto abyssorum, Hyperia galba, Calanus hyperboreus, C. glacialis, and C. hydromedusae*. A second species group prefers lower salinity barrier island lagoons and includes *Mysis relicta, Monoculodes crassirostris, Onisimus glacialis, Acanthostepheia incarinata, and Pontoporeia affinis*. A third species group is transitional, preferring shallow offshore waters, and this community includes species of the other two groups (NSBCMP 1984).

Larger invertebrate communities in the nearshore lagoons include animals living in the bottom (infauna), animals usually living on or near the bottom (epibenthic), and those living in the water column (pelagic). In Simpson Lagoon, infauna are restricted to depths greater than 2 m because shallower portions freeze solid during winter. These include polychaete worms (*Ampharete vega and Terebellides stroemi*) and bivalves (*Cyrotidaria kurriana*). Epibenthic organisms include amphipods, mysids, and isopods. Pelagic species include copepods and chaetognaths; important food sources for anadromous fishes. During winter, epibenthic and pelagic species disappear, and then emerge again in spring, whereas infauna and some amphipods may be present year-round (Craig et al. 1984). These organisms are an important source of food for birds and marine mammals.

The Boulder Patch, an area of Stefansson Sound located about 20 km northeast of Prudhoe Bay, supports abundant algae, including kelp, and invertebrates that are important to nearshore food webs (Dunton and Schonberg 2000; Dunton et al. 2005). The sea bed, which is usually composed of silty sands and mud, is made up of cobbles and boulders in this area. Water depths are generally shallow,



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Organisms of the Boulder Patch, Stefansson Sound.

ranging from 3-9 ft. The boulders and rocks of the area provide refuge to organisms and allow accumulation of detrital material (Dunton and Schonberg 2000).

Arctic kelp coexist with a large invertebrate community in Stefansson Sound, with *Laminaria solidungula* the most dominant species present. In contrast, shallow water and a lack of rocky substrate prevent Arctic kelp from surviving in Simpson Lagoon (Craig et al. 1984). This marine plant endures nine months of darkness, but grows fastest in late winter and early spring due to higher concentrations of inorganic nitrogen in the water column. Sediments trapped in the ice above the kelp block light and restrict growth, however the presence of leads and cracks has the opposite effect. Kelp make up between 50 and 55 percent of the available carbon in the Stefansson Sound kelp community, while phytoplankton make up between 23 and 42 percent. This ratio has been linked to the level of sediments on the surface in a given year. The consumers of this carbon include filter feeding invertebrates like the chiton, *Amicula vestita* (Dunton 1984).

B. Fish and Wildlife

1. Fish

At least 17 species of marine fishes, 14 species of freshwater fishes, and 12 anadromous species may be found in the waters of the Beaufort Sea area (Wiswar 1992; Wiswar et al. 1995; Wiswar and Fruge 2006; Scanlon 2008; USFWS 2008a; Table 4.2; Map 4.1). Anadromous fish-bearing streams flowing through or into the proposed lease sale area include the Aichilik, Hulahula, Okpilak, Kogotpak, Egaksrak, Kongakut, Aichiklik, Canning , Staines, Shaviovik, Sagavanirktok, Kuparuk, Colville, Fish Creek, Kogru, Ikpikpuk, Alaktak, Chipp, Topagoruk, and Meade rivers. Diversity of fish species is greater in lakes connected to rivers than in isolated lakes. Ninespine stickleback are the only species inhabiting many isolated lakes, and isolated lakes may be barren (Wiswar 1994).

Several of the more important fish species in the Beaufort Sea area are Dolly Varden and Arctic char, Coregonids (whitefishes and ciscoes), and Arctic cod.

a. <u>Dolly Varden and Arctic Char</u>

Dolly Varden are found in many rivers and streams throughout Beaufort Sea drainages, and during the summer adults are distributed widely in the nearshore waters of the Beaufort Sea (Viavant 2005). They are so closely related to Arctic char that distinguishing between the two species requires counting gill rakers and pyloric caeca (Morrow 1980). In Alaska, most Arctic char are lake resident (Armstrong 1996), but information about their distribution in the Beaufort Sea area is lacking (ADF&G 2008d). However, they are one of the dominant species found in Simpson Lagoon and adjacent coastal waters of the Beaufort Sea during summer (Craig et al. 1985). Dolly Varden are important to North Slope ecosystems because they provide marine-derived nutrients to low productivity aquatic food webs, and they are a source of food for bird and mammal predators (Viavant 2005).

Although Dolly Varden generally spawn in the fall, their life history is notoriously variable. For example, Dolly Varden populations can be sea-run (spending time in freshwater and nearshore marine waters) or resident (spending their entire life in freshwater), and within the same population some individuals may be sea-run while others are resident. Among freshwater residents, there are lake, stream, and dwarf forms (ADF&G 1994). Populations of the North Slope are generally sea-run, with a life history pattern as follows: Dolly Varden spawn in streams from mid-July through October, laying 600-6,000 eggs in redds (ADF&G 1994; Viavant 2005), or nests, covering the eggs with gravel; they hatch in the spring and rear in the stream until they are 3-5 years old before migrating to the ocean for the first time (Armstrong 1996; Viavant 2005). However, some Dolly Varden on the North Slope remain in freshwater their whole life, never migrating to the ocean (USFWS 2008c).

Table 4.2. Fish species that may be found in the Beaufort Sea area.

Freshwater Species		Anadromous Species		Marine Species	
Common Name	Scientific Name	Common Name	Scientific Name	Common Name	Scientific Name
Sheefish	*Stenodus leucichthys*	Least cisco*	*Coregonus sardinella*	Pacific herring	*Clupea harengus Pallas*
Round whitefish	*Prosopium cylindraceum*	Bering cisco*	*Coregonus laurettae*	Capelin	*Mallotus villosus*
Lake trout	*Salvelinus namaycush*	Arctic cisco	*Coregonus autumnalis*	Arctic cod	*Boreogadus saida*
Arctic char	*Salvelinus alpinus*	Broad whitefish*	*Coregonus nasus*	Saffron cod	*Eleginus gracilis*
Northern pike	*Esox lucius*	Humpback whitefish*	*Coregonus pidschian*	Fourhorn sculpin	*Myoxocephalus quadricornis*
Lake chub	*Couesius plumbeus*	Pink salmon	*Oncorhynchus gorbuscha*	Arctic sculpin	*Myoxocephalus scorpioides*
Longnose sucker	*Catostomus catostomus*	Chinook salmon	*Oncorhynchus tshawytscha*	Greenland seasnail	*Liparis tunicatus*
Trout-perch	*Percopsis omiscomaycus*	Chum salmon	*Oncorhynchus keta*	Pacific sand lance	*Ammodytes hexapterus*
Burbot	*Lota lota*	Coho salmon	*Oncorhynchus kisutch*	Slender eelblenny	*Lumpenus fabricii*
Ninespine stickleback	*Pungitius pungitius*	Rainbow smelt	*Osmerus mordax*	Stout eelblenny	*Lumpenus medius*
Slimy sculpin	*Cottus cognatus*	Arctic lamprey*	*Lampetra japonica*	Eelpouts	*Lycodes spp.*
Threespine stickleback	*Gasterasteus aculeatus*	Dolly Varden*	*Salvelinus malma*	Arctic flounder	*Pleuromectes glacialis*
Alaska blackfish	*Dallia pectoralis*			Starry flounder	*Platichthys stellatus*
Arctic grayling	*Thymallus arcticus*			Arctic hookear sculpin	*Artediellus scaber*
				Arctic staghorn sculpin	*Gymmocanthus tricuspis*
				Whitespotted greenling	*Hexagrammus stelleri*
				Bering wolffish	*Anarchichas orientalis*

Notes: * Denotes freshwater-only form of species also.

Source: USFWS 2008a.

After their first migration to the ocean, Dolly Varden spend the remainder of their lives migrating between the ocean and freshwater, spending summers feeding in marine waters, and overwintering in lakes or streams with deep pools (ADF&G 1994). North Slope Dolly Varden stocks generally return to their natal drainages for spawning, but probably do not spawn every year (Viavant 2005). Dolly Varden can live to be 16 years or older, but most on the North Slope are less than 10. Most have spawned for the first time by age eight, but only half survive to spawn a second time (USFWS 2008c).

Genetic studies indicate that there are multiple populations of Dolly Varden along the Arctic coast of Alaska and Canada, frequently corresponding to major river systems, and more than one population may occur within a given river system (Everett et al. 1998). Unlike Dolly Varden in other parts of Alaska, North Slope Dolly Varden appear to return to their natal drainages for overwintering as well as for spawning, and studies indicate that overwintering aggregations are primarily single stocks rather than mixed stocks from many drainages (Crane et al. 2005). Availability of overwintering habitat is considered to be the major limiting factor for Dolly Varden in the Beaufort Sea area (USFWS 2008b). They must overwinter in freshwater to avoid the below-freezing temperatures of the nearshore marine waters, but ice-free waters are scarce during the winter (Arvey 1991). Overwintering areas are generally in locations of upwelling springs.

Young Dolly Varden feed on insects, insect larvae, and small crustaceans (Morrow 1980 ;USFWS 2008c). The diet of older Dolly Varden depends on the age, location, time of year, and availability of food. In freshwater, food may include insects, spiders, annelids, snails, clams, fish eggs, and various small fishes. In marine waters, food consists mostly of small fishes, invertebrates, and mysids (small shrimp-like organisms) (Morrow 1980).

Detailed life history information, extent of distribution within drainages, abundance, age and size composition, and detailed knowledge of spawning and overwintering habitats are limited or lacking for Dolly Varden populations of Beaufort Sea drainages (Viavant 2005). However, a study in 2001-2003 estimated abundance of overwintering aggregations to be 49,523 (SE = 7,277) fish in 2001 and 21,634 (SE = 3,075) fish in 2002. The study also identified spawning locations in the Kongakut, Ivishak, Echooka, Kavik, Ribdon, Lupine, Saviukviayak, and Anaktuvuk rivers. Timing and location of spawning were highly variable, as was the proportion of the overwintering population that spawned; and although overwintering fish were found in a large portion of studied drainages, the overwintering locations were variable (Viavant 2005).

b. Coregonids (Whitefishes and Ciscoes)

Coregonids are one of the most abundant and important groups of fishes in the proposed Beaufort Sea lease sale area (Armstrong 1996). They are important as forage fishes and for subsistence. Coregonid species found in the marine and freshwaters of the area include Arctic cisco, Bering cisco, least cisco, humpback whitefish, round whitefish, broad whitefish, and sheefish. Some species are anadromous while others are permanent freshwater residents. Although the life histories of whitefishes and ciscoes differ from each other in many respects, they all share common spawning behavior in which the eggs are broadcast over gravel rather than being laid in a redd, or nest, as with salmon (Morrow 1980). Detailed life history information specific to populations of the Beaufort Sea is limited or lacking.

The ***Arctic cisco*** is an anadromous fish species that spawns in freshwater in the summer and overwinters in nearshore marine waters (Morrow 1980). They are one of the most abundant species in Camden Bay (Wiswar and Fruge 2006). They are also one of the dominant species found in Simpson Lagoon and adjacent coastal waters of the Beaufort Sea during summer (Craig et al. 1985). They tend tend to stay in warm, brackish nearshore waters, perhaps because they aree anadromous. Citing to numerous studies, ABR Inc. et al. (2007) presented an overview of the life history of Beaufort Sea Arctic cisco (Table 4.3), which generally originate from the Mackenzie River in Canada. Arctic ciscoes feed on a wide range of organisms, including mysids, copepods, amphipods, isopods, chironomids, other insects, and various small fishes (Morrow 1980).

Bering cisco may be found in salt or brackish waters, where they overwinter, but they are also found far upstream in some areas (Morrow 1980). Spawning is assumed to occur in the fall, probably in clear water tributaries of major rivers. Bering cisco probably make long migrations for spawning, and probably move back downstream after spawning. However detailed information about their life history is lacking.

Table 4.3. Life history of Arctic cisco drainages of the Beaufort Sea.

Age (years)	Season	Event
0	Spring Summer Fall Winter	Newly hatched young-of-year (YOY) Arctic cisco are flushed downstream from spawning/hatching tributaries of the Mackenzie River into ice-free coastal waters. Known spawning tributaries include the Peel, Liard, and Arctic Red rivers. Depending on the strength and persistence of easterly winds, an unknown portion of YOY passively migrate westward in nearshore coastal currents in the Beaufort Sea. In years with easterly winds on average, fish are transported as far west as Prudhoe Bay or beyond. Some unknown portion of YOY cisco (as well as ages 1–2) remain in the Prudhoe Bay / Sagavanirktok River area, while others move to overwintering habitat in the Colville River. YOY remain under ice in brackish riverine waters until spring thaw. Distribution is poorly known.
1–7	Spring/Summer	Juveniles and subadults move out into the marine environment to feed in nearshore habitat in Beaufort Sea.
	Fall	Most juveniles and subadults move up the Colville River and its tributaries to overwintering habitat.
	Winter	Juveniles and subadults remain under ice in brackish habitat until spring thaw. Distribution is poorly known.
4–8	Fall	Subadults are available to the under-ice subsistence and commercial fisheries in the Colville River.
7–8	Spring/Summer	Onset of sexual maturity occurs. Adults migrate back to the Mackenzie River and its tributaries to spawn.
8–19	Fall Winter	Post spawning and non-spawning adults overwinter in the Mackenzie River and its tributaries. In subsequent years, repeat spawning is thought to occur. Adults are believed to overwinter in brackish riverine waters until spring thaw.
	Spring/Summer	Adults move out into the marine environment to feed in nearshore habitat in Beaufort Sea.

Source: ABR Inc. et al. 2007.

Least cisco are commonly found in the lakes and stream of the Arctic coast, and may also be found in brackish waters (Morrow 1980). Populations may be stream-dwelling and migratory, or lake-dwelling and non-migratory. The least cisco is one of the dominant species found in Simpson Lagoon and adjacent coastal waters of the Beaufort Sea during summer (Craig et al. 1985; Thorsteinson et al. 1991). They have a patchy distribution across the Beaufort Sea (Thorsteinson et al. 1991). Least cisco tend to be found in warm, brackish nearshore waters, probably because they are anadromous (Craig et al. 1985). Spawning occurs in the fall in late September and early October at water temperatures between 0°F and 3°F (Morrow 1980). Eggs spend the winter in the gravel, hatching in the early spring. Young-of-the-year move downstream to slower water by mid-June. Most females become sexually mature at 4 years old, and matures can become sexually mature at age 2. The maximum age for least cisco is probably between 8 and 11 years. Least cisco feed on various types of zooplankton such as small copepods, cladocerans, mysids, and both adults and larvae of various insects. Predators include eagles, hawks, kingfisher, northern pike, inconnu, lake trout, and burbot. Arctic grayling and whitefish eat least cisco eggs during spawning (Morrow 1980).

Humpback whitefish are considered to be truly anadromous and have been found in the Beaufort Sea several miles offshore of the Colville and Sagavanirktok rivers (Morrow 1980). However, some populations may be freshwater resident. Humpback whitefish begin migrating to freshwater for spawning in June, and spawning takes place in October. They may spawn under the ice in some locations. They become sexually mature at 4 to 6 years. Eggs probably hatch in the late winter and spring, and then the young are assumed to move downriver (Morrow 1980).

Round whitefish are found in many freshwaters of the Beaufort Sea area (Morrow 1980). They make upstream migrations to spawn, and probably spawn annually in late September through October. Round whitefish reach sexual maturity between age 5 and 7, depending on the location, and they may live as long as 16 years.

Broad whitefish are found in most rivers draining into the Beaufort Sea (Morrow 1980). They are anadromous but while in the ocean, probably remain close to shore in relatively brackish waters. During the summer, and sometimes into the fall, broad whitefish migrate into rivers where they spawn in September through October, and possibly into November (Morrow 1980). After spawning, adults move downstream to deep overwintering areas in rivers or estuaries. Eggs hatch in the spring and the young subsequently move downstream.

Detailed life history information about broad whitefish is lacking for the Beaufort Sea area, although a few studies have been conducted. From the summer of 2001 through June 2002, a study tracked movements of broad whitefish in Fish, Judy, and Inigok creeks, and the Ublutuoch and Colville rivers, which empty into Harrison Bay. This study found that broad whitefish used main channel habitats, small off-channel systems, and numerous lakes connected to the study creeks and rivers (Morris 2003). Based on 21 radio-tagged fish, broad whitefish used the lower 15 km of the Ublutuoch River, and about 5 km of Fish Creek upstream from the Ublutuoch River. Some fish also used the Colville River, migrating into Harrison Bay and then up the Colville River where they were found from just downstream of the Itkillik River to Ocean Point. The Ublutuoch River appears to be a significant overwintering area and may also be used for spawning. Fish Creek, Judy Creek, the Colville River, and several deep lakes off of Fish, Judy, and Inigok creeks were used for over-wintering. Use of tundra lakes and small tundra drainages by the fish was significant, particularly for Fish and Judy creeks. The study also found that some broad whitefish never left the system, while others left the system briefly or for the entire winter (Morris 2003).

c. Arctic Cod

The Arctic cod is one of the most abundant species found in waters of the Beaufort Sea (Armstrong 1996; Wiswar and Fruge 2006; Thorsteinson et al. 1991). They are generally found in brackish lagoons, river mouths, and in nearshore marine waters, although they sometimes occur in deeper waters and farther offshore (Mecklenburg et al. 2002). They are one of the dominant species found in Simpson Lagoon and adjacent coastal waters of the Beaufort Sea during both summer and winter (Craig et al. 1985). Their use of nearshore versus offshore habitats is unclear and their local occurrence is highly variable (Craig et al. 1982). They are found dispersed throughout the year, but are also found in aggregations during the summer in nearshore waters (Welch et al. 1992). In Camden Bay, one study estimated 83.6 million cod in the upper 2 m of the bay, and the weight of the population weight was estimated to be 1.6 million kg (Thorsteinson et al. 1991).

Arctic cod are tolerant of cold water and often live along the edges of pack ice (Armstrong 1996) inhabiting narrow wedges of seawater along the melting edges of ice floes (Gradinger and Bluhm 2004). They are also found in ice-free waters during the summer (Mecklenburg et al. 2002).

Arctic cod are short-lived, mature early at age 2 or 3, and may only spawn once, in contrast to most other Arctic fishes that tend to be long-lived, be older when they reach sexual maturity, and spawn several times (Craig et al. 1982). Arctic cod spawn between late November and early February

(Craig et al. 1982). Spawning occurs in the water column near the surface. Spawning Arctic cod are found under the ice close to the ice margin(Ponomarenko 2000). Eggs are found in water below 0°C to 2°C. Developing eggs are found in accumulations under the ice and hatching occurs when the ice begins melting. The larval period lasts 3-4 months (Ponomarenko 2000).

Arctic cod are a critical component of arctic food webs as they are one of the main species that transfers planktonic organisms to other fish, birds, and wildlife (Welch et al. 1992; Welch et al. 1993). They feed on planktonic copepods and amphipods, ice-associated amphipods, and epibenthic crustacean. They are important food prey for other fish, seals, beluga whales, narwhals, and seabirds (Armstrong 1996). In arctic waters of Canada, they occasionally occur in large schools where they may be preyed on by thousands of seabirds and marine mammals such as black-legged kittiwakes, northern fulmars, harp seals, beluga whales, and narwhal (Welch et al. 1993). It has been estimated that 125,000 tonnes of cod are consumed by marine mammals and 23,000 tonnes by seabirds annually in the Landcaster Sound region of arctic Canada (Welch et al. 1992). Density of aggregations of Arctic cod, which may comprise over 900 million fish (Crawford and Jorgenson 1996), may be influenced by ice cover and conditions (Crawford and Jorgenson 1993). Large concentrations of Arctic cod in nearshore waters during the winter probably play an important role in the structure of the ecosystem (Benoit et al. 2008).

2. Birds

The Beaufort Sea area is inhabited by large numbers of migratory birds (Table 4.4), especially sea ducks, during the summer for breeding, molting, migration, and foraging. Their use of the area varies by species, timing, and location (Map 4.2; Fischer and Larned 2004; Noel et al. 2005a).

The Colville River, Fish Creek, Sagavanirktok River, Kuparuk River, and Canning River deltas, and Simpson Lagoon are important nesting and breeding areas for waterfowl (MMS 1996, Vol. III). The Colville, Sagavanirktok and Kuparuk river deltas provide important breeding and brood-rearing habitats for tundra swans, black brant, snow geese, and Canada geese. Howe Island, located in the Sagavanirktok River delta, is the location of one of two known snow goose nesting colonies in the United States (USFWS 1992b). This island is also important for black brant nesting (USFWS 1992b). The Return Islands, Jones Islands, McClure Islands, Cross Island, and Lion Point are important for nesting common eider. Thousands of long-tailed ducks concentrate near Flaxman Island to molt (USFWS 1992a). Greater-white fronted geese are also found nesting and rearing in the major river deltas and other coastal plain areas (ADF&G 1997).

The most abundant marine and coastal species include red phalarope, long-tailed ducks, glaucous gull, and common eider. Nearly all of these species are migratory and are found in the Arctic seasonally, generally from May through September. Shortly after spring migration, most shorebird and waterfowl populations disperse to nesting grounds primarily on tundra and marshlands of the Arctic Slope. Beginning in mid-July large concentrations of long-tailed ducks and eider occur in coastal waters inshore of islands where the birds feed and molt before fall migration. Use of lagoons and other coastal habitats peaks in August to late September before and during the fall migration (MMS 1996, Vol. III).

The spring lead system east of Point Barrow provides a long but narrow front of open water, which is utilized by millions of birds in their migration to nesting grounds. Nearly all of the king eider population of Alaska and Canada, as well as thousands of long-tailed ducks and common eiders, use this lead system (USFWS 1992b). Major concentrations of birds occur in nearshore and coastal areas such as the Plover Islands and Barrow Spit. They also concentrate at Pitt Point, and the Colville River Delta. Timing of the spring migration varies with changes in wind direction and in the availability of open-water leads (USFWS 1987, Vol. III).

Table 4.4. Birds commonly observed in the Beaufort Sea area.

Common Name	Scientific Name
Common Loon	*Gavia immer*
Red-throated Loon	*Gavia stellata*
Pacific Loon	*Gavia pacifica*
Yellow-billed Loon	*Gavia adamsii*
Red-necked Grebe	*Podiceps grisegena*
Tundra Swan	*Cygnus columbianus*
Brant	*Branta bernicla nigricans*
Greater White-fronted Goose	*Anser albifrons*
Snow Goose	*Chen caerulescens*
Canada Goose	*Branta canadensis*
Green-winged Teal	*Anas crecca*
Mallard	*Anas platyrhynchos*
Northern Pintail	*Anas acuta*
Northern Shoveler	*Anas clypeata*
American Wigeon	*Anas americana*
Greater Scaup	*Aythya marila*
Common Eider	*Somateria mollissima*
King Eider	*Somateria spectabilis*
Spectacled Eider	*Somateria fischeri*
Steller's Eider	*Polysticta stelleri*
Oldsquaw	*Clangula hyemalis*
Black Scoter	*Melanitta nigra*
Surf Scoter	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Red-breasted Merganser	*Mergus serrator*
Northern Harrier	*Circus cyaneus*
Rough-legged Hawk	*Buteo lagopus*
Golden Eagle	*Aquila chrysaetos*
Peregrine Falcon	*Falco peregrinus*
Gyrfalcon	*Falco rusticolus*
Willow Ptarmigan	*Lagopus lagopus*
Rock Ptarmigan	*Lagopus mutus*
Sandhill Crane	*Grus canadensis*
Black-bellied Plover	*Pluvialis squatarola*
American Golden-Plover	*Pluvialis dominica*
Semipalmated Plover	*Charadrius semipalmatus*
Whimbrel	*Numenius phaeopus*
Hudsonian Godwit	*Limosa haemastica*
Bar-tailed Godwit	*Limosa lapponica*

-continued-

Table 4.4. Page 2 of 3.

Common Name	Scientific Name
Ruddy Turnstone	*Arenaria interpres*
Red Knot	*Calidris canutus*
Sanderling	*Calidris alba*
Semipalmated Sandpiper	*Calidris pusilla*
Western Sandpiper	*Calidris mauri*
White-rumped Sandpiper	*Calidris fuscicollis*
Baird's Sandpiper	*Calidris bairdii*
Pectoral Sandpiper	*Calidris melanotos*
Dunlin	*Calidris alpina*
Stilt Sandpiper	*Calidris himantopus*
Buff-breasted Sandpiper	*Tryngites subruficollis*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Common Snipe	*Gallinago gallinago*
Red-necked Phalarope	*Phalaropus lobatus*
Red Phalarope	*Phalaropus fulicaria*
Pomarine Jaeger	*Stercorarius pomarinus*
Parasitic Jaeger	*Stercorarius parasiticus*
Long-tailed Jaeger	*Stercorarius longicaudus*
Mew Gull	*Larus canus*
Herring/Thayer's Gull	*Larus argentatus/thayeri*
Glaucous Gull	*Larus hyperboreus*
Black-legged Kittiwake	*Rissa tridactyla*
Sabine's Gull	*Xema sabini*
Arctic Tern	*Sterna paradisaea*
Black Guillemot	*Cepphus grylle*
Snowy Owl	*Nyctea scandiaca*
Short-eared Owl	*Asio flammeus*
Horned Lark	*Eremophila alpestris*
Cliff Swallow	*Hirundo pyrrhonota*
Common Raven	*Corvus corax*
Gray-cheeked Thrush	*Catharus minimus*
Varied Thrush	*Ixoreus naevius*
Yellow Wagtail	*Motacilla flava*
Water Pipit	*Anthus spinoletta*
Orange-crowned Warbler	*Vermivora celata*
Yellow Warbler	*Dendroica petechia*
American Tree Sparrow	*Spizella arborea*
Savannah Sparrow	*Passerculus sandwichensis*
White-crowned Sparrow	*Zonotrichia leucophrys*
Dark-eyed Junco	*Junco hyemalis*

-continued-

Table 4.4. Page 3 of 3.

Common Name	Scientific Name
Lapland Longspur	*Calcarius lapponicus*
Snow Bunting	*Plectrophenax nivalis*
Rusty Blackbird	*Euphagus carolinus*
Robin	*Turdus migratorius*
Northern shrike	*Lanius excubitor*
Wheatear	*Oenanthe oenanthe*
Bluethroat	*Luscinia avacica*
Arctic warbler	*Phyiloscopus borealis*
Wilson's warbler	*Wilsonia pusilla*
Fox sparrow	*Passereila iliaca*
Common/Hoary Redpoll	*Carduelis flammea/hornemanni*

Source: Adapted from ADNR 1991.

Shortly after spring migration, shorebirds and waterfowl disburse to nesting grounds primarily on moist tundra and marshlands. Teshekpuk Lake, to the southeast of the proposed lease sale area is a major nesting area. The Plover islands, such as Cooper and Deadman Islands, are important nesting grounds for black guillemont. The nearshore and coastal areas of Elson Lagoon in the Plover Islands also support thousands of marine birds. The same is true of the pelagic areas offshore Point Barrow (USFWS 1987, Vol. III). Other species, such as common eider, glaucous gulls, black guillemots, and Arctic turns, also nest on these barrier islands.

a. Common Eider

The common eider (*Somateria mollissima*) is abundant in the Beaufort Sea area (Map 4.2; Johnson and Herter 1989). Four races of common eider inhabit North America, but only the Pacific race is found in Alaska (ADF&G 1994). They are less common than king eiders, making up only about 10 percent of the total eiders that use the Beaufort Sea area (Johnson and Herter 1989). They breed and nest at scattered locations across the Arctic coast, as well as many other locations along the Pacific and Atlantic coasts, Iceland, and Siberia. Common eiders from the Beaufort Sea area may overwinter within the Arctic Ocean (Johnson and Herter 1989), but most probably spend the winter in Russia probably overwinter from the Bering Sea and migrate past Point Barrow during the spring and fall (USFWS 2006, Dickson et al. 2005, Petersen and Flint 2002).

Abundance of common eiders of the Beaufort Sea are considered to be declining. Common eiders migrating past Pt. Barrow in the spring declined from 156,081 birds in 1976 to 72,606 birds in 1996, but reasons for the decline are unknown (Suydam et al. 2000). Aerial surveys in 2008 indicated that some population indices were increasing for some locations (Dau and Larned 2008). Some indices, such as nesting effort, are highly variable by location and year (Flint et al. 2003, Chapter 10). Some studies have shown that common eiders are doing poorly in all stages of breeding, as evidenced by low nesting effort, small clutch sizes, poor hatch success, and poor fledging success (Flint et al. 2003, Chapter 14).

Common eiders are protected under the Migratory Bird Treaty Act, and are listed as Birds of Management Concern (USFWS 2006). Birds are included on this list if they present special management challenges because of a variety of factors such as too few, too many, conflicts with human interests, or societal demands. As a Bird of Management Concern, the common eider is considered a "game bird below desired condition", meaning the species has a population that is below long-term average or management goals, or exhibits declining population trends (USFWS 2006). An action plan has been developed by the USFWS because available information indicates that the population is decreasing and there are significant gaps in research and monitoring. The objectives of the action plan are to (USFWS 2006, p. 5):

1. Review the current state of knowledge of the species status, natural history, and possible limiting factors
2. Define what actions need to be taken to increase our knowledge of the species and overcome limiting factors.
3. Prioritize and set a timeline for actions needed to achieve the goals of improving the species status.
4. Identify programs or entities to address the management actions identified in Plan.

There is no conclusive data to explain population declines of common eiders in the Beaufort Sea area, although it is unlikely that contaminants are the cause. Possible explanations include gull predation and disease (Flint et al. 2003, Chapter 14). Overharvesting by humans, primarily by Native peoples of northern communities, could be a significant factor in declines of common eiders (USFWS 2006). Sustainable levels of exploitation are unknown, although the current level is believed to be sustainable.

Spring migrations of common eiders begin in early March, and they pass Pt. Barrow in early May (Johnson and Herter 1989). Their eastern migrations are usually within 48 km of shore during the early morning. Early spring migrations may be negatively affected by unfavorable weather and ice conditions, and birds may succumb to starvation during the migration. The amount of open water is considered an important factor regulating the spring migration.

Common eiders nest in loose aggregations or colonies on barrier islands and spits from mid to late June (Johnson and Herter 1989). They do not generally form large colonies, unlike populations in other areas. Nesting locations include islands in coastal lagoons and in river deltas, spits, and barrier island beaches that offer protection from terrestrial predators. Nesting birds also appear to prefer locations near marine feeding areas that are relatively ice-free, and they begin nesting after ice melts enough to isolate their nesting areas from the mainland to avoid predators (Johnson and Herter 1989; ADF&G 1994). Nests are usually made in well-protected locations near logs, in driftwood, between rocks, in clumps of grass or thick vegetation, and on tundra ponds. The female usually selects the nest site, and may return each year to the same site.

Common eiders begin breeding when they are at least two years old (ADF&G 1994) and may live longer than 20 years (USFWS 2006). Clutch size is usually about four eggs, but ranges from one to ten (Johnson and Herter 1989). Timing of ice breakup affects the timing of nesting, which in turn affects the amount of nesting that takes place and clutch size (Flint et al. 2003, Chapter 14). The young hatch in mid to late July after an incubation period of 26 days (Johnson and Herter 1989). Hatching success depends on many factors, including clutch size and density of cover near the nest site (Johnson and Herter 1989), and is also strongly influenced by predation (Flint et al. 2003, Chapter 14). Young are usually led directly to water soon after they hatch, during which they are exposed to extreme risk of predation (Johnson and Herter 1989). The young also experience high mortality from exposure and starvation (USFWS 2006). Females may crèche their young, a process in which several females care for the young jointly, allowing the females to feed more often and regain more quickly their weight lost during egg laying and incubation (Johnson and Herter 1989). Fledging occurs from 6 to 12.5 weeks after hatching.

Males leave the nesting areas in late June and early July as incubation begins. They migrate to molting areas near Point Lay, Icy Cape, and Cape Lisburne in western Alaska (Johnson and Herter 1989). Female common eiders have been found molting in shallow, protected waters near Cape Parry northeast of the Tuktoyaktuk Peninsula, and at Harrowby Bay near Cape Bathhurst. Females and their young begin the fall migration in late August or early September, moving west to their wintering areas in the Bering Sea (Johnson and Herter 1989). The fall migration may continue into late October and early November.

Common eiders spend most their life at sea. Females are found on land only while they are laying and incubating eggs, returning to the sea to rear their brood (USFWS 2006). Common eiders dive for their food, which is gathered from bottom sediments and includes clams, mussels, crabs, shrimps, aquatic insects, and vegetation (ADF&G 1994). Predators include glaucous gulls, arctic foxes, and polar bears which may prey heavily on nesting common eiders (Noel et al. 2005b; Johnson and Herter 1989).

Biology of common eiders is poorly understood. Their annual productivity is probably low, they likely reach sexual maturity late, annual survival of adults is probably high, and stability of the population probably depends on adult survival. Natural mortality on adults may be caused by periodic die-offs from extreme weather and ice conditions, and the only known human-caused mortality is from subsistence hunting (Suydam et al. 2000).

b. Spectacled Eider

Spectacled eiders (*Somateria fischeri*) breed from northcentral Siberia to the Yukon Territory, along the Beaufort Sea coast, south to northern Bristol Bay (Map 4.2; ADF&G 1994). In Alaska, they are a relatively uncommon breeding bird of the Beaufort Sea area, although they are found in the Colville River area, and along the coast plain near Prudhoe Bay (Johnson and Herter 1989). They are more common in the Yukon-Kuskokwim Delta, probably because they prefer shallow, muddy coastal waters.

USFWS

Common eider nest with eggs.

Spectacled eiders were listed as threatened under the Endangered Species Act on May 10, 1993 (58 FR 27474) because of the Yukon-Kuskokwim Delta breeding population had declined 96 percent from the 1970s to the early 1990s (USFWS 2002b). On February 6, 2001, the USFWS designated critical habitat for spectacled eider (66 FR 9146), none of which is located in the Beaufort Sea area (USFWS 2004b). Causes for declines in spectacled eider populations are poorly understood, but some potential factors are lead poisoning from ingesting spent lead shot, hunting, predation, and changes to spectacled eider prey populations in the Bering Sea (USFWS 1999).

The three primary breeding grounds for spectacled eiders are the central coast of the Yukon-Kuskokwim Delta, the Arctic coastal plain of Alaska, and the arctic coastal plain of Russian (USFWS 1999). Spectacled eiders leave wintering areas in March and April, arriving at coastal nesting areas by mid-May or early June (USFWS 2002b). Nests are usually built within 3 m of shallow ponds or lakes (USFWS 1999) on slightly elevated tundra (Johnson and Herter 1989). Females lay one egg per day, with most clutches numbering five or six eggs and ranging from four to nine eggs. Hatching occurs from late June through July after about 24 days of incubation (Johnson and Herter 1989). Predation on eggs and young spectacled eiders from gulls and foxes can be heavy (ADF&G 1994).

Breeding females and their young are found on the nesting grounds until late August or early September, although females whose nests have failed return to sea by late July (USFWS 2002b). Males only remain on shore for a few weeks, returning to sea after eggs have been laid by the end of June (USFWS 2002b). The distribution of non-breeding spectacled eiders from May to October is poorly documented (USFWS 2002b). They likely inhabit shallow coastal areas in the Bering and Chukchi seas in small, scattered flocks.

Breeding spectacled eiders congregate to molt in late summer and fall and may be found in molting areas from July to October. Males begin reaching molting areas first, in late June. Non-breeding or unsuccessful breeding females begin arriving in late July, and successful breeding females arrive in late August or September (USFWS 2002b). There are four principle molting areas. Two molting areas are found on the coast of Alaska: eastern Norton Sound and Ledyard Bay, between Cape Lisburne and Point Lay. Two areas are on the coast of Russia: Mechigmenskiy Bay on the Chukotka Peninsula, and an area between the Indigirka and Kolyma river deltas (USFWS 2002b). Females nesting in northern Alaska migrate to either Ledyard Bay or Mechigmenskiy Bay to molt. Males from all three breeding areas molt in Ledyard Bay, Mechigmenskiy Bay, and in the area between the Indigirka and Kolyma river deltas (USFWS 2002b).

By late October, spectacled eiders begin migrating to overwintering areas. These migration corridors follow coastal and offshore paths through the Bering and Chukchi seas. Wintering areas are offshore, primarily in the central Bering Sea south and southwest of St. Lawrence Island. Other wintering areas have not been documented (USFWS 2002b).

Spectacled eiders are diving ducks. In their wintering areas, they feed on bottom-dwelling molluscs and crustaceans at depths of up to 70 m (USFWS 2002b). Spring feeding is particularly important, because females must accumulate enough nutrient reserves for egg-laying and incubation. While breeding and nesting, they feed on aquatic insects, crustaceans, and vegetation in ponds and wetlands.

c. <u>Steller's Eider</u>

Three breeding populations of Steller's eider (*Polysticta stelleri*) are recognized: two in Arctic Russia and one in Alaska (USFWS 2002a). The Alaska-breeding population has been listed as threatened under the Endangered Species Act since June 11, 1997 (62 FR 31748). On February 2, 2001, the USFWS designated critical habitat for Steller's eiders (66 FR 8850), none of which is located in the Beaufort Sea area (USFWS 2004a), and a recovery plan was published in 2002

(USFWS 2002a). Possible causes for declines in Steller's eiders remain poorly understood, but could include predation, hunting, ingestion of lead shot, and changes in the marine environment. Aerial surveys, which do not demonstrate a significant population trend from 1989-2000, indicate that Steller's eiders probably number in the hundreds or low thousands on the Arctic coastal plain (USFWS 2002a).

The Alaska-breeding population intermixes with the two Russian populations during the spring migration, autumn molt, and winter (USFWS 2002a). Steller's eiders stage in the thousands to tens of thousands for the spring migration in estuaries along the north side of the Alaska Peninsula. They migrate across Bristol Bay and may spend days or weeks feeding and resting in northern Kuskokwim Bay and its smaller bays before continuing northward to nesting areas(USFWS 2002a).

Nesting of the Alaska-breeding population occurs primarily on the Arctic coastal plain (Map 4.2), and a very small subpopulation breeds on the Yukon-Kuskokwim Delta (USFWS 2002a). These subpopulations are poorly understood and historical information and current population abundance estimates are lacking. The area around Barrow is considered to be particularly important for breeding. Steller's eiders nest on tundra along the shores of lakes, ponds, and lagoons (Johnson and Herter 1989). Eggs are laid from early June to early July, with clutches ranging from 6-10 eggs. Eggs hatch after an incubation period of about 3 weeks, beginning during early July.

After breeding, Steller's eiders migrate to molting areas in marine waters from late July through late October (USFWS 2002a). Males probably depart for molting areas in mid-June, early in the incubation period; most Steller's eiders are gone from the Beaufort Sea area by early October (Johnson and Herter 1989). Large numbers of Steller's eiders molt in locations in southwest Alaska, particularly shallow areas with eelgrass beds and intertidal sand flats and mudflats that provide an environment for foraging for marine invertebrates such as molluscs and crustaceans. Steller's eiders then move to wintering areas of the Aleutian Islands, Alaska Peninsula, Kodiak Island, and Cook Inlet (USFWS 2002a).

d. King Eider

King eiders (*Somateria spectabilis*) have a circumpolar distribution, but are particularly abundant along the eastern Beaufort Sea coast (Map 4.2) and arctic islands of Canada (ADF&G 1994). From 1953-1976 the migration of king eiders passing Pt. Barrow in the spring was stable, but declined from 802,556 in 1976 to 350,835 in 1996 (Suydam et al. 2000). Reasons for this decline are unknown, but there is no corresponding indication that the number of king eiders breeding in Alaska has declined. Productivity of king eiders is affected by weather and ice conditions, and mass starvation and poor production can occur if temperatures are low and ice and snow cover persists (Johnson and Herter 1989).

King eiders winter in the Bering Sea and north Pacific Ocean (Suydam et al. 2000), including Kodiak, along the Alaska Peninsula, and the Aleutian Chain (ADF&G 1994). In the spring, they migrate north to nest in Russia, Alaska, and northwestern Canada (Suydam et al. 2000). Those nesting in Alaska and Canada migrate past Pt. Barrow and across the Beaufort Sea during the spring migration (Suydam et al. 2000). The entire western population is believed to migrate past Pt. Barrow (SDJV 2004). King eiders may begin migrating into the Beaufort Sea area as early as mid to late April, with large numbers arriving by mid-May (Johnson and Herter 1989). Migration routes and timing are determined largely by offshore lead systems in the Beaufort Sea pack ice.

Nests are usually built in vegetated areas near lakes or ponds (Johnson and Herter 1989). Clutch size ranges from two to six eggs, and eggs usually hatch by mid-July. King eiders form crèches of up to 100 ducklings, usually with two or three hens. Predators on eggs and young include arctic fox, jaegers, and glaucous gulls (SDJV 2004).

By late June through July, male king eiders migrate to molting areas in Bering and Chukchi seas (ADF&G 1994) with females following several weeks later (SDJV 2004). During fall migrations, they move west and south, again passing Point Barrow, to the Chukchi and Bering seas (Suydam et al. 2000).

Biology of king eiders is poorly understood, but they probably have low annual productivity, reach sexual maturity relatively late, have high annual survival of adults, and stability of the population probably depends on adult survival. Causes of natural mortality on adults include periodic die-offs from extreme weather and ice conditions; the only known human-caused mortality is from subsistence hunting (Suydam et al. 2000).

e. Long-tailed Duck

The long-tailed duck (*Clangula hyemalis*) is one of the most common species of waterfowl nesting in the Beaufort Sea area. They frequently nest in clusters or colonies. Their nests consist of small, cup-like hollows that are usually surrounded by tall grass. Long-tailed duck clutches of 9-12 eggs are common, but most number 5-10 eggs. In the Beaufort Sea area most eggs hatch from July 16 to July 28. Female long-tailed ducks lead their young to the nearest water shortly after the young have hatched and dried. Fall migration begins in late September or early October (Johnson and Herter 1989).

Barrier island shorelines, lagoons, and nearshore areas are important habitat for molting long-tailed ducks. Locations of major concentrations of molting long-tailed ducks include south shorelines and lagoons near Thetis, Spy, Long, Jones, Arey, McClure, Pingok, Leavitt, Cottle, Egg, Pole, and Flaxman islands. Peak densities of long-tailed ducks molting in Simpson Lagoon were estimated at 50,000 birds, and approximately 32,000 long-tailed ducks have been recorded at a single time in the lagoon area behind Flaxman Island. The molt period extends from early June through early September (USFWS 1998).

Although the population of long-tailed ducks on the Arctic Coastal Plain has remained relatively stable, populations in northwest Canada and other regions of Alaska have declined 75 percent (USFWS 1998). The USFWS considers long-tailed ducks to be a species-at-risk (USGS 2008).

f. Red Phalarope

Red phalaropes (*Phalaropus fulicarius*) are a common migrant and breeder throughout the Beaufort Sea. They appear in the area in late May or early June. Nesting takes place in hummocky, moss seged-tundra interspersed with numerous ponds. Females usually lay four eggs. However if breeding is delayed, clutch size is reduced. Males incubate the eggs and care for the young until shortly before they are fledged. The fledging period is 16 to 18 days. The male then abandons the young and departs the breeding area. Adult migration commences from early June to mid-August. The young depart the nesting areas from mid-August to early September (Johnson and Herter 1989).

g. Glaucous Gull

The glaucous gull (*Larus hyperboreus*) is a common migrant and breeder in the Beaufort Sea area, usually arriving during May. Glaucous gulls select several types of nesting sites depending on availability. Pairs either nest on low islands and sandbars near or on the coast or on inland river bars or small islands in lakes. They are most common on barrier islands immediately offshore from rivers that flood in the spring and thereby protect the nests from foxes. On level terrain, nests may be as much as a meter high and are composed of vegetation. Occasionally, nests consist of a simple depression in the beach and have little or no lining material. Egg laying begins in mid-June and continues through late June. The normal clutch size is three eggs and hatching begins in the second week of July. Chicks are attended by both parents until they fledge in about 45 to 50 days. During the breeding season these gulls prey heavily on the eggs and chicks of other birds. Fall migration begins in mid-September. The young remain somewhat later than most adults (Johnson and Herter 1989).

h. Tundra Swan

Tundra swans (*Cygnus columbianus*) are common breeders on the coastal plain of the Beaufort Sea area. Tundra swans begin nesting during the last week of May and the first two weeks of June. Nests are large, approximately 1 m high and up to 2 m in diameter, and widely scattered. The nests are generally located on sedge tundra. After hatching in late June or early July, broods are reared in nesting territory (Smith et al. 1993). Adults molt from mid-July through August. Fall migration occurs from late September to early October. They winter along the east and west coasts of North America, from the Aleutian Islands to California and from Maryland to North Carolina (Johnson and Herter 1989).

i. Black Brant

Black brant (*Branta bernicla nigricans*) are a common migrant and breeding bird along the Beaufort Sea coast. Black brant nest on islands in the Colville River and the Sagavanirktok River deltas. Nesting takes place in June. Black brant normally lay four to eight eggs. Black brant do not re-nest if their first attempt at nesting fails. The newly hatched geese leave the nest within 48 hours and they move to nearby tidal flats where they spend the brood-rearing period. Brood-rearing ends and the fall migration begins around the second week of August. Some brant remain in the Beaufort Sea area until late September or early October (Johnson and Herter 1989).

j. Arctic Peregrine Falcon

Arctic peregrine falcons (*Falco peregrinus tundrius*) nest south of the proposed lease sale area primarily on bluffs along the Colville River from Umiat to Ocean Point, and at Franklin and Sagwon Bluffs in the Sagavanirktok River drainage. Additional nest sites may occur at other locations. Arctic peregrine falcons are present on the North Slope from late April through September. Nesting begins by mid-May, and the young birds fledge from late July to late August. Immature peregrine falcons from the Colville to the Sagavanirktok River drainages move toward the Beaufort Sea coast in mid to late August. Peregrine falcons generally have left the North Slope by late September (ADF&G 1997). Arctic peregrine falcons are considered a species of special concern by the State of Alaska because of population declines (ADF&G 2008b).

k. Snow Goose, Canada Goose, and Greater White-fronted Goose

Snow geese (*Chen caerulescens*) arrive in the Sagavanirktok River delta during the last week of May and occupy nesting habitat on Howe Island in the first days of June. Most adult females arriving on the breeding grounds have already paired and copulated and have well-developed eggs in their oviducts. They lay their eggs within 4 days to a week after they arrive. They build their nests of grass and bits of willow on high ground. Clutch size is three to six eggs, which usually hatch during the last week of June or the first week of July. Snow goose goslings require about 7 weeks to fledge. They leave the brood-rearing areas by about August 15 to August 20 and congregate in immense flocks on the coastal tundra to feed almost continuously. Snow geese and black brant from the Howe Island colonies often move to the Kadleroshilik River delta to rear in the salt marshes (ADF&G 1992). Half of the snow geese from the Howe Island colony take their broods to the Kadleroshilik River salt marshes for the months of July and August (USFWS 1992b). Fall migration begins in the second or third week of September (Johnson and Herter 1989).

Canada geese (*Branta canadensis*) arrive along the Arctic coast during the last two weeks of May and the first week of June. They nest primarily away from the sea coast, on bluffs along the Colville River. However, some isolated pairs have been found nesting in moderate densities in coastal wetlands near Prudhoe Bay. They usually lay their eggs during the first or second week of June. The clutch size may vary from 1-10 eggs which hatch within the first two weeks of July. After the goslings have fledged in mid-August, flocks begin dispersing along the Beaufort Sea and begin their southward migration.

The ***greater white-fronted goose*** (*Anser albifrons*) is a common breeding bird along the Beaufort Sea coast. They reach the Beaufort Sea breeding areas from the second week of May to the first week of June. The female usually selects a nest site on well-vegetated (scrub willow tundra) and well-elevated habitat near a lake or river. Eggs are laid during the last half of May or the first two weeks of June. The female lays her eggs in a slight depression and builds the nest as she completes her clutch of four to seven eggs. The incubation period varies from 23 to 28 days. Breeding adults usually molt when goslings are 2 to 3 weeks old. Fall migration may begin as early as August 10 with the last greater white-fronted geese leaving Alaska by the end of September (Johnson and Herter 1989).

l. Yellow-billed Loon

The Colville River Delta supports some of the highest densities of breeding yellow-billed loons (*Gavia adamsii*) in Alaska (Smith et al. 1993). Yellow-billed loons arrive in the Beaufort Sea area in late May. They concentrate during spring with other species of loons in early-melting areas off the deltas of the Sagavanirktok, Kuparuk, and Colville rivers. Yellow-billed loons prefer gently sloping shores of deep tundra lakes as nest sites. The nest is usually a built-up mound of turf and mud on the shoreline of a lake or occasionally on the shoreline of a large river. Egg laying begins as early as the second week of June and hatching takes place in July and early August. The normal clutch size is two eggs. The age at which yellow-billed loons fledge has not been documented but may be similar to common loon chicks which is 45 days. The peak fall migration for yellow-billed loons is in late August or early September (USFWS 1992b; Johnson and Herter 1989). In 2007, the USFWS published a notice of 90-day petition finding and initiation of status review to begin the process of determining if yellow-billed loons should be listed as threatened or endangered under the Endangered Species Act (72 FR 31256-31264).

3. Terrestrial Mammals

a. Caribou

Caribou (*Rangifer tarandus granti*) inhabit much of Alaska, occurring in a small band of terrestrial habitat included in the proposed Beaufort Sea lease sale area. In Alaska, caribou occur in 32 herds, or groups with distinct calving areas (ADF&G 1994). Although their calving areas are separate, herds may intermingle on winter ranges. Four caribou herds use the coastal habitats adjacent to the proposed lease sale area: the Western Arctic Herd, Teshekpuk Lake Herd, Central Arctic Herd, and the Porcupine Caribou Herd (Map 4.3).

The Teshekpuk Lake Herd (TCH) uses the area around Teshekpuk Lake for calving, grazing, and insect relief. Note that most of this area is outside the proposed lease sale area and much of the critical habitat is subject to development restrictions and other protections. A photocensus of this herd counted a record 45,166 caribou in 2002 (Carroll 2007b; Table 4.5). The TCH moves towards Teshekpuk Lake during May (Carroll 2007b). The northeast, east, and southeast of the lake are the primary areas used for calving, which takes place in early June. The TCH seeks relief from insects along the Beaufort Sea coast from Dease Inlet to the mouth of the Kogru River, around the edges and on islands of Teshekpuk Lake, and on sand dunes along the Ikpikpuk River and south of Teshekpuk Lake. The area north of Teshekpuk Lake is particularly important for insect relief and grazing. Narrow strips of land to the east and northwest of the lake provide important migratory corridors for traveling to and from insect relief areas. The TCH usually winters on the coastal plain, especially around Atqasuk and South of Teshekpuk Lake, but this herd may also be found in the foothills and mountains of the Brooks Range, as far south as the Seward Peninsula, and as far east as the Alaska National Wildlife Refuge (Carroll 2007b).

The Central Arctic herd (CAH) calving area lies between the Colville and Kuparuk rivers on the west side of the Sagavanirktok River and between the Sagavanirktok and the Canning Rivers on the east side (Lenart 2007c). The most recent photocensus counted 31,857 caribou in 2002, a record since 1978 (Table 4.5). During the summer, this herd is found from Fish Creek, just west of the Colville River, eastward along the coast, and inland about 30 miles, to the Katakturuk River. Their winter range is the northern and sourthern foothills and mountains of the Brooks Range. In the summer and winter, this herd often overlaps the range of the PCH to the east, and the WACH and TCH to the west.

Table 4.5. Population estimates for the four caribou herds of the Beaufort Sea area.

Teshekpuk		Central Arctic		Porcupine		Western Arctic	
Year	Population Estimate	Year	Population Estimate[a]	Year	Population Estimate[a]	Year	Population Estimate[c]
1978-1982	3,000-4,000	1978	5,000	1961	110,000	1970	242,000
1984	11,822	1981	8,537	1972	99,959	1976	75,000
1985	13,406	1983	12,905	1977	105,000	1978	107,000
1989	16,649	1991	19,046	1979	105,683	1980	138,000
1993	27,686	1992	23,444	1982	125,174	1982	172,000
1995	25,076	1995	18,100	1983	135,284	1986	229,000
1999	28,627	1997	19,730	1987	165,000	1988	343,000
2002	45,166	2000	27,128	1989	178,000	1990	416,000
		2002	31,857	1992	160,000	1993	450,000
				1994	152,000	1996	463,000
				1998	129,000	2003	490,000
				2001	123,000	2007	377,000
				2002-2007[b]			

[a] Estimated by several different methods.

[b] No estimates because of weather or poor aggregation

[c] Minimum estimate.

Source: Carroll 2007b; Lenart 2007c; Lenart 2007b; Dau 2007.

The Porcupine caribou herd (PCH) migrates across a range covering 130,000 m^2 and multiple geopolitical boundaries including Alaska in the U.S. and the Yukon and Northwest Territories in Canada (Lenart 2007b), most of which is outside the proposed Beaufort Sea lease sale area. The most recent photocensus occurred in 2001, with 123,000 caribou counted (Table 4.5). Caribou of the PCH may occur in a small band of terrestrial habitat included in the proposed Beaufort Sea lease sale area. The PCH migrates more than 700 miles each way as it moves from wintering areas in the south of its range to spring calving grounds on the arctic coastal plain (USFWS 2009b). The calving grounds stretch from the northern foothills of the Brooks Range to the arctic coastal plain from the Tamayariak River in Alaska to the Babbage River in Canada. From 50-75 percent of calves are born in the Arctic National Wildlife Refuge between Katakturuk and Kongakut rivers (USFWS 2009a). This area provides important protection from predators, such as wolves, brown bears, and golden eagles which are more abundant in the adjacent foothills and mountains, and the area has an abundance of plant species that provide important nutritional value to pregnant cows (USFWS 2009a). By late June and early July, the herd moves along the coast, onto ice fields, and to uplands of the Brooks Range for insect relief. By mid-July, the herd begins migrating to its fall and wintering areas to the east and south (USFWS 2009b).

The Western Arctic herd (WAH) has a range covering about 140,000 m^2 (Dau 2007). In 2007, 377,000 caribou of this herd were counted (Table 4.5). Calving areas of the WAH include the Brooks Range and its northern foothills west of the Trans-Alaska Pipeline, with most calving occurring in the Utukok uplands. The herd moves west toward the Lisburne Hills and then into the western North Slope and DeLong Mountains. The herd then moves east through the Brooks Range and foothills toward Howard and Naktuvuk passes. This herd winters in the Nulato Hills as far south as the Unalakleet River drainage, and the eastern half of the Seward Peninsula.

Caribou undertake annual seasonal migrations, which begin in April when pregnant cows and some nonmaternal caribou begin migrating from winter range toward the calving grounds (Dau 2007). Cows reach calving grounds by mid to late May, and calving occurs from late May through early June. The remaining caribou follow, joining the cows and calves by mid to late June. By mid-June, aggregations of caribou begin forming and the herds begin moving in search of relief from insects (Dau 2007). These summer movements are influenced by insect abundance, which in turn depends on temperature and windspeed (Lenart 2007c). In warmer weather caribou will concentrate along the coast or on large gravel bars for insect relief. Other relief habitat includes cool, windy coastal beaches, low bluffs, sparsely vegetated river bars and deltas, mud flats, dunes, pingos, and gravel pads, roads, and the shade of elevated pipelines, buildings, and parked vehicles in the oil fields (Truett 2000, citing to multiple sources). In cooler, windy weather, they tend to be found inland. The fall caribou migration begins from mid-August through late September, and may extend through late November. Caribou are relatively sedentary through the winter, until April when the spring migration begins again (Dau 2007).

Although the calving areas tend to remain the same for each herd from year to year, migration routes may change, sometimes suddenly. These changes may occur as caribou select routes with more food (ADF&G 1994). Migrations are triggered by weather conditions such as the onset of cold weather or snowstorms.

The caribou rutting season begins in late August and early September, and calving occurs in May and June (ADF&G 1994). Female caribou reach sexual maturity between 16 and 28 months old, and they give birth annually. Mature male caribou average 350-400 lbs.

Caribou populations appear to be cyclic, although the mechanisms, timing, and population size fluctuations are not well understood. Hunting, weather patterns, overpopulation, predation, and disease appear to be the most common factors affecting caribou abundance (ADF&G 1994).

In the summer, caribou feed on grasses, sedges, flowering tundra plants, mushrooms, and the leaves of willows, dwarf birches (Smith and Walker 1995; ADF&G 1994). In the winter, they feed on lichens, small shrubs, and dried sedges which they are able to find beneath the snow. Predators on adults include wolves and bears; they are an important species for sport and subsistence hunting; and wolves and golden eagles prey on calves. Warble flies, bot flies, and mosquitoes harass caribou during the summer.

b. Moose

Moose (*Alces alces gigas*) may be found in the terrestrial portions of the proposed Beaufort Sea lease sale area, especially along recently burned areas with willow and birch shrubs, on timberline plateaus, and along major rivers (ADF&G 1994). Counts of moose in Game Management Unit 26A (Map 4.4) ranged from 326 to 1,535 moose from 1970-2005 (Table 4.6). During the summer, moose inhabiting the North Slope are found along small tributaries and riparian habitat, and may disperse as far as the foothills of the Brooks Range and across the coastal plain (Carroll 2006). During late May and early June, cows generally move away from river bottoms to calve, and remain near riparian habitat through the summer. Bulls disperse widely. During the winter, moose are concentrated along the riparian habitat of river corridors, particularly inland portions of the Colville River drainage.

Moose breed annually and both sexes may begin breeding at the age of 16 to 18 months. Calving occurs from mid-May through early June. Rutting occurs during the fall from late September through early October. Moose have high reproductive potential and can reach the carrying capacity of their range if not limited by predation, hunting, or severe weather (ADF&G 1994). Food abundance and habitat are important limiting factors for moose populations (ADF&G 2008c; Lenart 2006). Disease, natural environmental factors, winter severity, predation, and insect harassment also contribute to the size of moose populations in the Beaufort Sea area (Lenart 2006). Recent trends indicate that North Slope moose populations are increasing (Lenart 2006; Carroll 2006).

Moose eat a variety of foods, particularly sedges, equisetum, pond weeds, grasses, and leaves of birch, willow, and aspen. They are preyed upon by wolves and brown bears; and they are hunted by sport and subsistence hunters (ADF&G 1994).

Table 4.6. Number of moose counted during Game Management Unit 26A censuses.

Year	Number of Moose[a]
1970	1,219
1977	1,258
1984	1,447
1991	1,535
1995	757
1999	326
2002	567
2005	1,048

[a] Includes adults and calves.

Notes: Includes moose counted throughout the entire game management unit, most of which is outside the proposed Beaufort Sea lease sale area.

Source: Carroll 2006.

c. Brown Bears

Brown bears (*Ursus arctos*) are widely distributed throughout Game Management Unit 26 (Map 4.4), with higher densities found in the foothills of the Brooks Range and eastern areas, and lower densities on the coastal plains (Lenart 2007a; Carroll 2007a). Brown bears may follow the Porcupine caribou herd to their calving areas. Availability of habitat is considered to have remained relatively constant in recent years and largely undisturbed. Brown bear populations are considered stable or increasing slowly in some areas and at high levels relative to carrying capacity in others (Lenart 2007a; Carroll 2007a).

Brown bears mate from May through July with the peak of activity in early June (ADF&G 1994). The young are born the following January or February in a winter den. Litter size ranges from one to four cubs, but two is most common. Offspring typically separate from their mothers as two-year olds in May or June. In some areas where food is scarce, females may skip one to three years before producing new litters. Other than during mating in June and July, brown bears are usually solitary, except for sows with cubs. However, concentrations of brown bears do occur where food is concentrated (ADF&G 1994).

Brown bears eat a wide variety of foods, including berries, grasses, sedges, horsetails, cow parsnip, fishand many kinds of roots; and they prey on newborn moose and caribou calves, and can also kill and eat adult moose and caribou as well as domestic animals (ADF&G 1994). Arctic ground squirrels are a particularly important stable of the brown bear diet (Shideler and Hechtel 2000). Since their reintroduction into ANWR and at Kavik in the 1970s, muskoxen have become a prey species for brown bears (Shideler and Hechtel 2000). Brown bears eat most carrion, and will also become habituated to eating garbage (ADF&G 1994).

Most brown bears hibernate during the winter and emerge from their dens in spring, often in May (ADF&G 1994).

d. Muskox

The muskox (*Ovibos moschatus*) is a stocky, long-haired animal with cloven hooves, a slight shoulder hump and a very short tail. Taxonomists classify muskoxen with the sheep and goats. Muskoxen as a species have changed little since the ice age and are perfectly adapted to live in their harsh arctic environment (ADF&G 1994).

The original Alaska muskoxen disappeared in the mid- or late-1800s as a result of over-hunting. Muskoxen were reintroduced in ANWR in 1969 and in the Kavik area in 1970. They were reintroduced near Cape Thompson in 1970 and 1977. An estimated 270 muskoxen were counted between the Colville River and ANWR, and 91 animals were recorded west of the Trans-Alaska Pipeline near the Colville River (BLM 1997, Vol. III). Muskoxen are expected to repopulate their former home-range habitats in the NPR-A in the near future. Small numbers occur in the Colville River Delta, in the area of the lower Itkillik River valley, and the headwaters of the Miluveach and Kachemack Rivers (ADF&G 1997). Known wintering areas occur along riverside bluffs in the vicinity of the Sagavanirktok and Ivishak rivers, and along the Kavik and Shaviovik river drainages near the coast. During summer they also utilize the Kadleroshilik drainage (USFWS 1992b).

The most important habitats for muskoxen in the Colville River Delta are riparian, upland shrub, and moist sedge-shrub meadows (BLM 1997, Vol. III). Riparian habitat is preferred by muskoxen for virtually their entire annual cycle. River systems that provide diverse low shrub-forb and tall willow communities in proximity to relatively snow-free uplands, hillsides, and plateaus are also important habitat (USFWS 1992b).

The rutting season generally occurs in fall, from August to October (ADF&G 1994). Muskoxen eat a wide variety of plants, including grasses, sedges, forbs, and woody plants. In summer and fall, both sexes may be found along major river drainages where they feed on willows and forbs. In winter and spring, muskoxen groups of 10 to 20 animals may be found in the uplands adjacent to river drainages which afford forage of tussock sedges and have less snow cover (USFWS 1987). Muskoxen are poorly adapted for digging through heavy snow for food, so winter habitat is generally restricted to areas with shallow snow accumulations or areas blown free of snow (ADF&G 1997).

e. Furbearers

Arctic fox *(Alopex lagopus)* occur in two color phases, blue and white, with the white color phase more common in northern litters. Young of each color phase may occur in the same litter (ADF&G 1994). Arctic fox pups are born in dens excavated by the adults in sandy, well-drained soils of low mounds and river cut backs. Most dens have southerly exposure. They extend from 6 to 12 ft underground. Enlarged ground squirrel burrows with several entrances are often used as dens (ADF&G 1994).

Mating occurs in early March and early April. Gestation lasts 52 days. Litters average seven pups but may contain as many as 15 pups. Arctic foxes are monogamous in the wild. Both parents aid in bringing food to the den and in rearing the pups. Pups begin eating meat when about one month old and are fully weaned by 1 ½ months. They emerge from the den when about three weeks old and begin to hunt and range away from the den at about three months. Arctic foxes attain sexual maturity at 9 to 10 months, but many die in their first year (ADF&G 1994). Fully grown arctic foxes weigh from 6 to 10 pounds.

Arctic foxes are omnivorous. In summer, they feed primarily on small mammals, including lemmings and tundra voles. They sometimes eat berries, eggs, and scavenged remains of other animals. Many foxes venture out onto the sea ice during winter to eat the remains of seals killed by polar bears. In areas where lemmings and voles are the most important summer prey, numbers of foxes often rise and fall with cyclic changes of their prey. Fewer pups are successfully reared to maturity when food is scarce. There is evidence indicating that competition for food among young pups accounts for some of the heavy mortality in this age group (ADF&G 1994). Arctic foxes may move long distances over sea ice. A fox tagged along the coast of Russia was captured near Wainwright, Alaska a year later (ADF&G 1994).

Wolves *(Canis lupus)* are adaptable and exist in a wide variety of habitats including the Arctic tundra along the Beaufort Sea. They are highly social animals and usually live in packs averaging 6 to 7 animals (ADF&G 1994).

Wolves normally breed in February and March, and litters averaging about five pups are born in May or early June. Litters may include from 2-10 pups, but most often four to seven pups are born. Most female wolves first breed when 22 months old but usually have fewer pups than older females. Pups are usually born in a den excavated as much as 10 ft into well-drained soil, and most adult wolves center their activities around dens while traveling as far as 20 miles away in search of food, which is regularly brought back to the den. Wolf pups are weaned gradually during midsummer. In mid- or late summer, pups are usually moved some distance away from the den and by early winter are capable of traveling and hunting with adult pack members. Wolves are great travelers, and packs often travel 10 to 30 or more miles in a day during winter. Dispersing wolves have been known to move from 100 to 700 miles from their original range (ADF&G 1994).

Despite a generally high birth rate, wolves rarely become abundant because mortality is high. In much of Alaska, hunting and trapping are the major sources of mortality, although diseases, malnutrition, accidents, and particularly preying by other wolves regulate wolf numbers (ADF&G 1994).

Wolves are carnivores, with moose and/or caribou as their primary food. During summer, small mammals including voles, lemmings, ground squirrels, snowshoe hares, beaver, and occasionally birds and fish are supplements in the diet. Wolves are opportunistic feeders; very young, old, or diseased animals are preyed upon more heavily than other age classes. Under some circumstances, however, such as when snow is unusually deep, even animals in their prime may be vulnerable to wolves (ADF&G 1994).

Wolverines (*Gulo gulo*) are primarily found in the wilder and more remote areas of Alaska (ADF&G 1994). They frequent all types of terrain and often utilize rivers as territorial boundaries (USFWS 1987).

Wolverines become sexually mature in their second year. Breeding takes place between May and August. After wolverines mate, the embryo floats in the uterus until late fall or early winter. This type of reproduction is known as delayed implantation, and allows a female wolverine to become pregnant when food supplies are plentiful and when she is in good physical condition. The abundance of food determines whether a pregnancy will be maintained and the number of young that will be born (ADF&G 1994).

Litters are born between January and April. In interior and northern Alaska, most young are born in snow caves. These caves usually consist of one or two tunnels that can be up to 60 yards long. Litters usually number between one to three. Baby wolverines develop rapidly and are weaned at about eight weeks of age. They leave their mothers at approximately 5 or 6 months to forage for themselves (ADF&G 1994).

Wolverines travel extensively in search of food. They are opportunistic, eating about anything they can find or kill. They are poor hunters, but are well adapted for scavenging. Wolverines can survive for long periods on little food. Their diet varies from season to season depending on food availability. In the winter, wolverines rely primarily on remains of moose and caribou killed by wolves and hunters or animals that have died of natural causes. Throughout the year, wolverines feed on small and medium-sized animals such as voles, squirrels, snowshoe hares, and birds. In the right situations, wolverines can kill moose or caribou, but these occurrences are rare (ADF&G 1994).

4. Marine Mammals

Marine mammals inhabiting the proposed lease sale area include polar bear, bowhead whale, beluga whale, ringed seal, spotted seal, and bearded seal. Walrus are occasionally seen in the proposed lease sale area.

a. <u>Polar Bears</u>

Polar bears (*Ursus maritimus*) inhabit the coast of the Beaufort Sea area (Map 4.5). They are marine mammals and are protected under the Marine Mammal Protection Act of 1972. On May 15, 2008, the USFWS published a Final Rule in the Federal Register listing the polar bear as a threatened species under the federal Endangered Species Act (73 FR 28212-28303). The USFWS based its listing on the loss of sea ice, which it says threatens and will likely continue to threaten polar bear habitat. The USFWS believes that this loss of habitat puts polar bears at risk of becoming endangered in the foreseeable future, the standard established by the Endangered Species Act for designating a threatened species. This final rule activates the consultation provisions of Section 7 of the Act for the polar bear. The special rule for the polar bear, also published in the May 15, 2008, edition of the Federal Register, sets out the prohibitions and exceptions that apply to this species. It recognizes the adequacy of the existing regulatory structure in protecting polar bears.

The State of Alaska has challenged the listing (Office of the Governor 2008). The state maintains that there is insufficient evidence to support a listing of the polar bear as threatened for any reason at this time. Polar bears are currently well-managed and have dramatically increased over 30 years as a result of conservation measures enacted through international agreements and the Marine Mammal Protection Act.

Polar bears are distributed throughout the Arctic circumpolar region. Within this region, it is estimated that there are currently 20,000 to 25,000 polar bears (IUCN 2005), a substantial increase from the early 1970s. Although no Distinct Population Segments have been identified across the Arctic circumpolar region, the IUCN (International Union for Conservation of Nature and Natural Resources) has established 19 management units for purposes of research and management (IUCN 2005). Two of these overlap Alaska, the Southern Beaufort and the Chukchi Sea sub-populations.

Polar bears and brown bears evolved from a common ancestor and are closely related, as demonstrated by matings and production of fertile offspring in zoos (ADF&G 1994). At least one successful pairing has occurred in the wild, as confirmed in 2006 by DNA analysis of a hybrid bear from the southern tip of Banks Island, Northwest Territories (Roach 2006). Adaptations by the polar bear to life on sea ice include a white coat with water-repellent guard hairs and dense underfur, short

Female polar bear with young along the Beaufort Sea coastline.

furred snout, short ears, teeth specialized for a carnivorous diet, and hair nearly completely covering the bottom of the feet (ADF&G 1994).

Polar bears breed from late March to May (ADF&G 1994). During late October and November, pregnant females search for banks, slopes, or rough ice in which to dig a den, either on land or on sea ice (ADF&G 1994). Litters of one to three cubs are born in December or January (Smith and Walker 1995). In late March or early April, polar bears emerge from the den with their cubs and begin making excursions to drifting sea ice (ADF&G 1994). The young remain with the mother until they are about 28 months old (ADF&G 1994). Females can produce litters about every third year, and polar bears can live to be about 25 years old (ADF&G 1994).

Radio collar surveys indicate that the Beaufort Sea population dens locally, and is not dependent on reproduction from other known denning areas outside of the region (Amstrup and Gardner 1994). Polar bears do not exhibit site fidelity in denning, but return only to the general substrate and geographic area upon which they had previously denned: on ice or on land, and in the eastern or the western Beaufort respectively. The most preferred region for land denning is located in the northeast corner of Alaska and adjacent to Canada (Amstrup and Gardner 1994).

Regehr et al. (2006) compared production indices between two time periods, 1967-1989 and 1990-2006. They found that, in the spring, the proportion and number of adult females with cubs of the year increased significantly between the two periods, but that yearling production was not significantly different. In the autumn, they found that the proportion and number of adult females with cubs of the year was significantly lower in the second time period, but yearling production was not significantly different. Litter size was not significantly different between the two time periods.

Polar bears are usually found near coastlines and the southern edge of sea ice, and they may make extensive seasonal movements related to the ice edge (ADF&G 1994). This is because their primary food is the ringed seal, which inhabits the Arctic ice (ADF&G 1994). Bears capture seals by waiting for them at breathing holes and at the edge of leads or cracks in the ice, by stalking resting seals on top of the ice, and by breaking into pupping chambers on top of the ice in the spring (ADF&G 1994). However, Regehr et al. (2006) found that survival was not clearly related to sea ice coverage. Other prey includes bearded seals, walruses, and beluga whales, and polar bears will eat small mammals, bird eggs, and vegetation. Polar bears also feed on whale, walrus and seal carcasses (ADF&G 1994).

Regehr et al. (2006) estimated the southern Beaufort Sea polar bear population to be 1,526 (95 percent CI = 1,211; 1,841) in 2006, which was not significantly different from a 1986 estimate of about 1,800 polar bears.

b. Bowhead Whales

Bowhead whales (*Balaena mysticetus*) are found only in Arctic waters of the Northern Hemisphere where they are often associated with pack ice in shallow waters (NMFS 2008b). Bowhead whales inhabit five general areas: north of Europe; between Canada and Greenland; the Hudson Bay area; the Okhotsk Sea; and the Bering, Chukchi and Beaufort seas. The Western Arctic stock, which is found in Alaska, migrates between the Bering, Chukchi, and Beaufort seas and the eastern waters of Russia (Angliss and Outlaw 2008). The Western Arctic stock is also known as the Bering-Chukchi-Beaufort stock or the Bering Sea stock.

Bowhead whales are listed as endangered under the Endangered Species Act and are considered depleted under the Marine Mammal Protection Act. The Western Arctic bowhead whale stock has been increasing since 1980. With over 10,000 whales in 2001 (Table 4.7), the stock may be approaching carrying capacity (Angliss and Outlaw 2008). Recent high counts of calves provide further evidence that the Western Arctic population is healthy and increasing.

Bowhead whales are insulated by a very thick layer of blubber that provides insulation, food storage, and padding (ADF&G 1994). Bowheads are able to travel through ice covered waters because the heavy bone structure of their skulls is capable of breaking through ice up to 2 ft thick if they cannot find open water. Bowhead whales communicate vocally while traveling, feeding, and socializing. These underwater sounds may also be used in navigating (ADF&G 1994). Bowheads have excellent sight and hearing (ACS 2004)

Bowhead whales spend their entire lives in far northern waters, and unlike other baleen whales, they do not migrate to temperate or tropical waters to calve (ADF&G 1994). In Alaska, bowhead whales spend November through March in wintering areas of the northern Bering Sea (Map 4.6; Angliss and Outlaw 2008). In the spring, from March through June, they follow fractures in the ice, moving north and east along the coast through the Chukchi Sea to the Beaufort Sea (Angliss and Outlaw 2008). By mid-summer they are found in the ice-free waters of the southeastern Beaufort Sea and west Amundsen Gulf (Map 4.7; Richardson and Thomson 2002). In August and early September, large numbers of subadults are sometimes seen feeding in shallow waters along the north coast of the Yukon (Richardson and Thomson 2002). Bowhead whales are also occasionally seen around Barrow in the summer, indicating that there may be important summer feeding grounds in that area (Angliss and Outlaw 2008). Bowheads have also been spotted far offshore in the eastern part of the Alaskan Beaufort Sea in August (Richardson and Thomson 2002).

Table 4.7. Estimates of abundance of the Western Arctic stock of bowhead whales available for 1978-2001.

	Abundance			Abundance	
Year	Estimate	CV[a]	Year	Estimate	CV[a]
1978	4,765	0.305	1987	5,298	0.327
1980	3,885	0.343	1988	6,928	0.120
1981	4,467	0.273	1993	8,167	0.017
1982	7,395	0.281	2001	10,545	0.128
1983	6,573	0.345			

a Coefficient of variation.

Source: Angliss and Outlaw 2008.

In the fall months of September through November, bowhead whales make a return migration to the Bering Sea to overwinter (Angliss and Outlaw 2008). They spend an average of 3 to 8 days transiting the eastern Beaufort Sea area (from Flaxman Island to Herschel Island), although this average is variable. In some years most, if not all whales, may travel steadily across this area without stopping to feed or for other purposes, with an overall residence time of 5 days for the population (Thomson et al. 2002).

Bowhead whales usually travel alone or in small groups of up to six whales. They may be found in larger concentrations on feeding grounds (ACS 2004). Many factors contribute to the timing and path of bowhead whale migrations and their use of feeding areas. These include oceanographic characteristics, ice pack movements, wind-driven ocean currents, and upwellings (Schick and Urban 2000).

Bowheads whales filter their food through long baleen plates (NMFS 2008b). A single bowhead needs an estimated 100 metric tons of krill annually, consisting of copepods, amphipods, euphausiids, and other small crustaceans (NMFS 2008b; ACS 2004). Bowheads feed at all depths, from the surface to the bottom (ADF&G 1994), and sometimes even bring mud to the surface (Richardson and Thomson 2002). Bowheads concentrate for feeding at places and depths of zooplankton concentrations (Richardson et al. 1995 citing to Griffiths and Buchanan 1982, Bradstreet et al. 1987, and Richardson 1987). Copepods that are important food for bowheads undergo annual cycles that vary by location and may be influenced by timing of ice breakup in the spring (Richardson et al. 1995 citing to Longhurst et al. 1984, Sameoto et al. 1986). The only predators of bowhead whales are killer whales; and they are hunted by Alaska Native subsistence hunters (Smith and Walker 1995).

Bowhead feed year round (ADF&G 1994), but in the spring, fewer stomachs of harvested bowheads are found with food (Lowry and Sheffield 2002; Carroll and Smithhisler 1980). In the fall, their stomachs generally contain food (Carroll and Smithhisler 1980). Richardson and Thomson (2002) also found that bowhead whales feed regularly in the nearshore waters of the eastern, central, and western Alaskan Beaufort Sea during September – October as they make their fall migration. However, some studies have indicated that most of the annual food requirement of adults and subadults is obtained from the Bering and Chukchi seas, and that only a minority of their food comes from the eastern and central Beaufort Sea (Lee and Schell 2002). The bowhead whale population is estimated to consume only about 2.4 percent of its annual energetic requirements in the eastern Beaufort Sea area from Flaxman Island to Herschel Island (Thomson et al. 2002).

Mating bowhead whales have been observed from March to August, but mating is believed to occur primarily in March (Braham 1984). After a gestation period of about 13 months, most bowheads give birth in May, although calves may be born from March through July. Data from harvests indicate that bowhead whales produce a calf every 3-6 years (Braham 1984).

The life span of bowhead whales is considered to be about 50-60 years, but it may be much longer (Smith and Walker 1995). However, methods for aging bowheads have not yet been developed, so standard parameters used for population assessments, such as age, length-at-age, and age of sexual maturity are unavailable for bowhead whales (Braham 1984).

c. <u>Beluga Whales</u>

Beluga whales (*Delphinapterus leucas*) are a medium-sized cetacean related to narwhales, sperm and killer whales, dolphins, and porpoises (ADF&G 1994). They are found in the Northern Hemisphere throughout arctic and subarctic waters, both coastal and offshore (NMFS 2008a). Five stocks of beluga whale are recognized in Alaskan waters: Cook Inlet, Bristol Bay, eastern Bering Sea, eastern Chukchi Sea, and Beaufort Sea (Angliss and Outlaw 2008). The Beaufort Sea stock is estimated to be about 40,000 beluga whales, but population trends for the stock are unknown (Angliss and Outlaw 2008). The Beaufort Sea stock is not listed as depleted under the MMPA, or as threatened or endangered under the Endangered Species Act.

Distribution of beluga whales varies by season and region, and is affected by a range of conditions such as temperature, ice cover, tides, and prey availability (NMFS 2008a). Summering concentrations of belugas are found in Cook Inlet, Bristol Bay, Norton Sound, Kasegaluk Lagoon, and Mackenzie Delta. However, except for the Cook Inlet concentration, all these are thought to overwinter in the Bering Sea (Angliss and Outlaw 2008).

The Beaufort Sea beluga stock may undertake annual migrations of thousands of kilometers (Map 4.8 and Map 4.9). In the winter, this stock is found in offshore waters associated with pack ice. In the spring, they migrate to warmer waters of coastal estuaries, bays, and rivers for molting and calving (Angliss and Outlaw 2008). Belugas travel in groups, or pods, of 2-10 animals, although large pods of up to 100 individuals are not uncommon (Smith and Walker 1995). Radio telemetry studies have found that during summer and fall movements, belugas are somewhat segregated by sex. These studies also found that although belugas spend some time in estuaries, they spend far more time well offshore, far into the permanent ice pack (Richard et al. 2001).

Adult beluga males range in size from 11-15 ft and in weight from 1,000-2,000 lbs. Females tend to be smaller than males, usually no more than 12 ft in length (ADF&G 1994). Female belugas attain sexual maturity between 4 and 5 years old, and males mature slightly later. Females may produce a calf about every three years. Breeding occurs in March or April, and the gestation period is about 14.5 months. Calving occurs in May-July, usually near or in summer concentration areas. Belugas can live to be about 40 years old (ADF&G 1994).

Belugas are predators and consume a wide range of prey, probably influenced by both seasonal prey abundance and preference (Hobbs et al. 2006). Over 100 species of marine organisms have been documented as beluga prey (Smith and Walker 1995), including herring, capelin, smelt, Arctic and saffron cods, salmon, flatfishes, sculpins, octopus, squid, shrimps, crabs, and clams (ADF&G 1994). Predators of belugas include killer whales and polar bears; and they are hunted by Alaska Native subsistence hunters (Smith and Walker 1995).

d. Bearded Seal

Bearded seals (*Erignathus barbatus*) are circumpolar in distribution (Angliss and Outlaw 2008). In Alaska, they are distributed over the continental shelf of the Bering, Chukchi, and Beaufort seas (Map 4.10), with concentrations over the northern part of the Bering sea shelf in January-April. They appear to prefer areas with 70-90 percent ice coverage, and tend to be found over shallow waters less than 200 m. In winter, they tend to inhabit broken pack ice but they are also found on shorefast ice (Angliss and Outlaw 2008). During the summer, bearded seals are broadly distributed. They may remain in open water and rarely haul out on land. All bearded seals found in Alaska are considered to be from one Alaska stock. There is no reliable estimate of abundance for the Alaska stock of bearded seals (Angliss and Outlaw 2008). Bearded seals are protected under the MMPA but they are not listed as depleted (Angliss and Outlaw 2008). They are not listed as threatened or endangered, but on March 28, 2008 NMFS initiated a status review to determine if listing under the Endangered Species Act is warranted (73 FR 16617-16619).

Bearded seals are usually associated with ice, although young seals may be found in ice-free areas such as bays and estuaries (ADF&G 1994). Bearded seals undertake seasonal migrations following the sea ice, moving northward through the Bering Strait in spring. They are generally solitary animals and tend to be widely dispersed during late winter when sea ice is widespread. However, during spring migrations they are more concentrated, as well as during late summer when the sea ice has receded to the Arctic Ocean

Female bearded seals give birth in late April or early May after a gestation period of about 11 months. Females become sexually mature at about 5 or 6 years of age, and males at about 6 or 7 years of age. Adult bearded seals may weight over 750 lbs and average about 93 inches in length (ADF&G 1994). Their lifespan can exceed 25 years (NMFS 2009a).

L. Labunski, USFWS

Bearded seal.

The diet of bearded seals is composed of a wide variety of invertebrates such as crabs, shrimp, clams, snails, and octopus, and some fishes including Arctic cod (ADF&G 1994; NMFS 2009a).

e. Ringed Seal

Ringed seals (*Phoca hispida*) are circumpolar in distribution (Angliss and Outlaw 2008). They are found in all seas of the Arctic Ocean including the northern Bering, Chukchi, and Beaufort seas (ADF&G 1994), and as far south as Bristol Bay in years of extensive ice coverage (Angliss and Outlaw 2008). They are found throughout the Beaufort Sea (Map 4.10; Angliss and Outlaw 2008).

All ringed seals in U.S. waters are considered to be from a single Alaska stock (Angliss and Outlaw 2008). Abundance of the Alaska stock is estimated to be about 249,000 animals (NMFS 2009c), however trends for the stock are unknown (Angliss and Outlaw 2008). Ringed seals are protected under the MMPA although they are not listed as depleted (Angliss and Outlaw 2008). They are not listed as threatened or endangered, but on March 28, 2008 NMFS initiated a status review to determine if listing under the Endangered Species Act is warranted (73 FR 16617-16619).

Ringed seals appear to prefer ice-covered waters and remain in contact with ice for most of the year (Angliss and Outlaw 2008), which may provide some protection from predators (NMFS 2009b). They live on and under extensive, largely unbroken, shorefast ice (Frost et al. 2002). They are generally found over water depths of about 10-20 m (Moulton et al. 2002). Density of ringed seals varies greatly depending on area and season and changes in seasonal distribution appear to be correlated with changes in sea ice characteristics but are poorly understood (Frost et al. 2002). They begin appearing along coastal areas as shorefast ice forms in the fall and then disappear in the spring at ice breakup (ADF&G 1994). During breakup, more ringed seals are found near the ice edge; their densities are less in areas of high ice deformation and extensive melt water. There does not appear to be a relationship between time of day and density of hauled out ringed seals. The peak of the spring haulout is in early June (Moulton et al. 2002). When hauled out on the ice, they are solitary, maintaining separation from each other by hundreds of yards (NMFS 2009c).

Behavior of ringed seals is poorly understood because both males and females spend much of their time in lairs built in pressure ridges or under snowdrifts for protection from predators and severe weather (ADF&G 1994). They make and maintain breathing holes in the ice from freeze-up until breakup (Frost et al. 2002). In the spring, as day length and temperature increase, ringed seals haul out in large numbers on the surface of the ice near breathing holes or lairs. This behavior is associated with the annual May-July molt.

Mating occurs in late April and May (Moulton et al. 2002). After a gestation period of about 11 months, ringed seals give birth to pups in March and April in lairs on landfast or drifting pack ice (ADF&G 1994). Females become sexually mature at about 4 years old; males become sexually mature at about 7 years old (NMFS 2009c). The life span of ringed seals is 25 to 35 years (Smith and Walker 1995).

Ringed seals feed on a wide variety of small prey (NMFS 2009c). Important food species for ringed seals are primarily invertebrates such as shrimps and other crustaceans, and fish such as Arctic cod and saffron cod (ADF&G 1994). They may also feed on the same krill that makes up the bowhead whale diet (Smith and Walker 1995). There are differences in the diet content of male and female ringed seals, and Arctic cod becomes more prevalent in the diet of ringed seals as they age (Dehn et al. 2007). Polar bears are the main predator of ringed seals, but other predators include Arctic and red foxes, walruses, wolves, wolverines, and ravens; and they are hunted by Alaska Native subsistence hunters (ADF&G 1994).

f. **Spotted Seal**

Spotted seals are distributed along the coast of Alaska, along the continental shelf of arctic and sub-arctic waters of the North Pacific Ocean (Angliss and Outlaw 2008; NMFS 2009d). They are found in the Bering, Chukchi, and Beaufort seas (Map 4.10), and in the seas of Japan and Okhotsk (Angliss and Outlaw 2008; NMFS 2009d). The Alaska stock is the only recognized stock in U.S. waters. Abundance of the stock is estimated to be about 59,000 seals (NMFS 2009d), although relatively few are found in the Beaufort Sea (ADF&G 1994). Spotted seals are protected under the MMPA but they are not listed as depleted (Angliss and Outlaw 2008). They are not listed as threatened or endangered, but on March 28, 2008 NMFS initiated a status review to determine if listing under the Endangered Species Act is warranted (73 FR 16617-16619).

Spotted seals undertake an annual migration (Angliss and Outlaw 2008). They overwinter in the Bering Sea along the ice edge, making east-west movements along the edge. As spring arrives, they mainly inhabit the southern margin of the ice where they tend to be found on small floes less than 20 m in diameter. After the sea ice retreats, spotted seals move to coastal habitats. In summer and fall, they use coastal haulouts, including areas of the Beaufort Sea. In October, spotted seals move south from the Chukchi Sea, passing through the Bering Strait in November.

Eight breeding areas of spotted seals are known: three in the Bering Sea and five in the Okhotsk Sea and Sea of Japan (Angliss and Outlaw 2008). Spotted seals breed annually from January to mid-April (NMFS 2009d). After a gestation period of about 10 months (NMFS 2009d), females give birth from early April to early May, peaking during the first two weeks of April (ADF&G 1994). Females reach sexual maturity at 3-4 years of age, and males at 4-5 years of age. The average life span of spotted seals is about 25 years and the maximum age is about 35 years.

The diet of spotted seals is highly varied, depends on life stage and location, and consists primarily of schooling fishes (ADF&G 1994). Their prey includes Arctic cod, sand lance, sculpins, flatfishes, octopus, shrimps, Pollock, and capelin. Juveniles feed on krill and small crustaceans.

g. **Pacific Walrus**

Pacific walrus (*Odobenus rosmarus divergens*) are found primarily west of Barrow in the Bering and Chukchi seas (ADF&G 1994), which is outside the proposed lease sale area. They are found only occasionally in the Beaufort Sea (Angliss and Outlaw 2008). They inhabit pack ice during the winter, and during the summer are found near the coast. Males occupy terrestrial haulouts during the summer (USFWS 2008d). Walrus found in Alaska are considered a single Alaska stock, but their abundance is unknown (Angliss and Outlaw 2008). They are not listed as depleted under the MMPA, and are not listed as threatened or endangered under the Endangered Species Act.

Breeding occurs in the winter from December through March (USFWS 2008d). Females give birth in late April or May after a gestation period of about 15 months (ADF&G 1994). Females reach sexual maturity at about 4-5 years of age, and males at about 5-7 y ears of age (USFWS 2008d). They can live to be 30-35 years old and males may reach sizes of 10 ft in length and 4,000 lbs (Smith and Walker 1995).

Pacific walrus are benthic feeders, foraging in the sediments of the sea floor (USFWS 2008d). Common food species include clams, sea cucumbers, crabs, and segmented worms. Although they rarely consume fish, about 10 percent of walrus stomachs sampled contain seals. Predators of walrus include polar bears and killer whales; and they are hunted by Alaska Native subsistence hunters.

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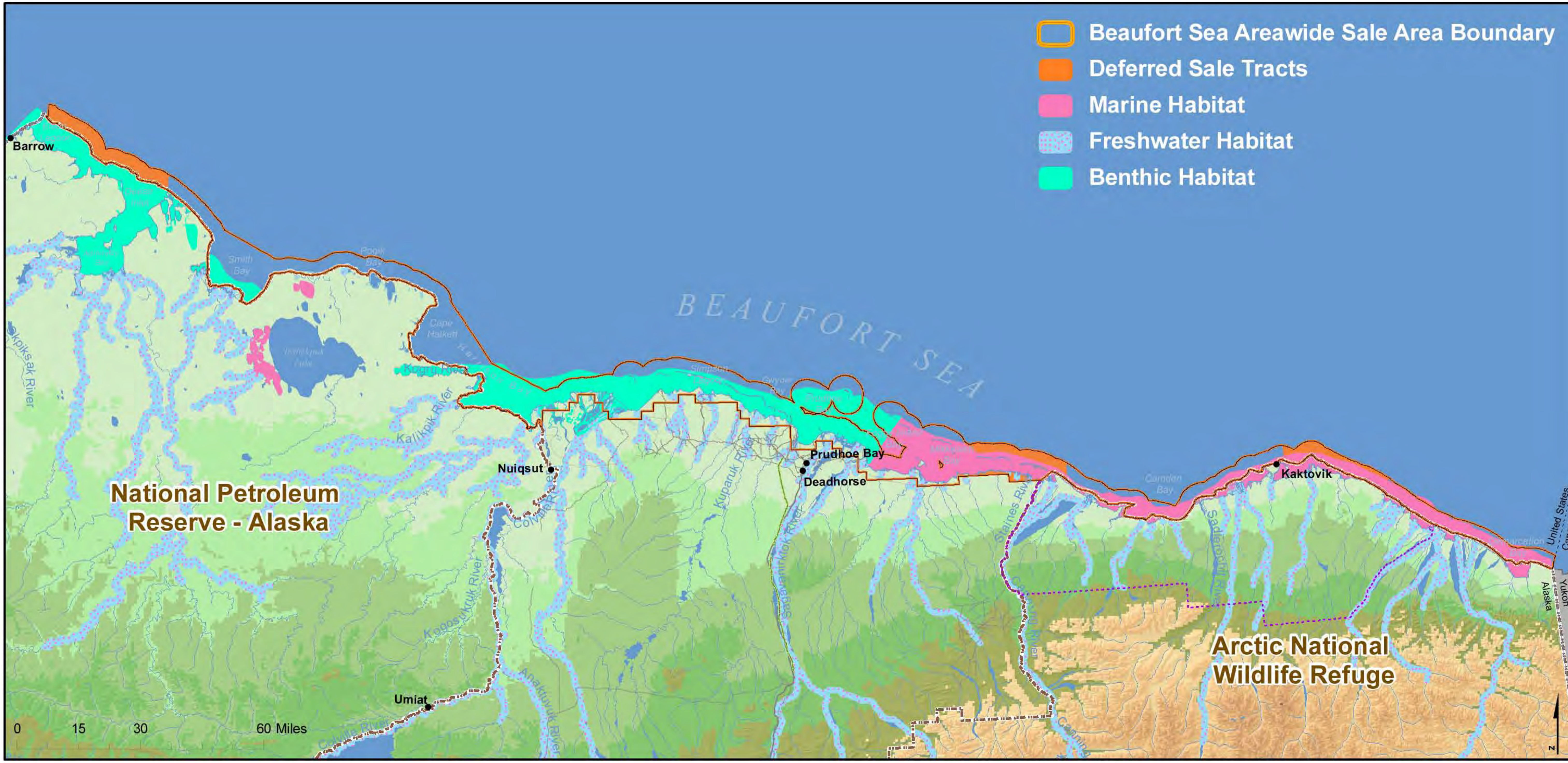
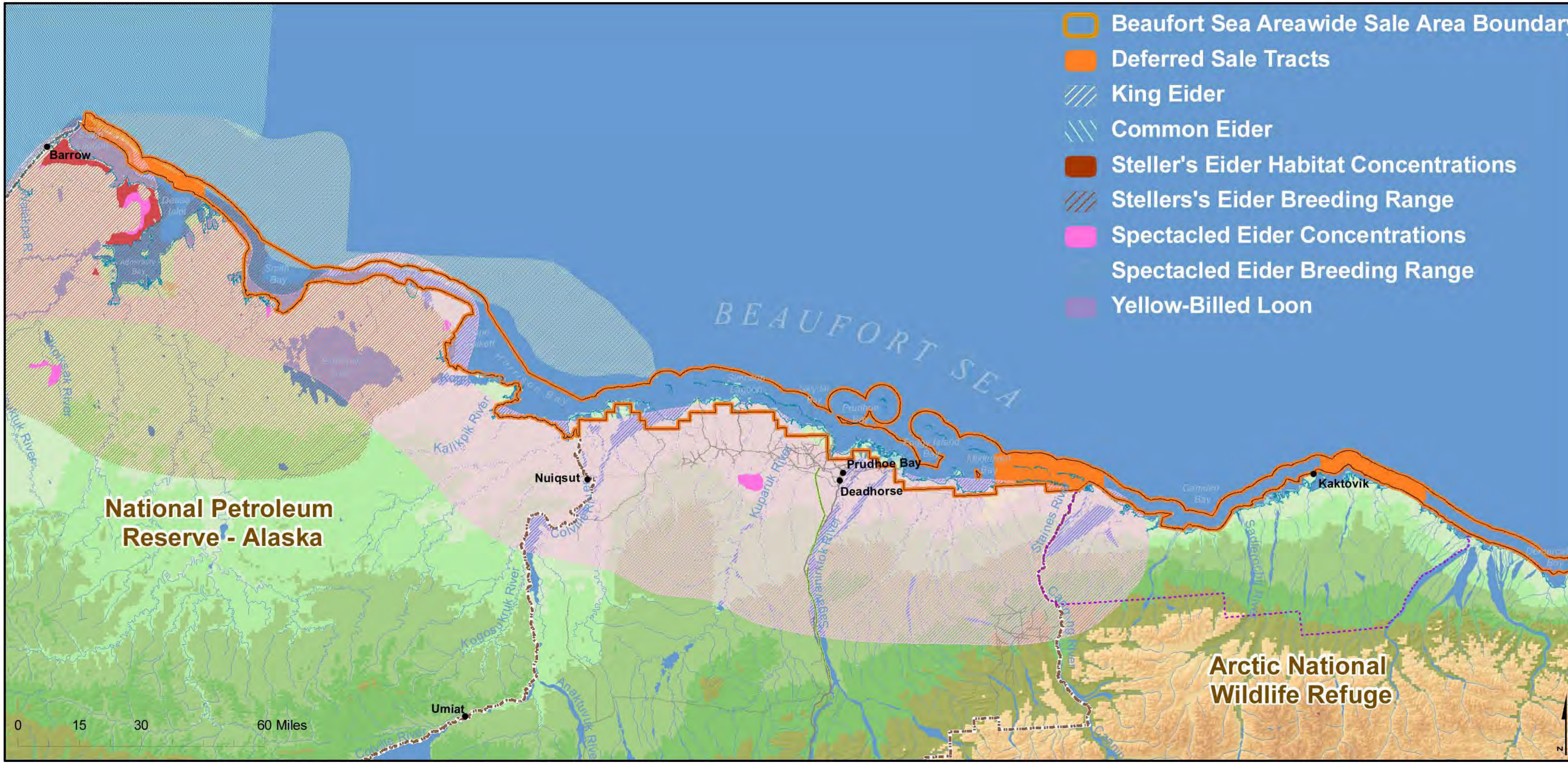
Maps



Notes: Information on this map is depicted only at a township or section level resolution. For detailed information regarding any specific area, interested individuals may consult the land records of one or more of the following agencies: ADNR, BLM, MMS, and NOAA. Discrepancies in boundary alignments are the result of merging multiple data sets from these various sources.

Map 4.1. Important fish habitat in the Beaufort Sea area.



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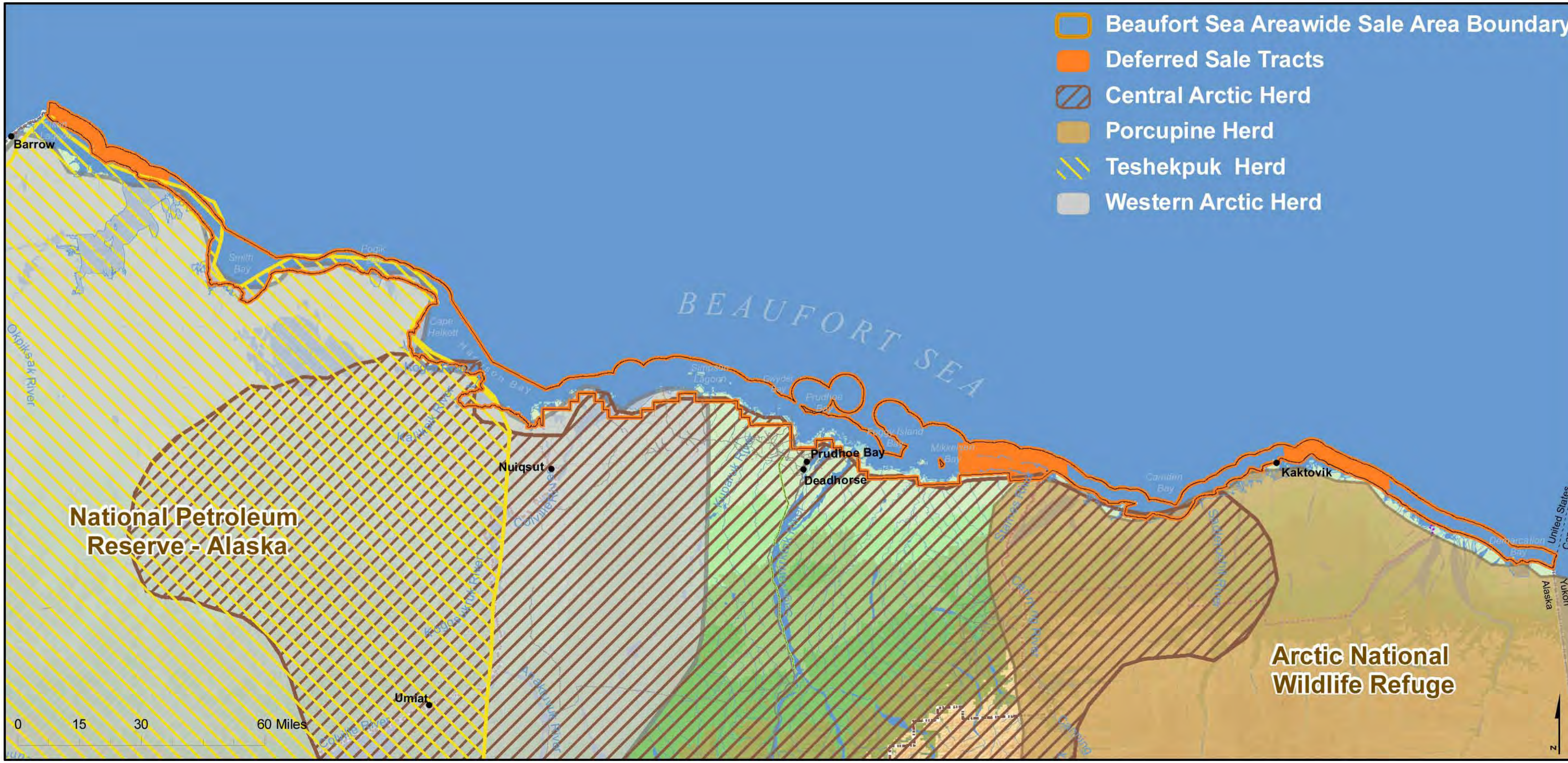
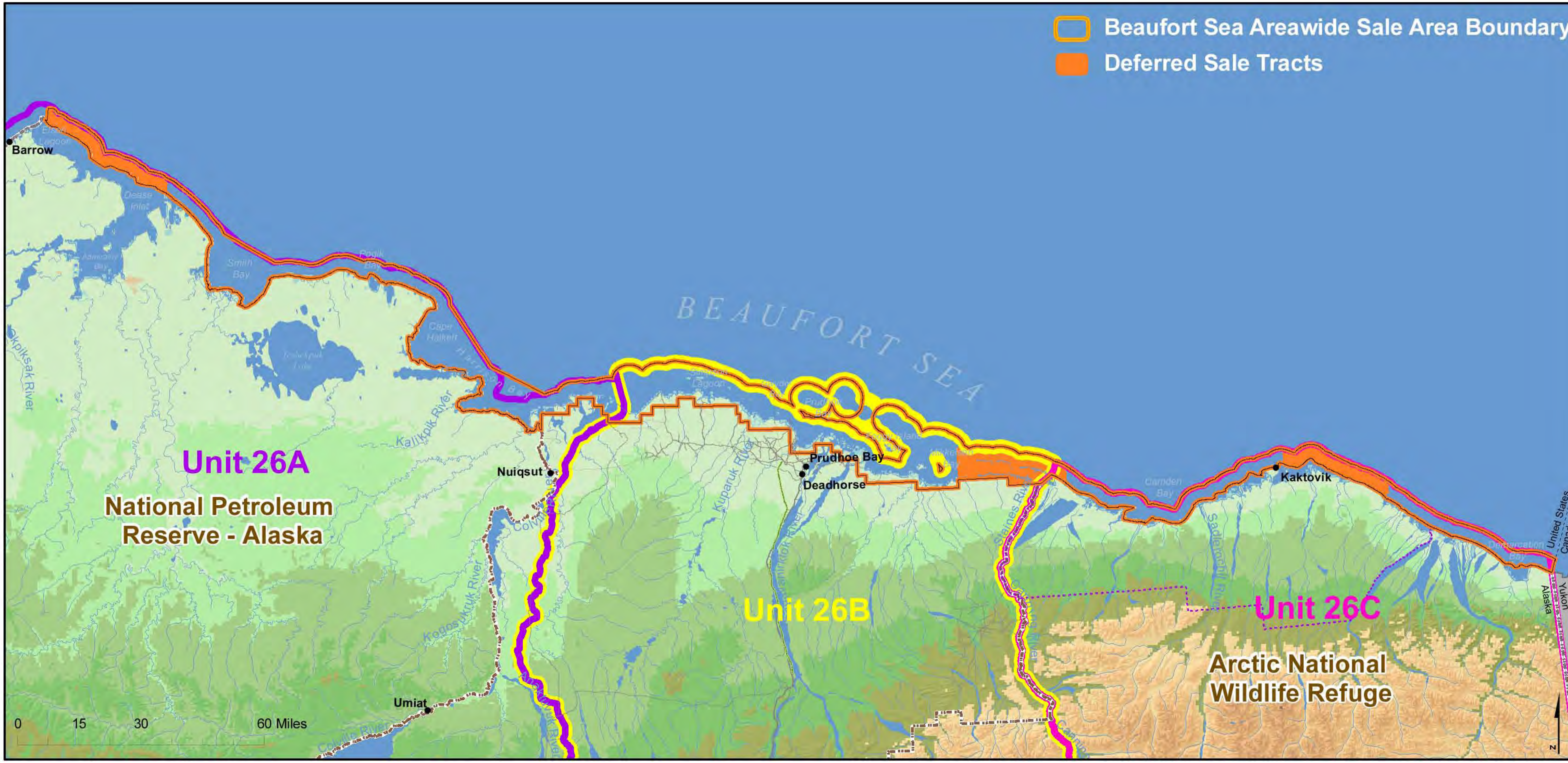
Map 4.2. Important habitat for king eider, common eider, Steller's eider, spectacled eider, and yellow-billed loon in the Beaufort Sea area.



Notes: Information on this map is depicted only at a township or section level resolution. For detailed information regarding any specific area, interested individuals may consult the land records of one or more of the following agencies: ADNR, BLM, MMS, and NOAA. Discrepancies in boundary alignments are the result of merging multiple data sets from these various sources.

Map 4.3. Locations of the four Alaska caribou herds of the Beaufort Sea area.



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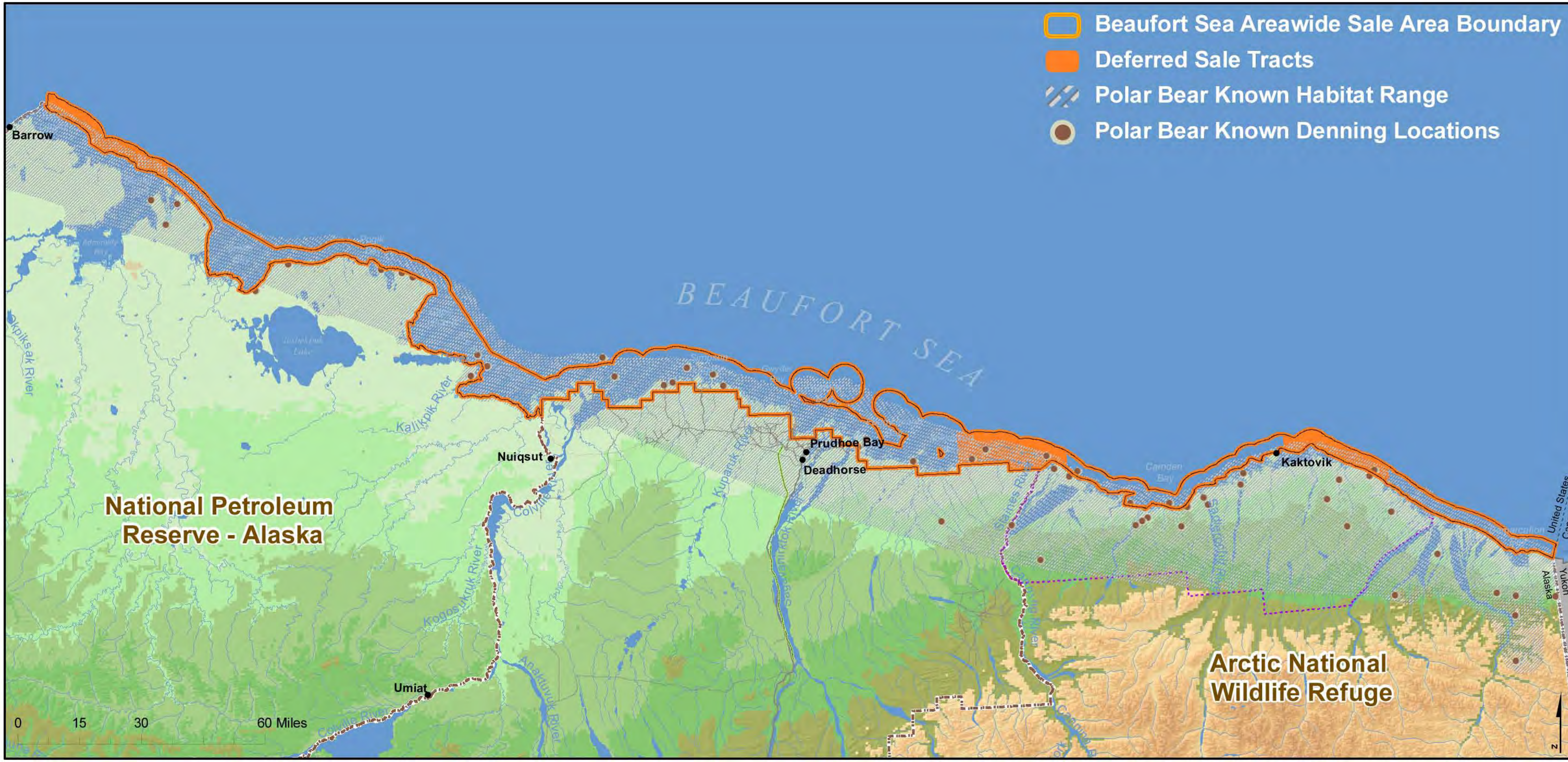
Map 4.4. Locations of ADF&G Game Management Units 26A, 26B, and 26AC



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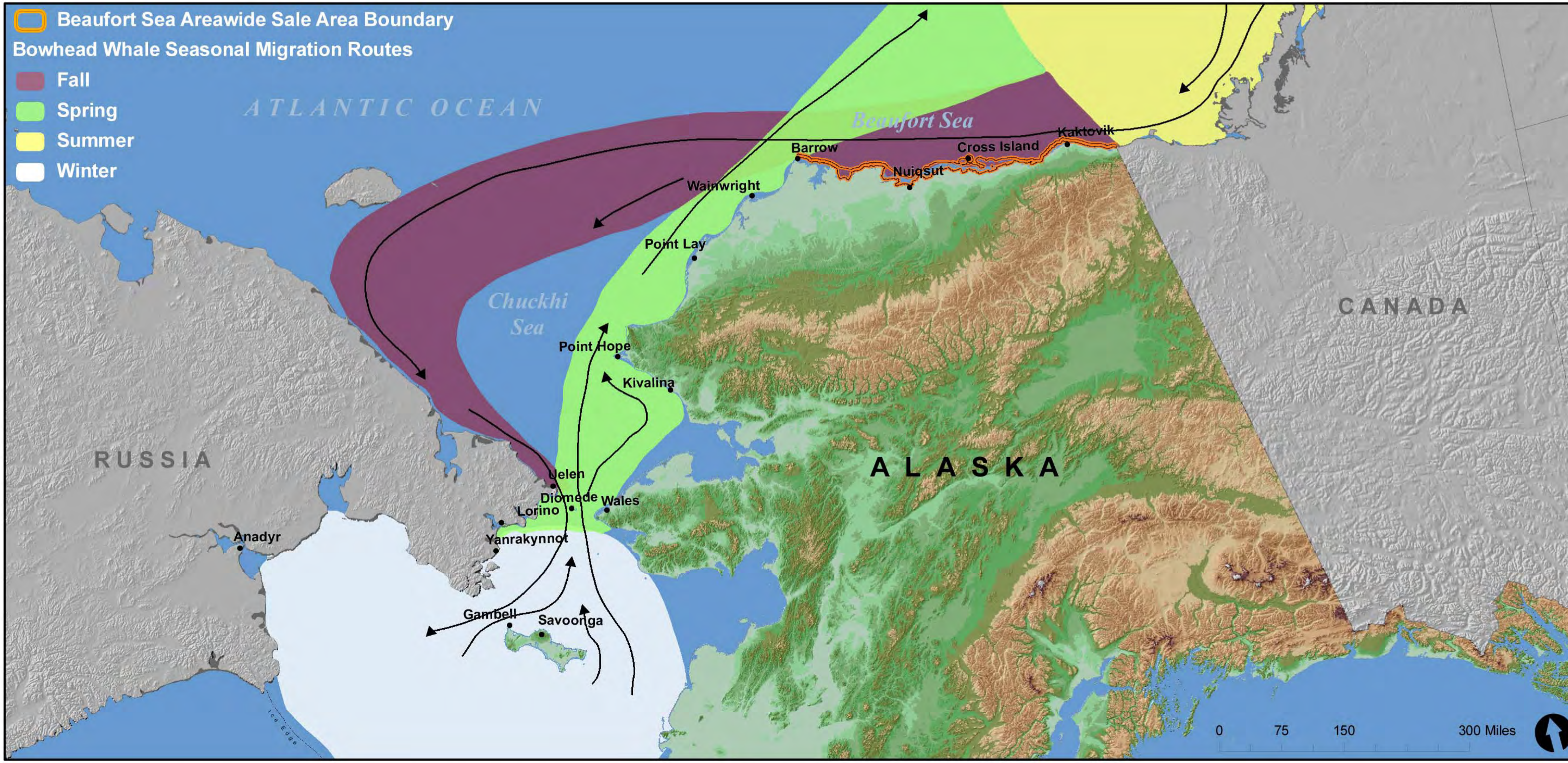
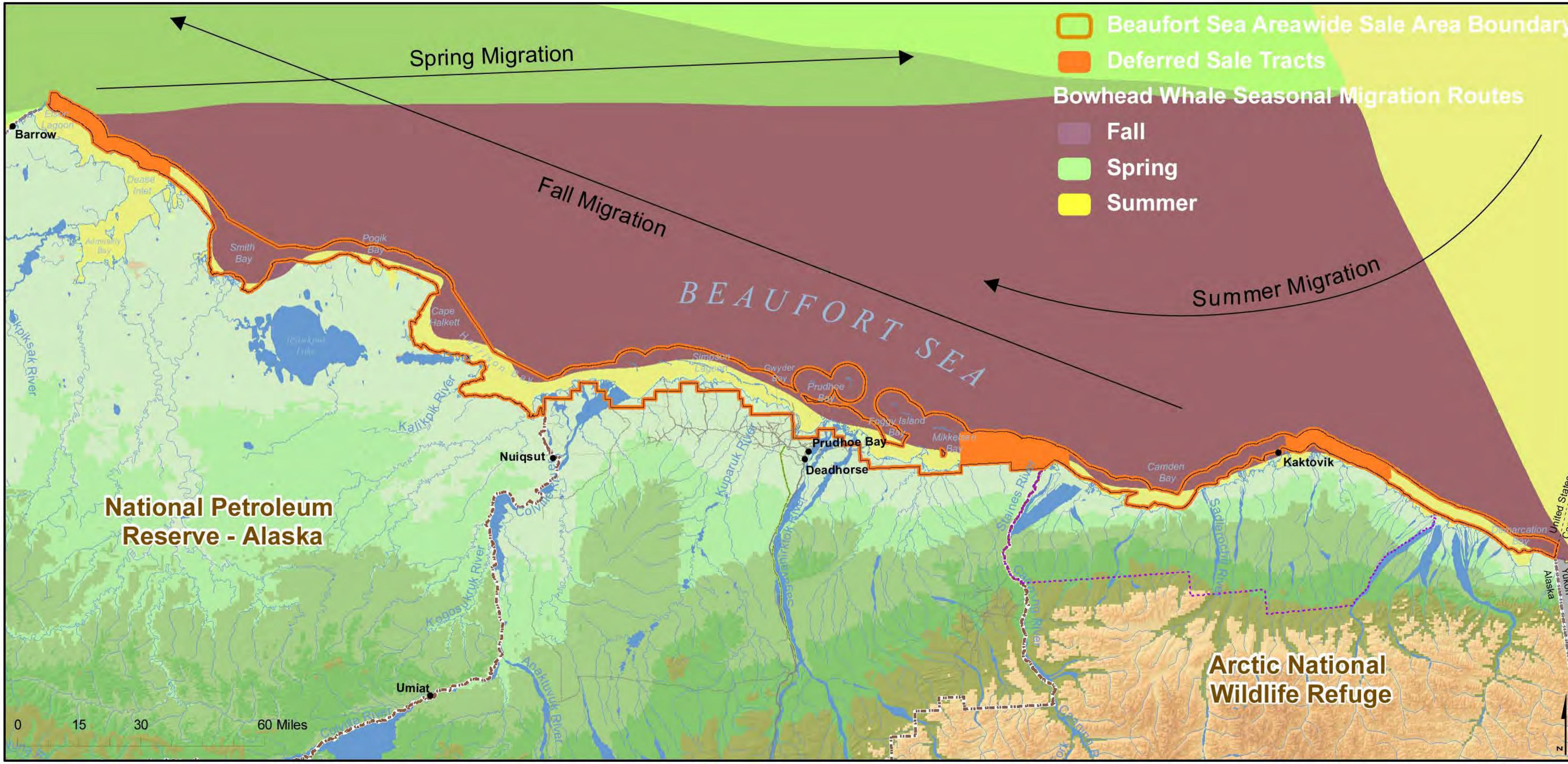
Map 4.5. Important polar bear habitat in the Beaufort Sea area.



Source: EDAW/AECOM 2007.

Notes: Information on this map is depicted only at a township or section level resolution. For detailed information regarding any specific area, interested individuals may consult the land records of one or more of the following agencies: ADNR, BLM, MMS, and NOAA. Discrepancies in boundary alignments are the result of merging multiple data sets from these various sources.

Map 4.6. Migration route of bowhead whales in the Arctic.



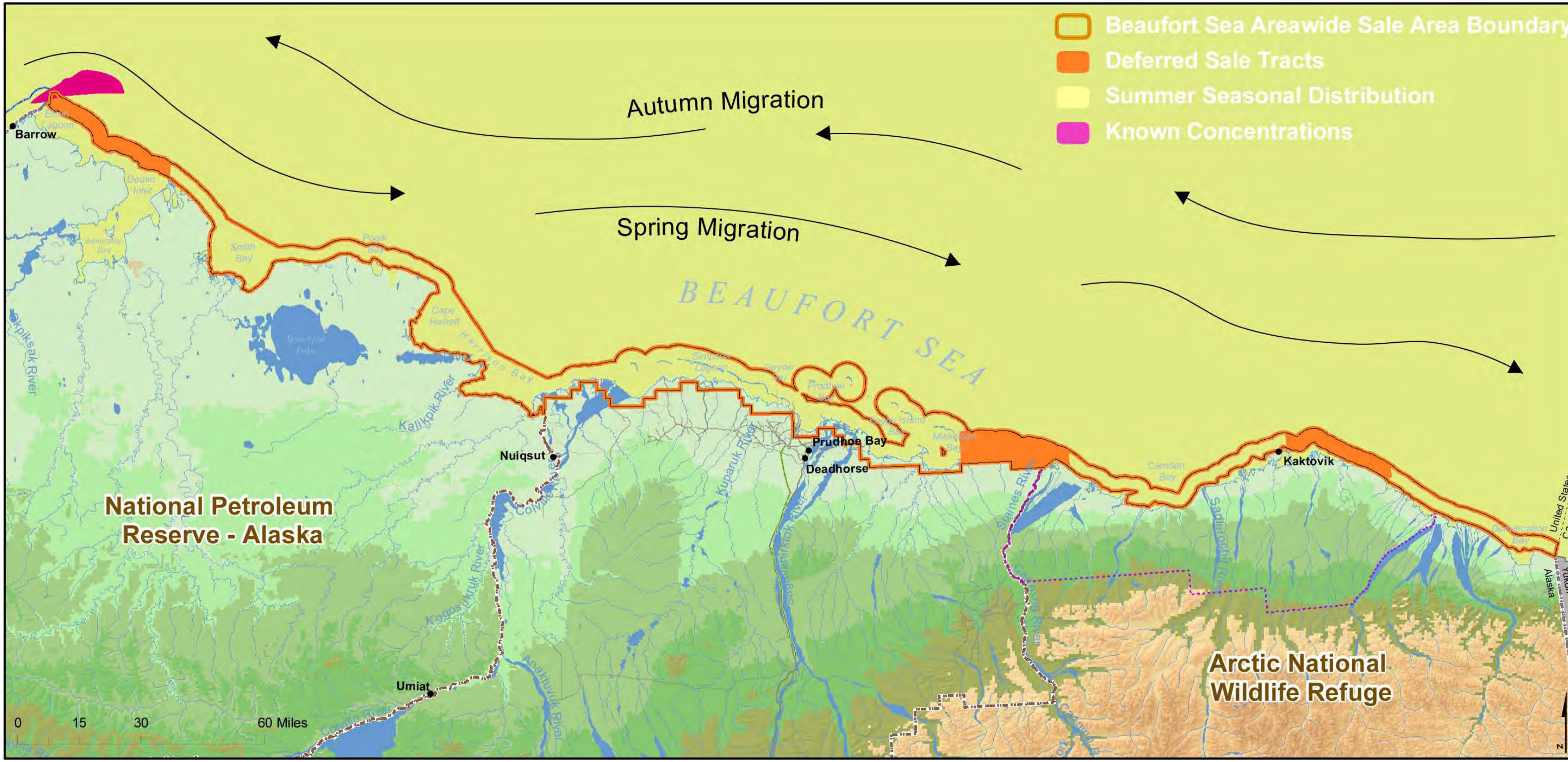
Source: EDAW/AECOM 2007.

Notes: Information on this map is depicted only at a township or section level resolution. For detailed information regarding any specific area, interested individuals may consult the land records of one or more of the following agencies: ADNR, BLM, MMS, and NOAA. Discrepancies in boundary alignments are the result of merging multiple data sets from these various sources.

Map 4.7. Migration route of bowhead whales in the Beaufort Sea.

Notes: Information on this map is depicted only at a township or section level resolution. For detailed information regarding any specific area, interested individuals may consult the land records of one or more of the following agencies: ADNR, BLM, MMS, and NOAA. Discrepancies in boundary alignments are the result of merging multiple data sets from these various sources.

Map 4.8. Seasonal distribution of beluga whales in northern Alaska.



Notes: Information on this map is depicted only at a township or section level resolution. For detailed information regarding any specific area, interested individuals may consult the land records of one or more of the following agencies: ADNR, BLM, MMS, and NOAA. Discrepancies in boundary alignments are the result of merging multiple data sets from these various sources.

Map 4.9. Seasonal distribution of beluga whales in the Beaufort Sea area.

Notes: Information on this map is depicted only at a township or section level resolution. For detailed information regarding any specific area, interested individuals may consult the land records of one or more of the following agencies: ADNR, BLM, MMS, and NOAA. Discrepancies in boundary alignments are the result of merging multiple data sets from these various sources.

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S. Hadwen, USFWS

Woman and girl ice fishing.

AS 38.05.035(g) directs that best interest findings consider and discuss the current and projected uses in the area, including uses and value of fish and wildlife. The Beaufort Sea area provides important habitat for freshwater and marine fishes, many species of birds, and terrestrial and marine mammals. The fish and wildlife of the area provide the resource base for subsistence fishing and hunting, and for several small sport fisheries and sport hunting. There are no commercial fisheries for marine species in the Beaufort Sea area although there is a very limited commercial fishery on whitefish. The area is used to a small extent for recreation and tourism. The primary industrial use of the area is for oil and gas development.

A. Uses and Value of Fish, Wildlife, and Plants

The fishes, birds, mammals, and plants of the Beaufort Sea area have been used by area residents for centuries, forming the resource base for the fishing, hunting, and gathering activities that are integral to the history, culture, and economy of the area. The primary use of these resources is for subsistence which, in the broad sense, refers to “any harvest or use of fish, wildlife, and wild plants for home use. It also incorporates the noncommercial exchange or sharing of resources…” (Fall et al. 2004).

Management of fish and wildlife in the Beaufort Sea area can fall under the authority of either the state or federal government, or international treaties or agreements. Management authorities and types of harvest activities may overlap. Sport and state subsistence hunting and fishing are managed by ADF&G. Subsistence hunting on federal lands, and subsistence fishing on federal waters or waters adjacent to federal lands, are managed by the Federal Subsistence Management Program. Management of marine mammals falls under federal jurisdiction or the International Whaling Commission (IWC). Migratory birds are federally managed. Local residents serve on a number of advisory committees that provide input to state or federal management agencies, and local residents are also members of commissions that participate in co-management of marine mammals or migratory birds.

1. Subsistence Fishing, Hunting, and Gathering

Subsistence fishing, hunting, and gathering are important to the residents of the Beaufort Sea area, both culturally and as important sources of food. Sharing of subsistence foods is an important part of the culture (Bacon et al. *Unpublished*). Harvests are routinely shared with elders, other households, and between villages. Subsistence harvests are also traded and bartered, for gasoline and equipment for example.

Although bowhead whale harvests tend to make up the largest proportion of total subsistence harvests, other species are also seasonally important, more so than their actual proportions may imply (EDAW/AECOM 2007). These other species become even more important in years when few or no whales are harvested.

Subsistence species tend to be migratory and seasonally abundant. Successful hunts require knowing when and where to intercept these resources as they migrate. For species that migrate through the area over a relatively short period, adverse weather conditions or equipment problems may result in missing the entire migration (Braund and ISER 1993).

a. <u>Community Subsistence Characteristics</u>

i. Barrow

The Barrow area has an abundant diversity of fish, wildlife, and other natural resources because of its location at the convergence of the Chukchi and Beaufort seas (Braund and ISER 1993). The area, which usually has some open water year round, is rich in migrating marine resources including bowhead whales, beluga whales, walrus, bearded seals, ringed seals, and eider ducks. Terrestrial species include caribou, fox, wolf, and wolverine. Many species of migrating birds nest in the Barrow area, and there are several fish species in local rivers, especially during summer and fall migrations to spawning areas. Although marine mammals, and bowhead whales in particular, are the main focus of Barrow subsistence harvests (URS Corp. 2005a), most of these fish, wildlife, and bird species are important for subsistence in the Barrow area (Braund and ISER 1993; Table 5.1).

Although Barrow has a cash economy, traditional subsistence activities remain fundamental to the local economy and culture (Braund and ISER 1993). In 2003, over 91 percent of Alaska Native households in Barrow participated in local subsistence activities, and for 66 percent of the households, at least half of their diet consisted of local subsistence resources (EDAW/AECOM 2007 citing to Circumpolar Research Associates 2004). For non-Alaska Native households, one-third used wild resources obtained from hunting, fishing, or gathering. In Barrow, bowhead whale hunting is the main subsistence activity, resulting in large concentrations of effort, time, money, group symbolism, and significance. It also provides much of the organization for social community relations (EDAW/AECOM 2007).

Table 5.1. Harvest of several species of wildlife and birds in the Barrow area.

12-mo Period	Caribou	Large Whitefish[a]	Geese[b]	Walrus	Eiders[c]	Bearded Seals
1995-1996	2,155	12,084	2,599	74	12,114	431
1996-1997	1,158	7,657	1,856	78	2,572	192
1999-2000[d]	3,359	23,213	7,550	115	2,572	729
2000-2001[d]	1,820	2,177	4,893	123	2,201	327
2002-2003[d]	2,092	8,899	3,321	313	4,773	776

Source: Bacon et al. *Unpublished*.

[a] Includes broad whitefish, humpback whitefish and unidentified whitefish.

[b] Includes greater white-fronted goose, Canada goose, snow goose and brant.

[c] Includes common eider, king eider, spectacled eider and Steller's eider.

[d] Estimates are from full calendar year surveys.

The subsistence hunting zone for Barrow is the largest in the region, extending beyond Wainwright in the west, to the Kuparuk River in the east, and south to the Avuna River (EDAW/AECOM 2007). Inland, the area stretches beyond the Colville River to the foothills of the Brooks Range. Although many residents from throughout the NSB have relocated to Barrow, many continue to hunt in the areas where they were raised (Braund and ISER 1993). For example, Barrow residents with ties to Nuiqsut may return there for subsistence activities because they continue to share use rights to cabins, camps, and allotments in the area (EDAW/AECOM 2007).

Although changes in subsistence patterns have occurred as Barrow transitioned to a cash economy, many residents balance wage employment with seasonal subsistence activities. Studies have shown that higher levels of household cash income are correlated with higher levels of subsistence activities and harvest. However, time constraints imposed by wage jobs may result in residents limiting subsistence activities to the most desired species (EDAW/AECOM 2007). In Barrow, the average expenditure on subsistence activities is $3,787, the median is $925, and 59 percent of households spend less than $2,000 per year on subsistence expenses such as fuel and ammunition (URS Corp. 2005a citing to Shepro et al. 2003).

Other changes include use of more efficient and reliable technology, such as all-terrain vehicles, snow machines, and outboard motors, which is possible because of increased financial resources. Recent economic declines may have resulted in increased reliance on subsistence resources (URS Corp. 2005a). Some studies have shown that young adults participate in subsistence at the same rate as older generations, and that students exposed to Western influences are more interested in subsistence activities than those who have not been (EDAW/AECOM 2007).


C. Lensink, USFWS

Beluga whale subsistence harvest.

ii. Nuiqsut

At Nuiqsut, subsistence activities are important to the economy and to the local culture and identity (EDAW/AECOM 2007; Table 5.2). Bowhead whales are an important subsistence resource. Other fish and game are also harvested, including ringed, spotted, and bearded seals; polar bears; birds and eggs; caribou; moose; furbearers such as wolf and wolverine; and freshwater and marine fishes. Berries, plants, Eskimo potato, medicinal plants, and greens are also important for subsistence (EDAW/AECOM 2007).

Table 5.2. Harvest of several species of wildlife and birds in the Nuiqsut area.

12-mo Period	Caribou	Large Whitefish[a]	Geese[b]	Walrus	Eiders[c]	Bearded Seals
1994-1995	258	3,419	474	0	90	0
1995-1996	362	3,419	381	0	287	17
2000-2001	496	5,533	1,172	0	86	1

Source: Bacon et al. *Unpublished*.
[a] Includes broad whitefish, humpback whitefish, and unidentified whitefish.
[b] Includes greater white-fronted goose, Canada goose, snow goose and brant.
[c] Includes common eider, king eider, spectacled eider, and Steller's eider.
[d] Estimates are from full calendar year surveys.

Patterns of subsistence hunting, fishing, and gathering have changed at Nuiqsut in recent years (EDAW/AECOM 2007). In 1998, subsistence resources made up at least half the food consumed for 73 percent of households; this decreased to 63 percent of households in 2003 (URS Corp. 2005c, citing to Shepro et al. 2003). There are many factors that may contribute to these changes. For example, the greater availability of cash resources through sources such as employment and dividends for the purchase of food and supplies may decrease the need for subsistence harvests (EDAW/AECOM 2007). In 2003, Nuiqsut households spent an average of $6,700 on subsistence activities, and the community as a whole expended 20 percent of its gross income on subsistence activities (URS Corp. 2005c).

Seasonal employment is generally available for those desiring work, and many Nuiqsut residents prefer seasonal work because it allows easier participation in subsistence activities (EDAW/AECOM 2007). However, non-subsistence activities may result in subsistence activities being compressed into shorter seasons. Another factor affecting subsistence patterns is that the CAA (Conflict Avoidance Agreement) now supplies logistical support for whaling in Nuiqsut which reduces the need for additional subsistence activities. Also at Nuiqsut, the distance of Cross Island from Nuiqsut, from where the community's whaling is staged, increases the expense of whaling and results in separation from family, resulting in compression of the whaling season (EDAW/AECOM 2007).

iii. Kaktovik

Residents of Kaktovik have a unique set of natural resources available for subsistence. Because of Kaktovik's location, hunters have access to terrestrial, riparian, and marine resources. Subsistence activities, particularly those surrounding the bowhead whale hunt, are central to the structural organization and cultural identity of Kaktovik residents. Although the bowhead whale is the primary marine mammal subsistence species, seals and polar bears are also important. Residents harvest both marine and freshwater fishes. Caribou are the most important terrestrial subsistence resource, but sheep, muskox, and grizzly bears are also harvested (Galginaitis and Koski 2002). Bird species harvested include geese and ptarmigan (URS Corp. 2005b; Table 5.3).

Table 5.3. Harvest of several species of wildlife and birds in the Kaktovik area.

12-mo Period	Caribou	Large Whitefish[a]	Geese[b]	Walrus	Eiders[c]	Bearded Seals
1994-1995[d]	78	0	273	0	111	21
2002-2003	112	3	479	0	38	8

Source: Bacon et al. *Unpublished*.

[a] Includes broad whitefish, humpback whitefish, and unidentified whitefish.

[b] Includes greater white-fronted goose, Canada goose, snow goose and brant.

[c] Includes common eider, king eider, spectacled eider and Steller's eider.

[d] Estimates are from full calendar year surveys.

Subsistence patterns in Kaktovik have also changed in recent years. In 1998, subsistence resources made up at least half the food consumed for 83 percent of households; this decreased to 69 percent of households in 2003 (URS Corp. 2005b, citing to Shepro et al. 2003). Residents have noted that they are involved in a wider range of activities and responsibilities, and that they travel away from the village more often for a wide variety of reasons (EDAW/AECOM 2007). These lifestyle changes may limit their subsistence activities and constrain the timing of subsistence activities. Residents have noted that winter subsistence is minimal and that overall, hunting trips are shorter. Studies of these changes have found that "aspects of the hunt other than the actual harvest are becoming increasingly important as cultural identity value markers and for the maintenance of mental health, especially as the time available for subsistence activities becomes less" (EDAW/AECOM 2007).

In Kaktovik, wage jobs are important for maintaining subsistence activities. The average household expended $4,788 on subsistence, and overall, the community spent approximately 10 percent of its total income on subsistence activities (URS Corp. 2005b, citing to Shepro et al. 2003). Seasonal employment is available to most Kaktovik residents desiring work. Some residents prefer seasonal work because it allows them to participate more fully in subsistence activities (EDAW/AECOM 2007). Kaktovik residents working at permanent jobs are generally able to take time off for activities that require larger blocks of time, such as whaling, fishing, and hunting birds and sheep. Whaling is generally conducted as day trips out of the village, but other types of hunting and fishing usually require travel and overnight camping. Many residents participate in fishing and birding, while some types of hunting, such as sheep hunting, is done by only a few specialized hunters (EDAW/AECOM 2007). Relatively little moose and muskox hunting is done by Kaktovik residents.

Residents with higher incomes are able to afford more equipment and supplies, such as snowmobiles, boats, outboard motors, rifles, ammunition, and gas, which helps to make up for less time available for subsistence activities. Although residents employed full-time may not necessarily participate in subsistence activities as much as other residents, they may support others in the community who are more active (EDAW/AECOM 2007). Residents with lower incomes also participate in subsistence activities that do not require as much cash input, such as fishing or sealing near the village.

b. Plant Harvests

Various types of plants provide subsistence foods to residents of the Beaufort Sea area (Table 5.4). Root species are generally harvested in August, while late summer and early fall are important times for gathering berries. Residents often pick berries in conjunction with other subsistence activities such as caribou hunting and fishing (Bacon et al. *Unpublished*). Berries and plants may be available for only a short time. They are found along raised banks of streams and rivers and in areas of wet tundra (EDAW/AECOM 2007).

Table 5.4. Estimated subsistence harvest and standard error (SE) of plants (gallons), by species, for Barrow, Nuiqsut, and Kaktovik.

	Barrow 2003[a]		Nuiqsut 2000-2001[b]		Kaktovik 2002-2003[c]
Species	Harvest	SE	Harvest	SE	Harvest
Berries					2
Blueberries	14	8	1	0	
Crowberries	5	3			
Wild Rhubarb	2	1			1
Roots	4	2			2
Salmonberries	33	15	1	0	1
Sour Dock					3
Wild Spinach	2	1			
Willow Leaves	2	1			

Source: Bacon et al. *Unpublished*.
[a] Calendar year.
[b] July 2000 - June 2001.
[c] July 2002 - June 2003. No standard error (SE) because survey was a census.

c. Fish Harvests

Fish harvests are an important food staple for residents of the Beaufort Sea area (Table 5.5). Whitefish species are particularly important and are used for dog food as well as for human consumption. Species such as broad whitefish, which are considered the preferred fish by many residents, are generally harvested in the summer and fall with gillnets. They are filleted and dried, or stored in ice cellars. Arctic grayling and Dolly Varden are also highly prized (Bacon et al. *Unpublished*). Subsistence harvests also occur through the ice on overwintering concentrations of whitefish and Arctic grayling (EDAW/AECOM 2007). Arctic cod are available year round.

Table 5.5. Estimated subsistence harvest and standard error (SE) of fish and invertebrates, by species, for Barrow, Nuiqsut, and Kaktovik.

	Barrow 2003[a]		Nuiqsut 2000-2001[b]		Kaktovik 2002-2003[c]
Species	Harvest	SE	Harvest	SE	Harvest
FISH					
Arctic Char	270	97	38	2	1,162
Arctic Cisco	62	24	18,222	377	1,051
Arctic Cod	0	0			46
Arctic Flounder	44	16			
Arctic Grayling	3,514	809	1,537	47	70
Broad Whitefish	8,207	1,237	2,968	80	3
Burbot	405	242	182	36	1
Capelin	5,285	3,475			
Chum Salmon[d]	272	182			
Dog Salmon[d]	1,345	683			
Humpback Salmon[d]	798	458			
Humpback Whitefish	569	297	1,628	113	
King Salmon	439	404	2	0	
Lake Trout	65	40			20
Least Cisco	1,337	503	630	38	
Northern Pike	37	23			1
Pink Salmon[d]	1,050	383			
Rainbow Smelt	193	185			
Salmon spp.	44	29	3	0	
Silver Salmon	845	308	5	0	
Tom Cod					9
Whitefish spp.	122	80	937	60	
Fish spp.			403	36	
INVERTEBRATES					
Clams	1,733	949			3

Source: Bacon et al. *Unpublished*.

[a] Calendar year.

[b] July 2000 - June 2001.

[c] July 2002 - June 2003. No standard error (SE) because survey was a census.

[d] Chum and dog salmon are the same species; humpback salmon and pink salmon are the same species.

d. Bird Harvests

Birds and bird eggs are an important component of the subsistence harvests in the Beaufort Sea area (Table 5.6). Hunting of other migratory birds is regulated under the Migratory Bird Treaty Act. Subsistence hunting of spectacled eiders is closed, and non-toxic lead shot must be used for all waterfowl hunting (USFWS 1999). Although they make up only a small proportion of total harvests by weight, they may be important seasonally, and participation in bird hunting is high (EDAW/AECOM 2007). Hunting corresponds to the spring migration and the molt and fall migration. Eiders, geese, and ptarmigan are particularly important (Bacon et al. *Unpublished*), with over 2,500 eiders and over 3,300 geese taken in Barrow in 2003 (Table 5.6). Ptarmigan are important in the early spring because they are found in flocks and are one of the few sources of fresh meat available at that time (EDAW/AECOM 2007). In Barrow, eider harvests generally occur in July. In some communities, birds are an important component of whaling events, when it is not uncommon for 200 ducks and geese to be used.

Table 5.6. Estimated subsistence harvest and standard error (SE) of birds, by species, for Barrow, Nuiqsut, and Kaktovik.

	Barrow 2003[a]		Nuiqsut 2000-2001[b]		Kaktovik 2002-2003[c]
Species	Harvest	SE	Harvest	SE	Harvest
American Widgeon					2
Brant	88	30			277
Canada Goose	3	2			33
Common Eider	317	67			12
Duck spp.	505	130			8
Eider spp.	2,568	707	55	4	18
Eider Eggs					30
Goose spp.	220	85	319	79	
King Eider	937	325	30	3	8
Mallard	86	83			1
Long-tailed Duck	25	14			5
Northern Pintail	18	12			2
Ptarmigan spp.	426	139	23	3	370
Sandhill Crane	2	1			1
Snow Goose	3	2			20
Spruce Grouse	18	12			
Steller's Eider	14	9			
Tundra Swan	2	1			
White-fronted Goose	3,314	487	787	188	149
White-fronted Goose Eggs	44	19			
Yellow-billed Loon	18	8			

Source: Bacon et al. *Unpublished*.

[a] Calendar year.

[b] July 2000 - June 2001.

[c] July 2002 through June 2003. No standard error (SE) because survey was a census.

Caribou harvest.

e. Terrestrial Mammal Harvests

Terrestrial mammals, particularly caribou, are an important component of subsistence harvests in the Beaufort Sea area (Table 5.7). However, their importance is not always reflected in reports giving the percent weight they contribute to total subsistence harvests because in some years, large bowhead whales harvests dominate the total harvest even if the actual number of whales taken is small (Bacon et al. *Unpublished*).

Caribou are generally available year round in the Beaufort Sea area. Caribou is the main terrestrial animal harvested for subsistence in Barrow, where harvests peak from February through early April, and from late June through late October (EDAW/AECOM 2007). In terms of participation, caribou hunting is the most important hunting activity in Barrow, perhaps because of high participation by non-Natives (Bacon et al. *Unpublished*). Harvests fluctuate from year to year, depending on proximity of overwintering caribou to Barrow. In 2003, 2,092 caribou were harvested by Barrow residents (Table 5.7).

Nuiqsut residents may hunt caribou year round, but caribou are particularly important when there is an immediate need for meat (EDAW/AECOM 2007). Caribou comprise the majority of the terrestrial mammal resources harvested for subsistence at Nuiqsut (Bacon et al. *Unpublished*). Nuiqsut residents harvested almost 500 caribou from July 2000 through June 2001 (Table 5.7). At Kaktovik, caribou can also be hunted throughout the year, but harvests fluctuate because movements of the Porcupine and Central Arctic caribou herds are unpredictable (EDAW/AECOM 2007). Kaktovik residents harvested 112 caribou from July 2002 through June 2003 (Table 5.7).

Barrow residents may hunt moose along the Colville River during the summer (EDAW/AECOM 2007). However relatively few or no moose are taken in years when hunting is restricted or closed by regulation (Bacon et al. *Unpublished*). In Barrow, most moose hunting is conducted by non-Natives (Bacon et al. *Unpublished*). Nuiqsut residents hunt moose by boat on the Colville, Chandler, and Itkillik rivers during August (EDAW/AECOM 2007). Few Kaktovik residents hunt for moose.

Dall sheep are hunted by Kaktovik residents. Dall sheep are second to caribou in importance of terrestrial mammals (Bacon et al. *Unpublished*).

Barrow residents harvest furbearers in the winter (Bacon et al. *Unpublished*). Nuiqsut residents may hunt for wolf and wolverine by snow machine in March and April, and may take them opportunistically while hunting for other species during the winter (Bacon et al. *Unpublished*; EDAW/AECOM 2007). Little trapping occurs in Kaktovik, although wolf and wolverine are hunted, usually in March and April.

Table 5.7. Estimated subsistence harvest and standard error (SE) of terrestrial mammals, by species, for Barrow, Nuiqsut, and Kaktovik.

	Barrow 2003[a]		Nuiqsut 2000-2001[b]		Kaktovik 2002-2003[c]
Species	Harvest	SE	Harvest	SE	Harvest
Arctic Fox	4	2	69	38	4
Brown Bear	2	1			
Caribou	2,092	221	496	17	112
Cross Fox	11	4			1
Dall Sheep					18
Ground Squirrel	17	11	5	0	48
Moose			6	0	
Muskox			2	0	
Red Fox	26	9	3	0	
Reindeer	5	2			
Weasel spp.	2	1			
Wolf	14	5	5	2	1
Wolverine	10	4	27	6	2

Source: Bacon et al. *Unpublished*.

[a] Calendar year.

[b] July 2000 - June 2001.

[c] July 2002 - June 2003. No standard error (SE) because survey was a census.

f. Marine Mammal Harvests

For most communities of the Beaufort Sea area, marine mammals tend to be the focus of subsistence harvests. Marine mammals harvested for subsistence include polar bears, whales, seals, and walrus.

i. Polar Bears

Polar bears are generally available anytime ice is present. They are taken occasionally, but harvested polar bears are primarily nuisance bears that are attracted to locations of where whales are being butchered (EDAW/AECOM 2007). In 2003, 21 polar bears were harvested in Barrow, 1 was harvested in Nuiqsut from July 2000 through June 2001, and 2 were harvested in Kaktovik from July 2002 through June 2003 (Bacon et al. *Unpublished*).

ii. Whales

Whales are an important marine mammal species to residents along the Beaufort Sea, particularly the coastal communities of Barrow, Nuiqsut, and Kaktovik, where the Inupiat and Yupik Eskimos have a long history of subsistence whaling (AEWC 2009). The thousands of pounds of whale meat harvested annually are shared throughout the community. Whaling is also an important cultural component, and the entire community participates in subsistence whaling and associated activities (AEWC 2009). Contemporary whaling in Kaktovik dates from 1964, and from 1973 in Nuiqsut (EDAW/AECOM 2007; Galginaitis and Koski 2002). During the 1960s and 1970s, subsistence whaling increased by more than 50 percent in Barrow because of increased opportunities for high-paying jobs. People interested in whaling could earn enough to purchase a new complete set of gear for a whaling operation in as little as six months (EDAW/AECOM 2007, citing to BLM 2005, Bockstoce 1977, and Brower 2004). Most whaling captains, who are expected to provide most of the equipment and supplies for their whaling crews, have other full-time employment or may be retired from full-time employment (EDAW/AECOM 2007).

Whales are managed worldwide by the International Whaling Commission (IWC), under the International Convention for the Regulation of Whaling, of which the U.S. is a member (NOAA 2009). The purpose of the IWC, which dates from 1946, is to "provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry" (IWC 2009b). The IWC sets quotas and size limits for whale harvests, harvest seasons and areas, and other necessary regulations. Within the U.S., whales are under federal jurisdiction, through the Whaling Act of 1949, the Marine Mammal Protection Act, and the Endangered Species Act, and are cooperatively managed through cooperative agreements with local Alaska Native organizations (AEWC 2009). The State of Alaska does not have management jurisdiction over whales. In the Beaufort Sea area, whales are managed cooperatively between NMFS and the Alaska Eskimo Whaling Commission (AEWC), and local associations of whaling captains. The AEWC is composed of registered whaling captains, who may vote, and their non-voting crew members (EDAW/AECOM 2007). Whaling captains must register with the AEWC and their local village whaling association: Barrow Whaling Captains Association, Nuiqsut Whaling Captains Association, or the Kaktovik Whaling Captains Association. Fifty-five whaling captains from Barrow are registered with the AEWC, eight captains from Kaktovik, and eight from Nuiqsut (EDAW/AECOM 2007). Some management practices that have been implemented by the AEWC to reduce wastage, increase success, and improve safety include a prohibition on taking females with calves, guidelines on the size of whales, and sanctions for violations (Galginaitis 2008).

Bowhead whale harvests are regulated by quotas set by the IWC (Angliss and Outlaw 2008). The AEWC is responsible for allocating the quota among Alaska whaling communities, which include Barrow, Nuiqsut, and Kaktovik within the Beaufort Sea area, as well as other coastal communities of the North Slope and western Alaska (NOAA 2009). In 2008, the quota for Alaska Eskimos was 75 strikes, which were allocated among the 11 Alaska whaling communities by the AEWC (50 CFR Part 230).

Bowhead harvests provide one of the main sources of meat for many of the communities of the Beaufort Sea area (EDAW/AECOM 2007). Bowhead harvests are often shared with other North Slope residents and with friends and relatives in other areas such as Fairbanks and Anchorage. Baleen is bartered and used in making traditional arts and crafts.

Subsistence whaling is highly correlated with the ice pack. Hunting for bowhead whales occurs when bowheads migrate relatively close to whaling communities (see Maps 4.5 and 4.6 in Chapter Four). This occurs during two seasons, spring (April-May) and fall (September-October). Most whaling communities located on the Bering and Chukchi seas (outside the proposed lease sale area) whale in the spring when whales follow open leads in the ice (Galginaitis 2008). Residents of Nuiqsut and Kaktovik, located on the Beaufort Sea, whale only in the fall because leads do not open up near these villages in the spring. Barrow residents whale in the spring and fall because Barrow is located where the Chukchi and Beaufort seas meet. At Barrow, whaling peaks from the last week of April to the last week of May (Braham et al. 1980).


MMS

Eskimo whale hunt.

A broad variety of equipment is required for whaling. The type of boat used depends on the season. In spring, traditional skin boats may be used when it is important to avoid noise. In the fall, wood, aluminum, and fiberglass boats are used because rougher seas and floating ice are more likely to be encountered, and because speed is needed to pursue whales successfully in open water (Galginaitis 2008). The AEWC requires that “traditional weapons” be used for whale hunting. However, they have broad authority in defining “traditional”, and may approve any weapon that improves the efficiency of the bowhead whale harvest (EDAW/AECOM 2007). Generally, black powder explosive bombs, darting guns, and lances are used in contemporary whaling. Other equipment used during bowhead whale hunting includes float-incorporated radio transmitters and portable receivers to locate whales, butchering tools, sleds, stoves and lanterns, global positioning units, VHF radios, snow machines, and equipment for setting up and maintaining a camp (EDAW/AECOM 2007).

The butchering process can require 20-25 people, and it may take 6-7 hours to butcher an average sized whale. The whaling season is marked with several celebrations for the entire town, and most residents are involved in whaling activities to some extent, particularly in the smaller villages (EDAW/AECOM 2007). After the whale is butchered, it is stored in ice cellars or chest freezers, or in some communities such as Kaktovik, it may be stored in walk-in freezers provided by the oil and gas industry (EDAW/AECOM 2007).

In Barrow, whales begin to be spotted in the spring in mid-April (EDAW/AECOM 2007). Most of the annual whale harvest is taken during the spring season. Hunting is based from 30-40 whaling camps stationed along the edges of landfast ice, usually located south of Barrow. Hunting is conducted from umiaqs (open boats made of skin stretched over a wooden frame), and usually occurs 1-3 miles from shore in leads in the ice. In the fall, whaling may begin in mid-August, continuing into October. During this season, whaling is shore-based, with crews leaving from town daily rather than from camps. Aluminum skiffs with outboard motors are used because hunting takes place in open water. Crews may travel up to 30 miles per day, and towing a whale back to shore can take 12-14 hours (EDAW/AECOM 2007).

Barrow hunting crews are generally composed of five to ten people, and may include people from other communities. In particular, Nuiqsut residents, who have close family ties to Barrow residents, participate in Barrow's spring whale hunt (EDAW/AECOM 2007).

At Nuiqsut, whaling occurs from early September through mid or late September as bowhead whales migrate west (EDAW/AECOM 2007). Whaling is staged from Cross Island, a low sandy barrier island located about 100 miles by boat east of Nuiqsut near Prudhoe Bay (Table 5.8; Maps 4.5 and 4.6 in Chapter Four). The island is 3 miles long, but only about 150 yards wide. An area on the island was built up of gravel during exploratory oil and gas drilling and now provides a location for setting up a whaling camp and other land-based activities associated with whaling such as butchering. Whaling is conducted from open, motorized aluminum or fiberglass boats. Nuiqsut generally has three to five active whaling crews.

The oil and gas industry provides Nuiqsut whalers significant logistical support through a Conflict Avoidance Agreement (CAA), previously called the Oil/Whalers Agreement (EDAW/AECOM 2007). This logistical support includes low-cost conex units that are used as seasonal cabins; a diesel-powered winch and loader to haul whales to Cross Island and for maneuvering whales during the butchering process; assistance with reliable gasoline supplies; a generator system to supply electricity to cabins during the whaling season; diesel fuel; water and other supplies; transportation of butchered whale product to Nuiqsut; some phone service; assistance with mobilization and demobilization of the Cross Island camp; availability of an emergency system; and a communications system to coordinate whaling with oil and gas activities to minimize conflicts. Most of the funding for this logistical infrastructure comes from BP, ConocoPhillips, and Shell Oil (EDAW/AECOM 2007).

Transporting whale harvests from Cross Island to Nuiqsut poses significant challenges. In most whaling villages, the first part of the whale harvest is traditionally shared with the entire village (EDAW/AECOM 2007). Because of the distance involved with Nuiqsut whaling, the first part of butchered whale harvest is sent to Nuiqsut by air, which may be funded by AEWC or through the CAA. Most of the remaining butchered whale product is taken to West Dock where it is stored at an Alaska Clean Seas cold storage facility. The harvest is then flown or barged to Nuiqsut. Some of the harvest may also be trucked from West Dock to Oliktok Point where it is picked up by Nuiqsut residents and transported by boat or snow machine to Nuiqsut. Most of these transportation costs are paid for by oil and gas companies through the CAA (EDAW/AECOM 2007).

In Kaktovik, whaling occurs in the fall, from late August through late September or early October (EDAW/AECOM 2007). The core whaling area stretches from the Okpilak and Hulahula rivers east to Tapkaurak Point. Whaling activities, which are staged from the village rather than from camps, use motorized boats. When a whaling crew is successful, the whale is towed back to Kaktovik for butchering. Because it takes so long to tow the whale, risk of spoilage can be significant. After the whale arrives in Kaktovik, heavy equipment is used to maneuver the it onto the beach, shift it during the butchering process, and transport the butchered meat to storage locations in the village (EDAW/AECOM 2007).

Up to 11 whaling captains operate in Kaktovik (EDAW/AECOM 2007). Most crews are composed of four to five crew members, and female family members sometimes participate on the crews. Although anyone from Kaktovik may join a whaling crew, most crews are based on kinship relationships. All crews work cooperatively in the whaling operations, and most people of the village participate in whaling activities in some role (EDAW/AECOM 2007).

Kaktovik whaling occurs in the fall, and about 83 percent of the Kaktovik harvest is taken during September (Galginaitis and Koski 2002). Kaktovik hunters use a core whaling area that extends from the Hulahula River in the west to Tapkaurak Point in the east and offshore as far as about 20 miles, although most whaling occurs within 12 miles of the village. The average distance of harvest locations from Kaktovik has not changed from the 1970s to present (Galginaitis and Koski 2002).

Because the Kaktovik harvest occurs in the fall, the village can often get unused strike quotas from spring whaling villages (EDAW/AECOM 2007). However, Kaktovik's quota of three whales usually provides enough meat for the entire village. Kaktovik residents trade whale meat for caribou from Anaktuvuk Pass residents.

Table 5.8. Use of Cross Island for whaling by Nuiqsut residents, 2001-2006.

Year	Number of Active Whaling Crews	Number of Scouting Boats[a]	Average Number of People on Cross Island[b]
2001	4	7	28
2002	3	9	27
2003	4	10	20
2004	4	8	19
2005	5	8	30
2006	4	7	29

Notes: Cross Island is the primary staging location for whaling by Nuiqsut residents.

Source: Galginaitis 2008.

[a] Not all boats were used all the time.

[b] People involved with whaling activities.

Alaska Native subsistence hunts take about 0.1-0.5 percent of the bowhead whale population annually (Angliss and Outlaw 2008). The number of whales landed at each village varies widely, and is influenced by village size, and ice and weather conditions. The size of whales landed also varies, probably due to differences in hunter selectivity and availability of whales (Angliss and Outlaw 2008). Canadian and Russian Natives also take some whales. From 1998-2007, an average of 22 bowhead whales were landed in Barrow, ranging from 16-29 (Table 5.9). The harvest averaged three whales at Nuiqsut, and three whales at Kaktovik. Additional whales were struck and lost but are not included in these statistics.

Beluga whales are harvested for subsistence uses in the Beaufort Sea area. Subsistence hunting of beluga whales is managed cooperatively through an agreement between NMFS and the Alaska Beluga Whale Committee (ABWC) (NMFS 1999). ABWC represents Alaska Natives who subsistence hunt the eastern Bering, Bristol Bay, eastern Chukchi, and Beaufort Sea stocks of beluga whales. Also represented on the ABWC are federal, state, and local governments, and beluga scientists. The purpose of the ABWC is to conserve beluga whale populations, protect subsistence hunting, promote research, and support provisions of the Marine Mammal Protection Act. The ABWC also obtains harvest information and biological samples (NMFS 1999).

From 1999-2003, 27-117 beluga whales of the Beaufort Sea stock were taken in subsistence hunts (Table 5.10). Subsistence harvest ranged from 24-66 during that period.

Table 5.9. Number of bowhead whales landed in Barrow, Nuiqsut, and Kaktovik, 1974-2007.

Year	Barrow	Nuiqsut	Kaktovik	Year	Barrow	Nuiqsut	Kaktovik
1974	9	0	2	1991	12	1	2
1975	10	0	0	1992	22	2	3
1976	23	0	2	1993	23	3	3
1977	20	0	2	1994	16	0	3
1978	4	0	2	1995	19	4	4
1979	3	0	5	1996	24	2	1
1980	9	0	1	1997	30	3	4
1981	4	0	3	1998	25	4	3
1982	0	1	1	1999	24	3	3
1983	2	0	1	2000	18	4	3
1984	4	0	1	2001	27	3	4
1985	5	0	0	2002	22	4	3
1986	8	1	3	2003	16	4	3
1987	7	1	0	2004	21	3	3
1988	11	0	1	2005	29	1	3
1989	10	2	3	2006	22	4	3
1990	11	0	2	2007	20	3	3

Note: Includes only bowhead whales landed; additional whales may have been struck and lost.

Sources: Suydam and George 2004; Suydam et al. 2005-2008.

Table 5.10. Subsistence harvest of beluga whales of the Beaufort Sea stock, 1999-2003.

Year	Reported total number taken	Reported number harvested	Estimated number struck and lost
1999	45+	35	10+
2000	117	66	51
2001	43	25	18
2002	27	24	3
2003	34	34	unknown

Source: 1999-2003 from Angliss and Outlaw 2008;

Gray whales of the eastern North Pacific stock were traditionally harvested by subsistence hunters in Alaska and Russia (Angliss and Outlaw 2008). This stock is now harvested in subsistence hunts by the Makah Tribe of Washington state and by the Chukotka people of Russia. In 1997, the IWC approved a 5-year quota for 1998-2002 of 620 gray whales, with an annual cap of 140, for aboriginals of Russia and the U.S. Makah Indian Tribe. The quota was shared, with an average annual quota of 120 whales for Russia and 4 whales for the Makah Indian Tribe (Angliss and Outlaw 2008). For 2008-2012, the quota is set at a total of up to 620 (total for the period), with no more than 140 whales harvested annually (IWC 2009a). The last harvest of gray whales in Alaska occurred in 1995 when two whales were harvested (Table 5.11 ;Angliss and Outlaw 2008).

Table 5.11. Subsistence harvest of gray whales by Alaska, Russia, and Makah Tribe (Washington state) Natives, 1995-2003.

Year	Alaska	Russia	Makah Tribe
1995	2		
1996		43	
1997		79	
1999		121[a]	1
2000		113[a]	
2001		112	
2002		131	
2003		126[a]	

Source: Angliss and Outlaw 2008.

[a] +2 struck and lost.

iii. Seals

At Barrow, bearded seals are an important subsistence resource because they are preferred for food, and they are also the preferred material for covering skin boats used in whaling (EDAW/AECOM 2007). Harvest of bearded seals usually takes place during the spring and summer from powerboats during the open water season (EDAW/AECOM 2007; Bacon et al. *Unpublished*), and while pursuing other marine mammals. Some Barrow hunters specialize in seal hunting based on sea ice, with peak hunting occurring in February (Bacon et al. *Unpublished*). At Barrow, 776 bearded seals, 413 ringed seals, and 12 spotted seals were harvested in 2003 (Table 5.12).

At Nuiqsut, ringed, spotted, and bearded seals are important subsistence resources. They are harvested along the coast, and offshore from Cape Halkett in the west to Foggy Island Bay in the east. In the spring, seals are shot in the water and on the ice edge. In the summer, ringed and spotted seals are harvested from powerboats in the Colville River as far south as Ocean Point (EDAW/AECOM 2007; Bacon et al. *Unpublished*). One bearded seal and 25 ringed seals were harvested from July 2000 through June 2001 (Table 5.12).

At Kaktovik, hunting for seals can occur throughout the year. Hunting for seals does not generally occur concurrently with whale hunting because Kaktovik hunters tend to focus on whaling during the whaling season (EDAW/AECOM 2007). Eight bearded seals and 17 ringed seals were harvested at Kaktovik from July 2002 through June 2003 (Table 5.12).

Table 5.12. Estimated subsistence harvest and standard error (SE) of seals, by species, for Barrow, Nuiqsut, and Kaktovik.

	Barrow 2003[a]		Nuiqsut 2000-2001[b]		Kaktovik 2002-2003[c]
Species	Harvest	SE	Harvest	SE	Harvest
Bearded Seal	776	266	1	0	8
Ringed Seal	413	79	25	1	17
Spotted Seal	12	4			

Source: Bacon et al. *Unpublished*.
[a] Calendar year.
[b] July 2000 - June 2001.
[c] July 2002 - June 2003. No standard error (SE) because survey was a census.

iv. Walrus

Harvest levels during the 1990s were lower than the 1980s, but it is unknown if the change is related to walrus abundance or hunting effort (Angliss and Outlaw 2008). Harvest levels may have been influenced by the cessation of Russian commercial walrus harvests after 1991, political, economic, and social conditions in Alaska and Chukotka, and weather and ice conditions. In 1997, subsistence hunters gained more participation in the conservation and management of walrus stocks in Alaska through a cooperative agreement between the USFWS and the Alaska Eskimo Walrus Commission (Angliss and Outlaw 2008).

In Barrow, harvest of walrus varies greatly from year to year depending on their abundance and distribution (Bacon et al. *Unpublished*). Since 1989, harvests have ranged from four walrus in 1994 to 51 walrus in 2003 (Table 5.13). Walrus harvests take place in June and July as they drift north with the flow ice, and they are also harvested if the pack ice moves close enough to Barrow (EDAW/AECOM 2007).

Walrus are usually not available around Kaktovik, and Cross Island, although Nuiqsut residents sometimes travel to Barrow to harvest walrus (EDAW/AECOM 2007). From 1989-2008, only two walrus were harvested from Kaktovik, and none by Nuiqsut residents at Cross Island (USFWS 2009).

Table 5.13. Reported subsistence harvest of Pacific walrus in Barrow, 1989-2008.

Year	Harvest	Year	Harvest
1989	12	1999	12
1990	7	2000	6
1991	22	2001	36
1992	7	2002	35
1993	7	2003	51
1994	4	2004	46
1995	5	2005	11
1996	13	2006	8
1997	37	2007	14
1998	25	2008	20

Notes: Only walrus for which the harvest date was known are included.
Source: USFWS 2009.

2. Sport Fishing

Sport fishing in the Beaufort Sea area is minimal, averaging less than 5,000 angler-days annually for the entire region, and most of that takes place on freshwaters outside the proposed lease sale area (Table 5.14; Table 5.15). Sport fishing effort in saltwater averaged only 374 angler-days from 1998-2007 (Table 5.15).

Most sport harvest in the Beaufort Sea area is of Dolly Varden and Arctic grayling, with smaller harvests of salmon, lake trout, whitefish, northern pike, and burbot. Dolly Varden and Arctic char are grouped together for sport fishing regulatory purposes because of the difficulty in distinguishing the species based on external characteristics (Scanlon 2008). Dolly Varden and Arctic char populations can generally support only low rates of exploitation. The Sagavanirktok River is one of the primary rivers for sport fishing for these species. Anglers access the Sagavanirktok River by the Dalton Highway which parallels much of the river. The Sagavanirktok River is the only specific location for which sport effort and harvest estimates are available: effort averaged 1,232 angler-days, harvest of Dolly Varden averaged 272 fish, and harvest of Arctic grayling averaged 205 fish from 1998-2007 (Table 5.16). Although the Sagavanirktok River flows into the Beaufort Sea, most of the river itself is outside the proposed lease sale area.

Anglers also occasionally fish for Dolly Varden and Arctic char on the Anaktuvuk River, a tributary of the Colville River. These anglers are mainly Barrow residents who fly into the area and land at a nearby private airstrip. Some sport fishing occurs on the Kongakut River which is a destination for recreationists making float trips in the eastern part of the Alaska National Wildlife Refuge (Scanlon 2008).

Fishing effort and harvest of Arctic char, Dolly Varden, Arctic grayling, and lake trout were expected to increase when the entire Dalton Highway was opened to the public in 1994, and again when improvements were made to the road south of Atigun Pass in 2001 and 2002. However, effort and harvest statistics show that this has not occurred (Scanlon 2008; Table 5.14). Increases in catch and harvest are expected from increased visitors floating rivers of the Alaska National Wildlife Refuge, particularly the Kongakut, Hulahula, and Canning rivers (Scanlon 2008).

3. Commercial Fisheries

There are no commercial fisheries for salmon on the North Slope (Scanlon 2008). A commercial fishery for whitefish on the Colville River dates from 1964 (Hayes et al. 2008). Fish are harvested with set gillnets under the ice. The fishery historically occurred during late June and July for broad and humpback whitefish, and October through early December for Arctic cisco and least cisco. Most fishing now occurs during October and November for Arctic cisco and least cisco. Some fish harvested under commercial permits are retained for subsistence.

Total harvest of all whitefish species from the Colville River ranged from 7,267 fish in 2004 to 36,038 fish in 1995 (Table 5.17). In 2007, a commercial whitefish permit was issued but no commercial sales were reported for the Colville River; in 2008, no commercial whitefish permits were issued (ADF&G 2008).

Table 5.14. Sport fishing effort and harvest in the Beaufort Sea area, 1998-2007.

Year	Anglers	Trips	Angler Days	Chinook Salmon	Pink Salmon	Coho Salmon	Lake Trout	Dolly Varden/ Arctic Char	Arctic Grayling	White-fish	Northern Pike	Burbot
1998	1,300	2,068	3,653	0	13	0	221	1,454	1,182	0	0	25
1999	1,044	3,344	5,230	0	0	0	77	929	1,206	68	0	0
2000	1,250	2,232	4,739	0	648	763	18	1,178	934	71	0	0
2001	865	3,817	6,032	0	0	0	37	1,589	846	26	0	18
2002	1,165	3,262	4,770	0	66	5	217	773	2,215	19	51	0
2003	834	1,756	2,710	0	49	0	98	193	1,122	304	22	22
2004	747	1,970	3,311	0	75	13	75	180	868	1,509	14	70
2005	1,469	2,085	4,352	0	0	0	96	493	1,313	0	32	0
2006	833	2,314	3,463	26	134	195	10	273	594	258	0	0
2007	907	2,975	4,154	0	0	0	0	151	572	0	0	0
Avg.	1,041	2,582	4,241	3	99	98	85	721	1,085	226	12	14

Source: Jennings et al. 2004, 2006a, b, 2007; *In prep.-a, b, c*

Notes: North Slope Brooks Range drainages (Statewide Harvest Survey Area Z), including all Alaskan waters, including drainages, north of the Brooks Range and flowing into the Beaufort and Chukchi Seas to the north and east of Point Hope. Does not include Point Hope. Includes waters outside the proposed Beaufort Sea lease sale area.

Table 5.15. Sport effort and harvest in saltwater, Beaufort Sea area, 1998-2007.

Year	Anglers	Trips	Days	Chinook Salmon	Pink Salmon	Coho Salmon	Dolly Varden	Arctic Grayling	White-fish
1998	155	358	408	0	13	0	17	0	0
1999	119	319	403	0	0	0	176	0	68
2000	88	96	743	0	648	763	702	0	0
2001	86	508	635	0	0	0	238	17	0
2002	163	481	558	0	66	5	222	0	0
2003	48	76	82	0	49	0	0	0	0
2004	50	96	96	0	0	0	0	0	0
2005[a]									
2006	87	358	359	26	134	195	38	290	0
2007	38	85	83	0	0	0	0	0	0
Avg.	93	264	374	3	101	107	155	34	8

[a] Too few surveys specific to saltwater were returned to make estimates in 2005.

Source: Jennings et al. 2004, 2006a, b, 2007; *In prep.-a, b, c*

Notes: Total saltwater (shore and boat fishing) of Statewide Harvest Survey Area Z (North Slope Brooks Range drainages).

Table 5.16. Sport effort and harvest at the Sagavanirktok River, 1998-2007.

Year	Anglers	Trips	Angler Days	Dolly Varden	Arctic Grayling	Burbot
1998	374	620	840	812	370	0
1999	367	1,844	2,055	330	181	0
2000	459	742	1,108	105	107	0
2001	359	1,615	2,537	757	206	7
2002	322	922	1,162	257	282	0
2003	242	375	423	0	163	22
2004	316	315	437	105	23	50
2005	614	535	1,042	51	354	0
2006[a]						
2007	391	1,281	1,482	30	158	0
Average	383	917	1,232	272	205	9

[a] Too few surveys specific to the Sagavanirktok River were returned to make estimates in 2006.

Source: Jennings et al. 2004, 2006a, b, 2007; *In prep.-a, b, c*

Notes: The Sagavanirktok River drains into the Beaufort Sea, but most of the river itself is outside the proposed lease sale area.

4. Sport Hunting and Trapping

ADF&G manages and monitors sport harvest of wildlife in the Beaufort Sea area. Harvests are estimated by management year which is defined as July 1 through June 30, or by calendar year. ADF&G Game Management Unit 26 encompasses the terrestrial portion of the proposed Beaufort Sea lease sale area as well as a large portion of land outside the proposed lease sale area. Sport hunting of big game in Unit 26 occurs for brown bear, moose, muskox, sheep, wolf, and two caribou herds. The Teshekpuk herd occurs in Unit 26A, and the Central Arctic herd occurs in Units 26B and 26C. Sport harvest of most big game is low, averaging less than 100 animals annually, except for caribou for which harvest averaged almost 4,000 for the Teshekpuk herd and 687 for the Central Arctic herd (Table 5.18).

B. Oil and Gas

Oil and gas exploration, development, and production have been ongoing in the Beaufort Sea since the late 1970s. Chapter Six provides a detailed description of the history of the oil and gas industry on the North Slope and in the Beaufort Sea.

Table 5.17. Commercial harvest and sales of freshwater whitefish, Colville River, 1995-2004.

	Number of Whitefish Harvested Intended for Commercial Sale[a]				Estimated Commercial Sale Based on Fish Tickets[b]	
Year	Humpback Whitefish	Least Cisco ("herring")	Arctic Cisco ("kaktok")	Total	Arctic Cisco	Whitefish Species[c]
1995	33,794[d]	-	-	33,794	13,921	6,000
1996	6,425[e]	7,796	21,817	36,038	9,076	4,127
1997	1,721[e]	10,754	9,403	21,878	9,403	4,760
1998	4,881[e]	9,936	7,019	21,836	5,648	7,105
1999	6,875[e]	7,430	8,832	23,137	7,095	6,170
2000	3,706[e]	5,758	2,619	12,083	2,809	6,569
2001	6,078[e]	2,839	1,740	10,657	1,779	7,306
2002	4,183[e]	5,503	3,935	13,621	899	4,093
2003	6,463[e]	4,777	5,627	16,867	0	1,292
2004	1,145[e]	3,061	3,061	7,267	2,412[f]	476

Source: Hayes et al. 2008.

Notes: dashes indicate information is not available.

a Reported on daily catch form returned to ADF&G. Catch reports were returned to the department following the fishing season. All fish reported on the catch report were harvested with the intent to sell.

b Fish tickets were often not generated at the time of sale. Since 1990, the commercial harvest is based on fish ticket information.

c Whitefish species include mostly humpback whitefish and least cisco with some broad whitefish.

d Humpback whitefish harvest includes undetermined amounts of broad whitefish, least cisco, and Arctic cisco.

e Humpback whitefish harvest includes undetermined amounts of broad whitefish.

f Mixed commercial harvest of mostly Arctic cisco along with humpback and broad whitefish, and least cisco. Estimated commercial harvest sales based on 1995 to 2001 combined average of $1.07/lb. for whitefish species and Arctic cisco.

Table 5.18. Sport harvest of big game in Game Management Unit 26, regulatory years 2002-03 through 2006-07.

	Species						
		Caribou Herd					
Regulatory Year	Brown Bear	Teshekpuk[a]	Central Arctic[b]	Moose	Muskox	Sheep	Wolf
2002-03	28	2,700	760	12	7	58	8
2003-04	30	2,700	311	5	3	75	19
2004-05	32	4,642	625	6	8	93	10
2005-06	19	4,460	687	14	4	92	16
2006-07	30	4,050	1,050	19	0	77	35
Average	28	3,710	687	11	4	79	18

[a] Game Management Unit 26A. Harvest for this herd was estimated by the area management biologist.

[b] Game Management Units 26B and 26C. The 2006-07 harvest was estimated by the area management biologist.

Source: ADF&G 2007.

Notes: Most of these harvest totals do not include unreported harvest which may be substantial and can even exceed the reported harvest for certain caribou herds. In addition most harvest totals do not include harvest from federal hunts. Harvest estimates for the 2006-2007 regulatory year are considered preliminary.

C. Recreation and Tourism

The Beaufort Sea area is used relatively little for recreation and tourism. The attractions for this area are its unusual location, the northern lights, the dramatic contrast of a modern petroleum industry side-by-side with the Arctic wilderness, abundant wildlife, unique scenery, national parks and wildlife refuges, and the distinct Inupiat Eskimo culture (NSB *Undated*). However, the extreme climate, remote location, and distance from major tourism corridors that increase expense and time required to reach and travel within the region, are obstacles to increased recreation and tourism (NSB *Undated*).

Although the area is relatively undeveloped for tourism, most North Slope communities have hotel or lodge accommodations for guests, cafe or restaurant facilities, and local guide services (NSB *Undated*). Of the three communities along the Beaufort Sea, Barrow has relatively more infrastructure to support recreation and tourism. Barrow is served by passenger jet service from Anchorage and Fairbanks (City of Barrow 2009). The community has phone, mail, a public radio station, Internet capability and cable TV (NSB *Undated*). Four hotels, eight restaurants, a dry cleaner, fur shop and a bank operate in Barrow, along with a grocery and merchandise store and three convenience stores. Visitors to Barrow can visit the Inupiat Heritage Center, which also offers them the opportunity to purchase Alaska Native arts and crafts such as baleen boats, etched baleen, carved ivory, masks, parkas and fur mittens (City of Barrow 2009).

Cultural heritage tourism, wilderness adventure travel, and ecotourism offer the greatest potential for expanding tourism on the North Slope (NSB *Undated*). However, although the existing infrastructure may be able to support modest increases in the service industry, it probably cannot accommodate large increases in visitors (NSB *Undated*).

R. St. Amour, DCED

Inupiat Heritage Center, Barrow.

Visitor statistics specific to the communities of Barrow, Nuiqsut, and Kaktovik are limited. For the entire North Slope region, excluding Nome, an estimated 41,000 visitors came to the region in 2006 (McDowell Group 2007). Including Nome, visitors stayed in the region for an average of 6.1 nights, longer than most other Alaska destinations. These visitors' total stay in Alaska averaged 15.4 nights. Most (76 percent) visitors to the North Slope area came for vacation or pleasure. Visitors participated in a variety of activities: 52 percent purchased multi-day packages; 35 percent participated in an adventure tour package; 20 percent stayed at a wilderness lodge; 71 percent took part in wildlife viewing; 68 percent went shopping; 54 percent went on day cruises; 51 percent went sightseeing; 50 percent visited museums; and 38 percent participated in Native cultural tours and attractions (McDowell Group 2007).

Many visitors to the North Slope are adventure travelers seeking wilderness experiences such as camping, float trips, wildlife viewing, and sport fishing and hunting (NSB *Undated*). However, visitors also come on package tours that include the North Slope as an add-on to a primary itinerary such as an Alaska cruise. These visitors want to experience the area's unique geographical features, Native history and culture, and wildlife. The primary tours of this type are "Top of the World" tours to Barrow, an oil field tour to Prudhoe Bay, or a village tour (NSB *Undated*).

People visiting the North Slope region tend to differ from visitors to other parts of Alaska in several ways. North Slope visitors generally stay in Alaska almost a week longer than the average visitor, and they travel widely to other Alaskan destinations. They are relatively more likely to participate in Native cultural experiences and visit museums and historical attractions, and they are less likely to sport fish or visit friends and relatives. Visitors to the North Slope come from all regions of the U.S. and other countries, they tend to be repeat visitors to Alaska, and they plan well in advance (McDowell Group 2007).

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Chapter Six: Oil and Gas in the Beaufort Sea

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A. Geology

The proposed lease sale area contains acreage that is located in the Arctic Coastal Plain region within the North Slope Structural Province. The North Slope Structural Province forms the modern northern continental margin of Alaska.

The geologic history of the proposed sale area includes periods of plate collisions, continental rifting, regional uplift, episodes of major regional erosional scour, and sedimentary deposition. Northern Alaska has four major geologic sequences of rocks, each having a unique structural setting, provenance (sediment source area), and depositional environment. During the deposition of each of these major geologic sequences, smaller scale events, such as changes in sea level and differential amounts of basin subsidence, have altered and shaped the depositional environments, sculpturing local internal complexities within each of the four major sequences. The four major rock sequences from oldest to youngest (older rocks are deposited first and in the absence of structural complexities are stratigraphically lower): the Franklinian, Ellesmerian, Beaufortian Rift, and the Brookian. The structural events that shaped the evolution of the North Slope Structural Province were (Figure 6.1):

1. A stable early continental platform before Devonian time;
2. Onset of continental rifting during the Late Jurassic through Early Cretaceous time, with uplift to the north of this stable Arctic Platform and deposition of sediments southward; and
3. Continued rifting, uplift, and termination of deposition from the north, along with uplift of the Brooks Range and deposition of sediments from the south onto the Arctic Coastal Plain during the Early Cretaceous through Tertiary time.

The Franklinian (pre-Mississippian) sequence was once a stable continental platform before Middle Devonian time (about 400 million years ago). Pre-Mississippian rocks of the Franklinian sequence comprise the oldest rock sequence that underlies the Arctic Coastal Plain region. The Franklinian sequence consists of fractured carbonate, argillite, quartzite, volcanic, and granitic rocks that were deformed, uplifted, and eroded during Cambrian through Devonian time. During the Late Devonian time, the Franklinian sequence was uplifted. Erosion off the uplifted Franklinian high provided the northerly source of sediments for the Ellesmerian sequence. The highly metamorphosed and fractured rocks of the Franklinian sequence have limited petroleum potential, most likely only as fractured reservoirs.

The Ellesmerian sequence contains marine carbonates and quartz- and chert-rich clastic rocks that were deposited over a 150 million year period on a subsiding foldbelt terrain during the Mississippian through Early Jurassic time. The Ellesmerian thins to the south due to depositional distance from its source and thins to the north due to subsequent uplift and erosion (Moore et al. 1994). The Permo-Triassic Ivishak Formation was deposited within the Ellesmerian sequence as a large fan-delta complex. It forms the reservoir for the giant Prudhoe Bay Oil Field that has produced over 12 billion bbl of oil.

The modern northern continental margin of Arctic Alaska has been shaped by structures that were formed as a result of Jurassic to Early Cretaceous rifting events that created the Barrow Arch, a structural high that has dominated the structural and depositional history of the area (Moore et al. 1994). Rifting of the continental mass dominated the geology of the North Slope by the end of the late Jurassic to late Cretaceous periods. The northern continental source for the Ellesmerian sediments

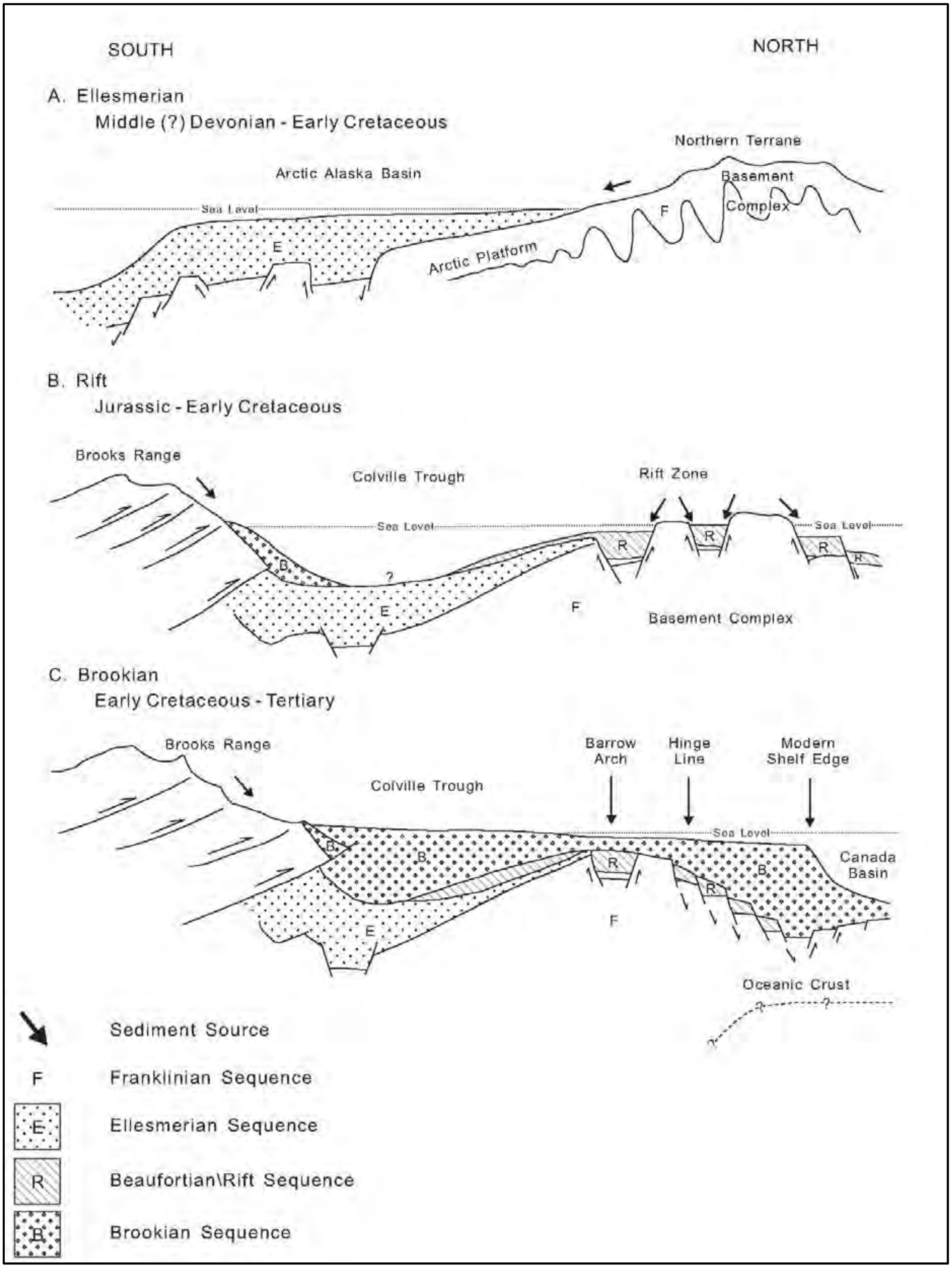


Figure 6.1. Evolution of North Slope geology.

supplied less and less sediment to the Arctic Basin as time passed. Uplift and faulting of the Franklinian and Ellesmerian sequence formed normal fault blocks, consisting of horst and grabens. The grabens were filled with sediments from nearby locally uplifted or block-faulted Ellesmerian and Franklinian sequences, forming the Beaufortian Rift sequence (Craig et al. 1985). At this time, the Barrow Arch formed along the present day Beaufort Coast. Sedimentation from the north eventually ended in the Late Cretaceous.

The following period of non-deposition along with continued uplift along the Barrow Arch created a regional scouring event known as the Lower Cretaceous Unconformity (LCU), which becomes angular where approaching the Barrow Arch from the south. Ellesmerian strata were progressively uplifted, subaerially exposed, eroded, and truncated in a northeasterly direction along the emerging Barrow Arch during the Late Jurassic and Early Cretaceous. The LCU stripped off significant amounts of Ellesmerian strata and resulted in the creation of enhanced porosity, creating excellent hydrocarbon reservoirs in the formations that lay directly under this angular unconformity. The regional erosional activity of the LCU is one of the most significant geological events with regards to the creation of secondary porosity in potential reservoir rocks as well as creating a conduit for the migration of oil and gas into these enhanced porosity reservoirs. In general, the Ellesmerian formations that are prolific oil producers such as the Kuparuk ‘A’ Sandstones and the Ivishak and Kekiktuk formations, directly underlie the LCU.

Following the uplift and erosion of the Ellesmerian section by the LCU along the Barrow Arch, the Arctic Coastal Plain was buried by marine shales, siltstones, and sandstones of the Beaufortian Rift sequence. Oil and gas traps within the Beaufortian Rift sequence include purely stratigraphic traps as well as combination structural/stratigraphic traps that were formed by the sequence of rift events. Many of the Beaufortian Rift sandstones that directly overlie the LCU such as the Kuparuk ‘C’ and Alpine sandstones are prolific North Slope oil reservoirs. The rift-derived sediments of the Beaufortian Sequence contain many known oil and gas accumulations (Map 6.1) such as the Kuparuk River, Milne Point, Pt. McIntyre, Niakuk, Alpine, and Pt. Thomson fields as well as discoveries in the Colville Delta area such as the Texaco Colville Delta, Fiord, and Kalubik wells. Known gas accumulations are present within this interval in NPR-A with the East Barrow, South Barrow, Sikulik, and Walakpa fields.

Since the formation of the continental margin in the Early Cretaceous, the northern flank of the Barrow Arch has been dominated by passive-margin subsidence and sedimentation. To the south, compressional forces in the Jurassic to Early Cretaceous caused thrust faulting in what is now the present-day Brooks Range. Sediments from the thrust-faulted blocks in the Brooks Range poured into the Colville basin, progressively filling it from the south, forming the Brookian sequence. The post Albian Brookian sequence records the progressive filling of a large east-west trending foreland basin (the Colville Trough) formed in response to thrust loading from the Brooks Range, a large north vergent fold and thrust belt. During latest Cretaceous and Paleocene time, deposition of Brookian sediments filled the Colville Trough, eventually overstepping the Barrow Arch and spread out onto Alaska’s continental margin. Petroleum accumulations in the Brookian sequence are found throughout the North Slope basin. Fields and hydrocarbon accumulations include: the West Sak, Schrader Bluff, Ugnu, Flaxman Island, Badami, and the Outer Continental Shelf (OCS) accumulation at Hammerhead (Weimer 1987).

The onshore present-day geology of the proposed lease sale area is comprised of a thick section of unconsolidated Quaternary sediments (Brown and Kreig 1983) that have been deposited within the last million years. These sediments comprise the Gubik Formation that unconformably overlie the weakly cemented sediments of the upper Brookian sequence. Most Quaternary deposits are unconsolidated sand and gravel composed of reworked Brookian sediments and reworked sediments from the present day Brooks Range. Overlying these deposits are gravels, sands, ice-rich silts, and sandy silts (that include variable amounts of organic matter) that are deposited by the numerous rivers on the North

Slope. In addition to the extensive fluvial deposits, there are local areas of modern eolian deposits (sand dunes) that are derived from river silts (Brown and Kreig 1983).

During middle to late Devonian time, a mountain building and rifting event uplifted the Franklinian sequence, deforming and metamorphosing the rocks in the process. Sediments from the uplifted Franklinian sequence spread southward into the large arctic basin (epicontinental shelf). This process continued through to late Cretaceous time. These northerly sourced sediments formed the Ellesmerian sequence (Moore et al. 1994).

The Ellesmerian sequence is the most important geologically in terms of petroleum production. Formations within the Ellesmerian sequence form the primary petroleum reservoirs at Prudhoe Bay, and Endicott. The Ellesmerian sequence contains marine carbonates and quartz and chert rich clastic rocks, representing about 150 million years of deposition (Mississippian through Triassic). From the center of the Colville Basin, the Ellesmerian thins to the south due to depositional distance from its source and it thins to the north due to subsequent uplift and erosion (Moore et al. 1994).

Rifting of the continental mass dominated the geology by the end of the late Jurassic to late Cretaceous periods. The northern continental source for the Ellesmerian sediments supplied less and less sediment to the arctic basin as time passed. Uplift and faulting of the Franklinian and Ellesmerian sequence formed fault block and grabbens (low areas between fault blocks). These grabbens were filled by sediments from the locally uplifted or upfaulted Ellesmerian and Franklinian sequences, forming the Rift sequence (Craig et al. 1985). It is also at this time that the Barrow Arch formed along the present day Beaufort Coast. Sedimentation from the north eventually ended sometime in the Late Cretaceous and the following period of non-deposition along with continued uplift along the Barrow Arch created a regional Lower Cretaceous Unconformity (LCU) that becomes angular approaching the Barrow Arch from the south. To the north of the Barrow Arch the Ellesmerian sequence is absent. The LCU is an important migration and accumulation element for most of the oil fields on the North Slope including Prudhoe Bay (Jamison et al. 1980).

To the south, compressional forces in the Jurassic to early Cretaceous caused thrust faulting in what is now the Brooks Range. Sediments from the thrust-faulted blocks in the Brooks Range poured into the Colville Basin, progressively filling it from the south, forming the Brookian sequence. Brookian sediments filled the Colville Basin and spread out over the Barrow Arch and onto Alaska’s continental margin during the upper Late Cretaceous through Tertiary time. Petroleum accumulations in the Brookian sequence are found throughout the North Slope basin, including at West Sak, Schrader Bluff, Flaxman Island, and the Outer Continental Shelf (OCS) accumulation at Hammerhead (Weimer 1987).

Onshore present day geology of the proposed lease sale area is, in general, comprised of a thick section of unconsolidated Quaternary sediments (Brown and Kreig 1983), deposited within the last 1 million years. These sediments are probably of the Gubik Formation, which unconformably overlies the weakly cemented sediments of the upper Brookian sequence. Most Quaternary deposits are unconsolidated sand and gravel composed of reworked Brookian sediments, along with materials from the present day Brooks Range. Overlying these deposits are ice-rich silts and sandy silts (1.5 m to 2.5 m thick at Prudhoe Bay) that include variable amounts of organic matter, which are deposited by the numerous rivers on the North Slope. In addition to these fluvial deposits are local areas of eolian deposits (sand dunes) derived from river silts (Brown and Kreig 1983).

B. Petroleum Potential

ADNR has determined that the proposed lease sale area, in general, has moderate to high petroleum potential. This represents ADNR’s assessment of the oil and gas potential of the area and is based on a resource evaluation made by the state. This resource evaluation involves several factors including geology, seismic data, exploration history of the area, and proximity to known hydrocarbon accumulations.

In order for an accumulation of hydrocarbons to be recoverable, the underlying geology must be favorable. This may depend on the presence of source and reservoir rock; the depth and time of burial; and the presence of migration routes and geologic traps or reservoirs. Source rocks are organic rich sediments, generally marine shales, which have been buried for a sufficient time, and with sufficient temperature and pressure to form hydrocarbons. As hydrocarbons are formed, they will naturally progress toward the surface if a migration route exists. An example of a migration route might be a permeable layer of rock in contact with the source layer, or fractures that penetrate organic rich sediments. A hydrocarbon reservoir is permeable rock that has been geologically sealed at the correct time to form a “trap.” The presence of migration routes therefore affect the depth and location where oil or gas may pool and form a reservoir. For a hydrocarbon reservoir to be producible, that is, economic, the reservoir rock must be of sufficient thickness and quality (good porosity—number of pore spaces per volume, and permeability—a rock’s capacity for transmitting a fluid), and must contain a sufficient volume or fill of hydrocarbons.

The Beaufort Sea has all these favorable geologic conditions and, considering the exploration history of the area, the chances of finding undiscovered petroleum reservoirs are very good. However, the remaining undiscovered reservoirs are expected to be non-economic to marginally economic accumulations under current market conditions. In light of this, the petroleum potential of this basin for the discovery of new fields is moderate.

The process of evaluating the oil and gas potential for state lease sale areas, such as the Beaufort Sea, involves the use of seismic data and well engineering information, which by law, the division must keep confidential under AS 38.05.035(a)(8)(C). In order to protect these data, the division must generalize the assessment, which is made public.

C. Phases of Oil and Gas Development

Lease-related activities proceed in phases, moving from leasing, to exploration, and then to development and production. Each phase’s activities depend on the completion or initiation of the preceding phase. Table 6.1 lists activities that may occur during the exploration, development, and production phases.

1. Lease Phase

Oil and gas lease sales are the first step in developing the state’s oil and gas resources. Annually, ADNR prepares and presents a 5-year program of proposed oil and gas lease sales to the legislature. Currently, DO&G conducts competitive annual areawide lease sales, offering for lease all available state acreage within five areas (North Slope, Beaufort Sea, Cook Inlet, North Slope Foothills, and Alaska Peninsula). The proposed lease sale area is divided into tracts, and interested parties that qualify may bid on one or more tracts.

Not later than 45 days before the lease sale, DO&G issues a notice describing the interests to be offered, the location and time of the sale, and the terms and conditions of the sale. The announcement includes a tract map showing generalized land status, estimated tract acreages, and instructions for submitting bids. The actual lease sale consists of opening and reading the sealed bids and awarding a lease to the highest bid per acre by a qualified bidder on a tract. DO&G verifies the state’s ownership interest only for the acreage within tracts that received bids. Only those state-owned lands within the tracts that are determined to be free and clear of title conflicts are available to lease.

Alaska has several leasing method options designed to encourage oil and gas exploration and maximize state revenue. These methods include combinations of fixed and variable bonus bids, royalty shares, and net profit shares. Lease terms are set at 5, 7, or 10 years, depending on a number of factors, including geographical location. An oil and gas lease grants to the lessee the exclusive right to drill for, extract, remove, clean, process, and dispose of oil, gas, and associated substances. A lease plan of operations must be approved before any operations may be undertaken on or in the leased area, except for activities that would not require a land use permit or for operations undertaken under an approved unit plan of operations.

Although beyond the scope of this preliminary best interest finding, exploration licensing supplements the state's areawide oil and gas leasing program by targeting areas outside of known oil and gas provinces. The intent of licensing is to encourage exploration in areas far from existing infrastructure, with relatively low or unknown hydrocarbon potential, where there is a higher investment risk to the operator. Because bonus payments are required to win a lease, lease sales held in some of these higher-risk areas tend to attract little participation. Exploration licensing gives an interested party the exclusive right to conduct oil and gas exploration without this initial expense. Through exploration licensing, the state receives valuable subsurface geologic information on these regions and, should development occur, additional revenue through royalties and taxes (AS 38.05.131-134).

Table 6.1. Potential activities during exploration, development, and production phases.

Exploration	Development	Production
Permitting	Gravel pits, pads, and roads	Well work over (rigs)
Water usage	Dock and bridge construction	Gravel islands, pads, and roads
Environmental studies	Drilling rigs	Produced water
Seismic acquisition	Pipelines	Air emissions
Exploratory drilling rigs	Work camps	Pipeline maintenance
Drilling muds and discharges	Permitting	Work camps
Gravel or ice road beds	Monitoring	Trucking
Work camp	Well heads	
Increased air traffic	Injection wells	
Temporary ice or gravel pads	Seismic acquisition	
Research and analysis		

2. Exploration Phase

During the exploration phase, information is gathered about the petroleum potential of an area by examining surface geology, researching data from existing wells, performing environmental assessments, conducting geophysical surveys, and drilling exploratory wells. In the offshore environment, surface analysis includes the study of surface topography or the natural surface features of the near-by coastal area; and near-surface structures revealed by examining and mapping near-by exposed rock layers. Geophysical exploration and exploration drilling are the primary activities that could result in potential effects to the proposed Beaufort Sea lease sale area. Geophysical surveys, primarily seismic, help reveal what the subsurface geology may look like. Exploration of the Beaufort Sea Sale area has been ongoing since the first geologic and topographic studies were conducted in 1901.

a. Geophysical Exploration

Before proceeding with geophysical exploration, companies must acquire one or more permits from the state, depending on the timing and extent of the proposed activity. ADNR tailors each permit approval to the specifics of the proposed project. Restrictions on geophysical exploration permits depend on the duration, location, and intensity of the project. They also depend on the potential effects the activity may have on fish and wildlife resources or human use in the area. The extent of potential effects varies, depending on the survey method and the time of year the survey is conducted. Geophysical exploration activities are regulated by 11 AAC 96.

Seismic surveys are the most common type of geophysical exploration, and are typically conducted by geophysical companies under contract to leaseholders or as multi-client and speculative surveys run directly by the seismic contractors. At the survey location, energy is emitted into the subsurface and reflected seismic waves are recorded at the surface by geophones and/or hydrophones, land and marine vibration-sensitive devices. Different rock layers beneath the surface have different velocities and densities. This results in a unique seismic profile that can be analyzed by geophysicists to interpret subsurface structures and petroleum potential. Both 2-dimensional (2D) and 3-dimensional (3D) data are gathered from seismic surveys. In the proposed Beaufort Sea lease sale area, seismic surveys are conducted on land, grounded ice, floating ice, and in open marine waters.

Seismic source and receiver locations are surveyed using GPS (Global Positioning Systems) and laid out or sailed in predesigned patterns. For land or ice 2D data, the receivers and sources lie in a straight line (as topographic and ice conditions permit), and can extend for many tens of miles. For 3D data, data is collected over a much wider swath, and can cover tens to hundreds of square miles. 2D seismic programs usually have fewer crewmembers and employ much less equipment than 3D programs.

Seismic data over coastal lands can be collected after the ground is well frozen and covered with a protective snow layer. Seismic in shallow water can be collected on the ice in winter, or by using ocean bottom cables in the summer months. Ice based seismic programs are dependent on ice pack thickness

B. Havelock, DO&G

Example of vibroseis trucks conducting a seismic survey.

and stability, and are rarely executed farther out than the barrier islands. Collecting data in the winter months minimizes effects to fish and wildlife habitats, and avoids conflicts with migrating marine mammals.

Multiple seismic sources can be used on land or ice surveys, but vibrator trucks are by far the most common. A vibrator truck is a low ground pressure vehicle with a heavy plate attached. The entire weight of the truck rests on the plate as it puts energy of continuously varying frequency into the ground. The vibration typically lasts 4 to 16 seconds. This energy source is less destructive than an impulsive explosive source, where all the energy is imparted in an instant. Less commonly, airguns can be lowered through holes drilled in the ice to provide the acoustic energy. For marine surveys, towed airguns, or an array of several airguns, are used as the energy source.

Open water surveys are conducted in the summer, ice free, months. Marine surveys use a towed energy source, and can use either towed receivers (streamer cables) or ocean bottom cables (OBC surveys) where the cables containing the geophones and hydrophones lay directly on the sea floor. Marine seismic programs typically use a vessel between 100-175 feet long. Shore-based helicopters, which can land on the vessel's helideck, resupply the operation and transfer crew when necessary. Seismic equipment consists of an airgun array for the energy source, hydrophones (and sometimes geophones) to detect reflected sound energy, an amplifier and recording system, and a navigation system. The airgun array, towed directly behind the ship at a depth of 30 to 40 feet (or shallower if required by water depth), consists of several sub-arrays, each containing several airguns of various sizes. Hydrophones and geophones are housed in long streamer cables (1-2 miles), which are towed behind the ship at depths between 20 and 40 feet. For 2D surveys, one cable is towed at a time. For 3D surveys, multiple cables can be towed. For OBC seismic surveys, the detectors and cables are placed directly on the bottom where they remain stationary as the shooting boat traverses across them. In addition to ice hazards, the season can be also be limited by protections for fishing, wildlife, marine mammals, and subsistence hunting.

Additional geophysical techniques can be used to gather information specifically about the ocean bottom and very near surface geology, usually to identify drilling hazards. They include high-resolution shallow seismic, side-scan sonar, fathometer recordings and shallow coring programs. High-resolution shallow seismic surveys are specifically designed to image the ocean bottom and very shallow geology. They employ smaller vessels, a lower energy seismic source and a shorter cable than surveys targeting deeper oil and gas potential.

b. Exploration Drilling

Exploratory drilling often occurs after seismic surveys are conducted, and when the interpretation of the seismic data incorporated with all available geologic data reveals oil and gas prospects. Exploration drilling, which proceeds only after obtaining the appropriate permits, is the only way to learn whether a prospect contains commercial quantities of oil or gas, and aids in determining whether to proceed to the development phase. Drilling operations collect well logs, core samples, cuttings, and a variety of other data. A well log is a record of one or more physical measurements as a function of depth in a borehole and is achieved by lowering measuring instruments into the well bore. Well logs can also be recorded while drilling. Cores may be cut at various intervals so that geologists and engineers can examine the sequences of rock that are being drilled.

The drilling process is as follows:

- Large diameter steel pipe (conductor casing) is bored into the soil.
- A drill bit, connected to the end of the drill pipe, rotates and drills a hole through the rock formations below the surface.

- After a prescribed depth of drilling, the hole is cleaned up and surface casing, a smaller diameter steel pipe, is lowered into the hole and cemented in place. This keeps the hole from caving in; seals off rock formations; seals the well bore from groundwater; and provides a conduit from the bottom of the hole to the drilling rig.
- After surface casing is set, drilling continues until the objective formation is reached. In instances where subsurface pressures are extremely high, an intermediate casing string may be lowered into the hole and cemented in place.
- The well either produces, is completed, suspended or is plugged and abandoned.

When directionally drilling from onshore, the drill site is selected to provide access to the prospect and, if possible, is located to minimize the surface area that may have to be cleared. Sometimes temporary roads must be built to the area. Non-permanent roads are constructed of ice, with permanent roads being constructed of sand and gravel placed on a liner above undisturbed ground. Construction of support facilities such as production pads, roads, and pipelines may be required. A typical drill pad is made of sand and gravel placed over a liner and is about 300 feet by 400 feet. The pad supports the drill rig, which is brought in and assembled at the site, a fuel storage area if necessary, and a camp for workers. If possible, an operator will use nearby existing facilities for housing and feeding its crew. If the facilities are not available, a temporary camp of trailers on skids may be placed on the pad. Enough fuel is stored on-site to satisfy the operation’s short-term needs. The storage area is a diked gravel pad lined with an 80 mil synthetic membrane. Additional amounts of fuel may be stored at the nearest existing facility for transport to the drilling area as needed (Chevron 1991).

Offshore exploratory drilling rigs include bottom-supported rigs such as submersibles and jackup rigs, barges, floating rigs such as drill ships, and semi-submersibles. In shallow water an ice island or gravel island may be constructed and, on occasion, a barrier island may be used to drill offshore. Island drilling is a function of both depth and environmental conditions. Water depth and bottom conditions determine which equipment will be used. Some mobile offshore drilling units (MODUs) that may be used during the exploration phase, their support types, and operational depths are listed below:

- Bottom supported
    - Submersibles
        - Posted barges (water <30 feet)
        - Bottle-type submersibles (water <200 feet)
        - Arctic submersibles (concrete island drilling system (CIDS; water up to 150’)
    - Jackups
        - Columnar legs (water 300’ to 600’)
        - Truss legs (water 300’ to 600’)
    - Inland barges (shallow water)
    - Ship-shaped barges and drill ships
- Semi-submersibles (deep-water applications).

When a prospect cannot be reached using directional drilling (Appendix C) from shore, an arctic rated rig and support facility are most likely to be used in the Beaufort Sea for exploratory wells, as they are best suited for sometimes shallow water locations and can withstand currents, ice buildup, and tidal variations experienced there. These rigs may have watertight barge hulls that can float on the surface of the water while the unit is being moved between drill sites. Some units are towed while others are self-propelled. Some types of drilling rig facilities are bottom founded while others may be mounted on a ship or jackup platform. Sometimes drilling will be done from a man-made island or a natural barrier island if conditions allow. Before the location is finalized, the operator performs a geological hazards survey to make sure that the sea floor can support the rig. High-resolution shallow seismic surveys look for shallow gas (methane) deposits and faults. When the rig facility is positioned at the drill site, it will be affixed to the site either by legs jacked from the seafloor, positioned dynamically if floating or landed on the seafloor if in shallow water. Depending on the type of drilling facility, the drilling topsides are positioned to accommodate ice, tides, and waves.

An exploratory drilling operation generates approximately 12,000 cubic feet of drilling cuttings. Cuttings are fragments of rock cut by the drill bit. These fragments are carried up from the drill bit by the mud pumped into the well (Gerding 1986). Gas, formation water, fluids, and additives used in the drilling process are also produced from drilling operations. The fluids pumped down the well are called “mud” and are naturally occurring clays with small amounts of biologically inert products. Different formulations of mud are used to meet the various conditions encountered in the well. The mud cools and lubricates the drill bit, prevents the drill pipe from sticking to the sides of the hole, seals off cracks in down-hole formations to prevent the flow of drilling fluids into those formations, and carries cuttings to the surface.

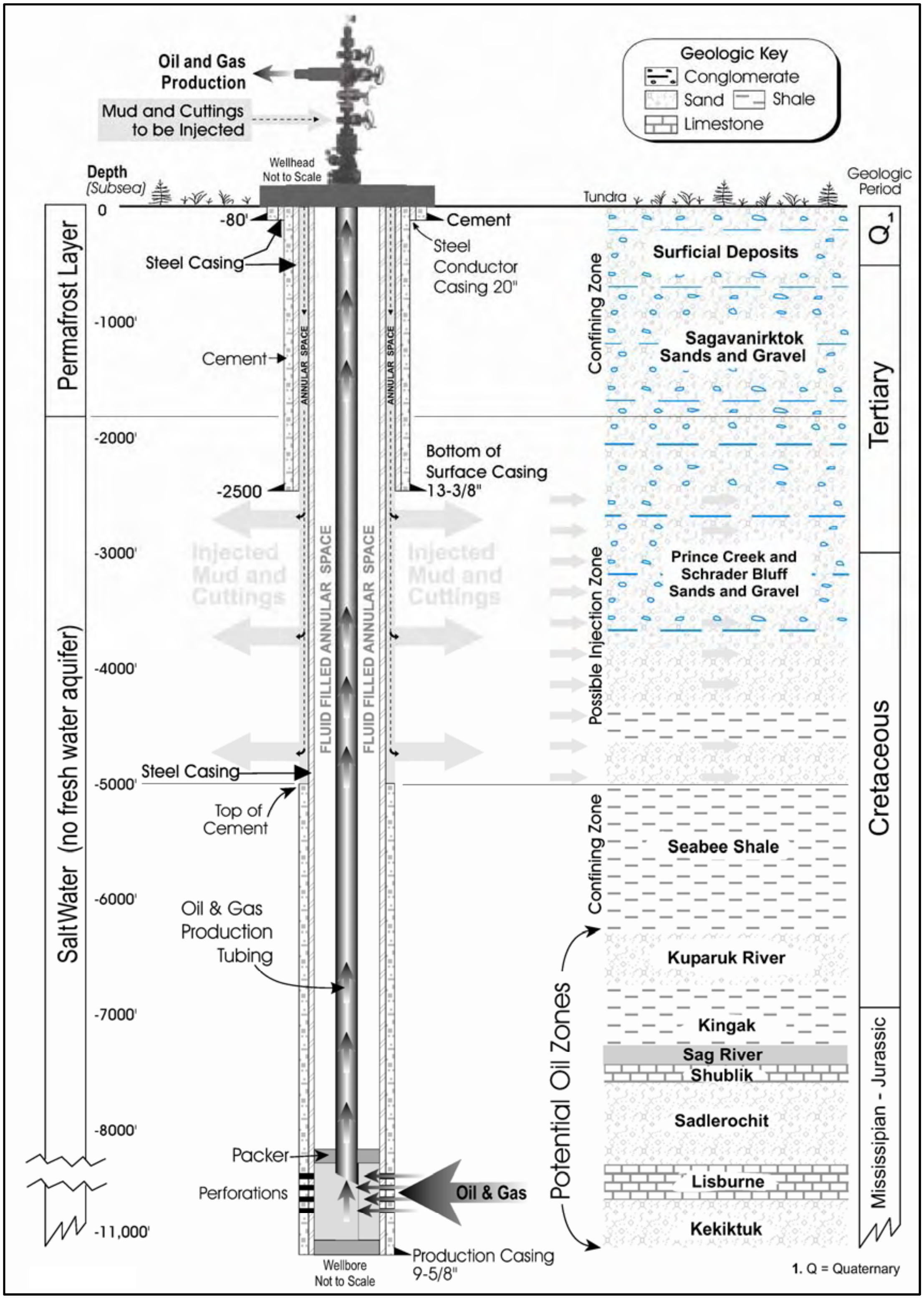
Disposal of mud, cuttings, and other effluent is regulated by the National Pollutant Discharge Elimination System (NPDES) and the EPA’s Underground Injection Control program administered by the Alaska Oil and Gas Conservation Commission under regulations in 20 AAC 25. The state discourages the use of reserve pits, and most operators store drilling solids and fluids in tanks or in temporary on-pad storage areas until they can be disposed of, generally down the annulus of the well or in a disposal well that is completed and equipped to take mud and cuttings, and permitted in accordance with 20 AAC 25.080 and 20 AAC 25.252. If a reserve pit is necessary, it is constructed off the drill pad and could be as large as 5 feet deep and 40 feet by 60 feet. It is lined with an 80-mil geotextile liner to prevent contamination of surrounding soils. Drilling muds, fluids, and cuttings produced from the well are separated and disposed of, often by reinjection into an approved disposal well annulus or disposal well, or they may be shipped to a disposal facility out-of-state. With appropriate permits, solids may be left in place in a capped reserved pit. If necessary, a flare pit may be constructed off the drill pad to allow for the safe venting of natural gas that may be encountered in the well.

If oil or gas is discovered at the exploratory well, it is likely that the gravel pad used for the exploratory well will also be used for development and production operations. Gravel pads are semi-permanent structures and can be rehabilitated following field depletion.

3. Development and Production Phases

The development and production phases are interrelated and overlap in time; therefore, this section discusses them together. During the development phase, operators evaluate the results of exploratory drilling and develop plans to bring the discovery into production. Production operations bring well fluids to the surface and prepare them for transport to the processing plant or refinery. These phases can begin only after exploration has been completed and tests show that a discovery is economically viable (Gerding 1986).

After designing the facilities and obtaining the necessary permits, the operator constructs permanent structures and drills production wells. The operator must build production structures that will last the life of the field and may have to design and add new facilities for enhanced recovery operations as production proceeds. Figure 6.2 depicts a typical wellbore. The development “footprint” has decreased in recent years as advances in drilling technology have led to smaller, more consolidated pad sizes. Directional drilling (Appendix C) allows more wells to be drilled from a common location (drill pad). A single production pad and several directionally drilled wells can develop more than one and possibly several 640-acre sections.



Notes: When injection phase is completed, the 9-5/8" X 13-3/8" annular space is pumped full of cement and permanently sealed.

In the Kuparuk River Unit the surface casing is set through the West Sak interval (to approximately -4000 ss).

Figure 6.2. Typical production/injection well, North Slope, Alaska.

K. Marsh, DO&G

Prudhoe Bay.

The Northstar Field has been developed from a man-made offshore island of approximately 5 acres (Ragsdale 2007). The reservoir area covers nearly 10,000 acres (about 16 - 640 acre sections) The Oooguruk Field is based on an offshore man-made island of approximately 6 acres (Lidji 2008). Footprints at these two fields compare with the first Beaufort Sea development at the Endicott Field, which was developed from two islands linked by a causeway that cover approximately 47 acres in total (Nelson 2000b). The Liberty Field will be developed from the Endicott SDI, which will be enlarged to accommodate additional wells.

Development wells are often drilled at an angle through a formation to increase productivity and allow the oil and gas to be extracted from a larger subsurface area (by increasing the drainage area) than would be possible from a single straight wellbore. In addition, lateral bores are being drilled from one “parent” well bore to penetrate separate sands within a reservoir and increase the area of reservoir exposed to production. Multiple laterals, up to five, have been drilled to improve drainage and productivity. This technique is especially effective in the heavier viscous oil accumulations.

The Alaska Oil and Gas Conservation Commission through its statutory and regulatory mandate oversees drilling and production practices to maximize oil and gas recovery, prevent waste and ensure protection of correlative rights within the state. It is a quasi-judicial agency, which conducts hearings to review drilling and development to ensure regulatory compliance. The Commission may issue Conservation Orders (pool rules) to grant exceptions to regulations conditioned on prevention of waste, maximizing ultimate oil and gas recovery. Unless pool rules (oil or gas field rules governing well drilling, casing, and spacing that are designed to maximize recovery and minimize waste) have been adopted under 20 AAC 25.520, existing spacing rules stipulate that where oil has been discovered, not more than one well may be drilled to that pool on any governmental quarter section (20 AAC 25.055(a)). This would theoretically allow a maximum of four well sites per 640-acre section.

4. Subsurface Oil and Gas Storage

Under AS 38.05.180(u), the Commissioner of ADNR may authorize the subsurface storage of oil or gas to avoid waste or to promote conservation of natural resources. In Alaska, depleted reservoirs with established well control data are preferred storage zones. By memorandum dated September 2, 2004, the Commissioner approved a supplement to Department Order 003 and delegated the authority to authorize subsurface storage of oil or gas to the Division of Oil and Gas Director.

North Slope gas is now used to support production of oil and gas on the North Slope. When a gas pipeline is constructed from the North Slope to market, gas will also be transported to market. Subsurface storage of gas increases reliability of gas delivery to all sources of demand.

A subsurface storage authorization allows the storage of gas and associated substances in the portions of the gas storage formation, subject to the terms and applicable statutes and regulations, including mitigation measures and advisories incorporated by reference into the authorization. It does not matter whether the oil or gas is produced from state land, so long as storage occurs in land leased or subject to lease under AS 38.05.180. An oil and gas lease on which storage is authorized shall be extended at least for the period of storage and so long thereafter as oil or gas not previously produced is produced in paying quantities. The feasibility of subsurface storage depends on favorable geological and engineering properties of the storage reservoir, including its size and its gas cushion (or base gas requirements). It also depends on access to transportation, pipeline infrastructure, existing production infrastructure, gas production sources, and delivery points.

Subsurface storage must comply with all applicable local, state, and federal statutes and regulations, and with any terms imposed in the authorization or in any subsequent plan of operation approvals, or in the AOGCC Storage Injection Order. The plans of operation must identify the specific measures, design criteria, construction methods, and standards that will be employed to meet the provisions of the subsurface storage authorization. Plans of operation are subject to extensive technical agency review. They are also subject to consistency with the ACMP standards if the affected lands are within the coastal zone. The plans are available for public review upon submittal to the state. Oil and gas storage-related activities will be permitted only if proposed future operations comply with all borough, state, and federal laws and the provisions of the authorization.

A storage authorization is for only specified sand horizons and does not grant the right to drill, develop, produce, extract, remove, or market gas other than injected gas. A storage authorization allows the overlying oil and gas leases to continue as long as their original terms are met. Subsurface storage will be subject to terms and conditions identical to existing oil and gas lease permitting and bonding requirements. Storage operations may not interfere with existing oil and gas lease operations. Subsurface storage must comply with 20 AAC 25, specifically 20 AAC 25.252. Before any gas may be injected, approval of the Injection Order from AOGCC must be obtained.

Some unproduced “native” gas may remain in gas storage reservoirs and serve as “cushion gas” to support gas withdrawal and delivery rates. Cushion gas is the volume of gas intended as permanent inventory in a storage reservoir to maintain adequate pressure and deliverability rates throughout the withdrawal season. Royalty on this native cushion gas may be paid from a percentage of each year’s annual gas withdrawal as if it were originally produced from the overlying oil and gas lease, and allocated according to the unit agreement. Injected gas will mix with native gas in the reservoirs. Royalty on the native gas within the gas storage formation under the leased area is computed at the royalty rate and paid at the value as specified in the applicable oil and gas leases.

ADNR may amend a subsurface storage authorization if stored gas migrates from the gas storage formation to other formations or if stored gas expands beyond the limits of the authorized area. DO&G shall be notified of any anticipated changes in the project resulting in alteration of conditions that were originally approved and further approval must be obtained before those changes are implemented.

USGS Photo Library, ID. Reed, J.C. 883 rjc00883

Meade River test well 1 derrick. Barrow district, Northern Alaska region, Alaska. April 17, 1950.

Where gas has been discovered, not more than one well per section may be drilled into the pool. An oil and gas producer may apply to change the spacing requirements if there is technical justification to support greater ultimate recovery by changing the spacing requirements. A Conservation Order will grant exception to regulations under 20 AAC 25 upon finding and concluding the spacing exception will not cause waste.

D. Oil and Gas Exploration, Development, and Production in the Beaufort Sea

1. History of Oil and Gas on the North Slope and in the Beaufort Sea

Oil seeps have long been known to the Inupiat people of the North Slope, who excavated tar-saturated tundra for use as fuel within historic time. Following reports of oil seeps along the coast by early traders, the first geologic and topographic studies were conducted in 1901 and the first formal descriptions were recorded by the U.S. Geological Survey (USGS) in 1919. By 1921, prospecting permits were filed and in 1923, President Harding established the Naval Petroleum Reserve No. 4 (NPR-4) by executive order. The USGS conducted reconnaissance mapping from 1923 through 1926 and published the results in 1930 (Jamison et al. 1980; AEIDC 1975).

The first exploration phase of NPR-4 ended in 1953. Between 1923 and 1953, the United States Navy drilled 37 test wells and found three oil accumulations and six gas accumulations within and adjacent to the reserve. Only two of these discoveries were considered sizable, namely Umiat, with an estimated 70 million bbl of recoverable oil, and Gubik (partly outside the reserve), with an estimated 600 billion cubic-feet of recoverable gas (Molenaar 1982; Kumar et al. 2002). Gas from another of the discoveries, the small South Barrow gas field, is being produced today for local consumption at Barrow.

BLM opened North Slope lands for competitive bidding in 1958 when 16,000 acres were offered in the area of the Gubik gas field. That same year BLM opened 4 million acres in an area south and southeast of NPR-4 for simultaneous filing and subsequent drawing. From 1962-1964 industry exploration programs expanded rapidly. During this period, Sinclair and British Petroleum drilled a total of seven unsuccessful wildcat wells in the Arctic foothills (Jamison et al. 1980).

In 1964, under the Statehood Act, the state of Alaska selected some 80 townships across the northern tier of lands between the Colville and Canning Rivers and received tentative approvals on the 1.6 million acres from the federal government in October of the same year. In December 1964, the state held the 13th State Competitive Sale (the first on the North Slope) of leases covering 625,000 acres in the area east of the Colville River delta. In July 1965, the state held the 14th State Competitive Sale, which included the onshore area in the vicinity of Prudhoe Bay. In the 18th State Competitive Sale, held in January 1967, the offshore Prudhoe Bay tracts were offered and leased (Jamison et al. 1980).

Following the succession of dry holes in the Arctic foothills, exploration shifted northward to the central coastal area. In 1965, the first holes drilled in the area immediately surrounding the Prudhoe Bay structure came up dry. In January 1967, in what was essentially a last-ditch effort, a rig was moved to the Prudhoe Bay State No. 1 location near the mouth of the Sagavanirktok River. Twelve months later the discovery of the Prudhoe Bay oil field was announced (Jamison et al. 1980; AEIDC 1975). Prudhoe Bay field began production in 1977 and, with its satellite fields (Map 6.1), is currently estimated to have originally contained in excess of 15 billion bbl of economically recoverable oil, making it the largest oil field ever discovered in North America.

Following the Prudhoe Bay discovery, exploration activity increased dramatically. Thirty-three exploration wells were completed in 1969, as industry prepared for the Lease Sale 23 in September of that year. The state offered 413,000 acres along the Arctic coast between the Canning and Colville Rivers and earned more than $900 million in bonus bids on 164 tracts (Weimer 1987; Jamison et al. 1980). One significant find that came out of this increased activity was the discovery of the Kuparuk River field. In the spring of 1969, the Sinclair Ugnu No. 1 well tested oil from the Kuparuk Formation at a rate of 1,056 bbl of oil per day (Masterson, 1992). Subsequent delineation proved the field to contain 1 billion bbl of recoverable oil. Production at Kuparuk began in December of 1981, and current estimates place the ultimate recovery of oil from the field at more than 2.6 billion bbl, including satellite accumulations (Nelson 2007b). The 1969 sale was the last lease sale on the North Slope until the joint federal-state sale in December 1979. After the discovery of the Prudhoe Bay field and before the 1979 joint sale, more than 100 exploratory wells were drilled on the North Slope, with 19 of those wells discovering oil or gas.

In 1974, spurred by the OPEC oil embargo of 1973, the federal government began a second large exploration program in NPR-4, which was re-designated the National Petroleum Reserve-Alaska (NPRA) in 1976. Between 1974 and 1981, the USGS drilled a total of 27 test wells within NPRA. Other than two additional gas fields that are currently being produced to supply Barrow, no commercial deposits were discovered by this program. The two currently producing fields are the Walakpa field, which contains an estimated 142 billion cubic feet of economically recoverable gas (Imm 1996), and the East Barrow field, which contains an estimated 13 billion cubic feet of economically recoverable gas (Kornbrath 1995). In 1980, Congress authorized competitive leasing within NPRA. From 1982-1984, four lease sales were held. A total of more than 1.3 million acres were leased in the first three sales, generating over $84 million in total bonus bids. The final sale received no bids. Only one industry well was drilled on a lease acquired in these sales. This well, the ARCO Brontosaurus No. 1, was completed, plugged, and abandoned in 1985.

The 1994 discovery of the giant field in previously unknown Jurassic sandstones on the northeastern border of NPRA demonstrated that the area contained significant untapped potential for commercial oil and gas accumulations. The field began production in late 2000, and is currently estimated to contain 429 million bbl of economically recoverable oil (Nelson 2000a). The discovery and subsequent development of the Alpine field has spurred renewed interest in the oil and gas potential of NPRA, west of the Colville delta, as well as the exploration and potential development of similar places in the Colville delta area.

Since the 1979 joint sale, five federal lease sales have been held in the Beaufort Sea, and there have been 28 state lease sales offering both onshore and submerged Beaufort Sea acreage. To date, 31 exploratory wells have been drilled in the federal waters of the Beaufort Sea, resulting in five discoveries: Seal Island/Northstar, Kuvlum, Hammerhead, Sandpiper, and Tern Island/Liberty. Exploration wells drilled through 2006 on North Slope state leases have resulted in 26 discoveries.

It is not surprising that many of these accumulations were found in the vicinity of Prudhoe Bay and Kuparuk, where the density of wells and seismic control is the highest and the geologic conditions optimal. At least eight of these post-Prudhoe Bay discoveries are currently producing oil because of the Prudhoe Bay infrastructure and their relatively close location to the trans-Alaska oil pipeline. Six of these, Lisburne, Kuparuk, Milne Point, Endicott, Niakuk, and Point McIntyre are major fields (Map 6.1). While initial production on the North Slope was from onshore areas, five fields, Endicott, Point McIntyre, Milne Point, Niakuk, and Northstar, produce at least some of their reserves from offshore areas.

The most recent development projects in the Kuparuk and Prudhoe fields have involved low-gravity oil sands (Shrader Bluff/West Sak, and Ugnu) that were primarily discovered in the Kuparuk River area in 1969. In the Kuparuk area, the West Sak sands alone contain an estimated 16 billion bbl of oil in-place and combined estimates for the West Sak and Ugnu area are as high as 40 billion bbl in-place (Werner 1987). Start-up of production of the West Sak occurred in 1997, with estimates that the initial pilot area contains 300-500 million bbl of economically recoverable oil (ADN 1996b). Low-gravity production from the correlative Schrader Bluff formation sands at the Milne Point field exceeded 20,000 bbl of oil per day on average by 2004 (AOGCC 2007). The geographic area over which this West Sak/Schrader Bluff resource occurs is extensive, and includes portions of the Kuparuk, Milne Point, and Prudhoe Bay units. Since the initial production at Kuparuk and Milne Point fields, the Prudhoe Bay field has begun its own Schrader Bluff oil projects in the western portion of the unit, called Orion and Polaris, and recent Schrader Bluff oil discoveries have been unitized to the northwest of Milne Point (Nikaitchuq) and southeast of Kuparuk (Rock Flour).

State lands east of Prudhoe Bay saw renewed exploration activity during the 1990s, yielding oil discoveries in Canning formation sandstones and the Sourdough and Yukon Gold prospects south of the Point Thomson field adjacent to ANWR. Current information indicates Sourdough could contain 100 million bbl of recoverable oil. The Sourdough project would require up to 35 miles of pipeline to link up with the Badami field (Staff 1997).

Oooguruk, located about northeast of Prudhoe Bay, is estimated to contain 100 million bbl of economically recoverable oil; Pioneer Resources constructed an island and pipeline in 2007-2008 and sold its first barrel of oil in June of 2008 (APRN 2008).

As of year-end 2008, 506 exploration wells have been drilled on state acreage in the North Slope and Beaufort Sea, with 407 lease tracts that have been drilled and 292 tracts that are or were under commercial development. There have been 31 exploration wells in the federal waters of the Beaufort Sea, resulting in five discoveries: Seal Island/Northstar, Kuvlum, Hammerhead, Sandpiper, and Tern Island/Liberty. Figure 6.3 shows the number of exploration wells drilled each year since 1944. Except for Northstar, which spans federal and state submerged lands, all of the region’s commercially producing fields are on state leases.

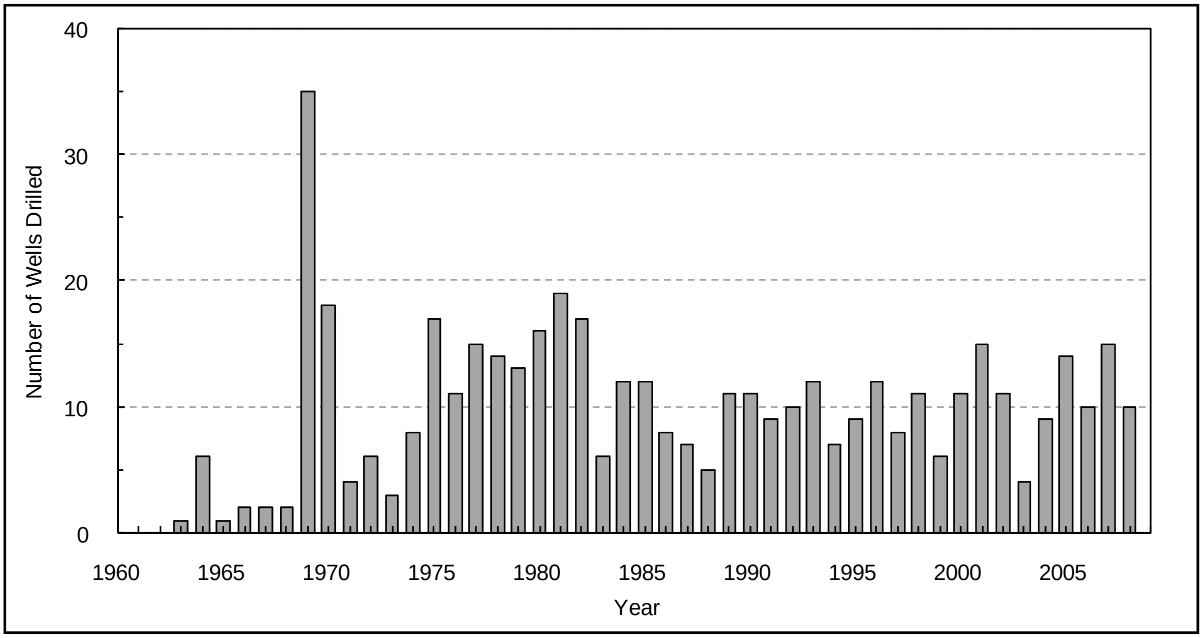


Figure 6.3. Alaska exploration well data, North Slope wells.

To date, over 30,000 miles of conventional (2-D) seismic surveys have been conducted on state acreage on the North Slope and in the Beaufort Sea. In addition, over 5,200 mi^2 of 3-D seismic surveys have been permitted in this region since 1985.

Table 6.2 lists the known oil and gas accumulations on state lands onshore and in state and federal waters. Six of the producing fields are offshore (Badami, Endicott, Milne Point, Niakuk, Northstar, and Point McIntyre; Map 6.1). However, all except Endicott, Northstar, Point McIntyre, and Oooguruk are being produced from directional wells drilled from onshore facilities. Both Endicott and Point McIntyre utilize causeways (Endicott also utilizes two artificial islands) to support offshore drilling and production facilities. In addition, BPX produces the Northstar Field totally from offshore facilities with winter ice roads for re-supply of consumable materials.

2. Proposed Development on the North Slope and in the Beaufort Sea

The Liberty field is proposed for development, but not yet producing. The Liberty field is located on federal leases approximately 5 miles offshore in the Beaufort Sea, southeast of the Endicott field. BPX owns the lease and estimates there are 120 million bbl of recoverable oil. BPX plans to develop Liberty using extended reach drilling from the Endicott Satellite Drilling Island. Production probably will begin in 2011 (Bailey 2008). ENI Corporation recently announced it has slowed work on the Nikaitchuq field, in the Beaufort Sea north and west of the Milne Point oilfield. The field has an estimated 180 million bbl of recoverable oil and production was anticipated to begin by 2009 but may now be delayed by lower oil prices and the global economy – for six months to a year (Lidji 2009).

Another potential development includes Sourdough. In 1997, BPX and Chevron announced the discovery of the Sourdough field next to ANWR. Current information indicates Sourdough could contain 100 million bbl of recoverable oil. Further exploration is needed before determining whether to develop the field. The Sourdough project would require up to 35 miles of pipeline to link up with the Badami field to the west (Staff 1997).

Table 6.2. North Slope and Beaufort Sea oil and gas accumulations.

Unit or Area	Oil Reserves (MMBO)[1]	Gas Reserves (Bcf)[1]	Royalty Percent	Royalty Oil Reserves (MMBO)	Royalty Gas Reserves (Bcf)
Badami Unit[2]	2	0	14.6%	0	-
Barrow					
East Barrow	-	5	0.0%	-	-
South Barrow	-	4	0.0%	-	-
Walakpa	-	25	0.0%	-	-
TOTAL Barrow	-	34		-	-
Colville River Unit					
Alpine	252	-	9.85%	25	-
CRU Satellite	203	-	14.2%[3]	33	-
TOTAL CRU	455	400		57	60
Duck Island Unit	120	843	12.5-14.4%	15	121
Kuparuk River Unit					
Kuparuk	799	1,000	12.5%	100	125
West Sak[4]	403	100	12.5%	50	13
Tabasco	8	-	12.5%	1	-
Tarn	41	50	12.5%	5	6
Meltwater	6	-	12.5%	1	
Other Kuparuk Satellite	-		12.5%	-	-
TOTAL KRU	1,256	1,150		157	144
Milne Point Unit[4]	331	14	14.6%	48	2
North Star	97	450	16.0%	16	72
Prudhoe Bay Unit					
Prudhoe IPA[5]	2,240	23,000	12.5%	280	2,875
PBU Satellites [4], [6]	504	-	12.5%	63	-
Aurora	43				
Borealis	117				
Orion	232				
Polaris	91				
Midnight Sun	15				
Greater Point McIntyre Area					
Lisburne	71	1,000	12.5%	9	125
Niakuk	15	26	12.5%	2	3
Pt. McIntyre	164	500	13.8%	23	69
TOTAL GPMA	250	1,526		33	197
TOTAL PBU	2,995	24,526		376	3,072
Point Thomson Area	295	8,000	12.5-16.0%	37	1,000
Other Undeveloped[7]	392	-	6%[8]	23	-
TOTAL North Slope (State Lands)	5,943	35,417		694	3,471
NPR-A	246				
TOTAL North Slope Alaska	6,189	35,417	-	694	3,471

1 Remaining recoverable oil reserves based on the sum of Alaska Department Revenue forecasted production from 2007 through 2036. Gas reserves estimates from DNR. MMBO = Million Barrels of Oil; Bcf = Billion Cubic Feet.

2 The Badami field was put in warm shut-in in August 2003; production resumed in 2005.

3 Average of royalty rates on State of Alaska lands.

4 Based on an aggressive heavy oil component.

5 Prudhoe Bay Initial Participating Area includes Prudhoe Oil Pool oil, gas, and gas liquids; Gas Cap gas; and gas injected to enhance oil recovery.

6 Includes Aurora, Borealis, Orion, Polaris, Midnight Sun, and Raven Pools.

7 Includes Liberty and other known offshore accumulations.

8 Estimated combined rate for State and Federal on- and off-shore accumulations.

As production of existing fields continues, production and development well drilling and well workovers will occur into the future. The extent of activity is likely to decline as fields become depleted. Several undeveloped accumulations (e.g. Sourdough, Point Thomson, Yukon Gold) are located beyond the existing pipeline infrastructure. These accumulations may or may not be developed. Existing fields also contain considerable amounts of gas that may be extracted and transported to market in the future. Tapping the North Slope's gas reserves may require additional facilities, wells, and a new pipeline.

3. Activity Subsequent to the Sale

It is reasonable to assume that some exploration drilling will occur on tracts leased in this sale within the initial term of the lease. However, whether or not exploration and eventual development will occur in areas of the Beaufort Sea depend on several factors: 1) the subsurface geology of the area, 2) a company's worldwide exploration strategy, and 3) the projected price of oil and its demand. Geology dictates the extent of exploration. Several dry holes (no substantial hydrocarbons encountered) can discourage further exploration in an area. Whether a lessee proceeds with exploration of an area may depend on the area's priority when weighed against the lessee's other worldwide commitments. If extensive exploration does occur in an area, and an accumulation is discovered, development and production will only proceed if the lessee can be assured an acceptable profit. This depends on the price of oil, the lessee's development costs, and the cost of getting the oil to market.

Where gas has been discovered, not more than one well per section (640 acres) may be drilled into the pool. An oil and gas producer may apply to change the spacing requirements if there is technical justification to support greater ultimate recovery by changing the spacing requirements. A Conservation Order will grant exception to regulations under 20 AAC 25 upon finding and concluding the spacing exception will not cause waste.

When the development area is offshore and not within reach of existing infrastructure, a new platform, or drilling island may be proposed. Existing offshore platforms and structures were constructed onshore, floated to the desired location, sunk, and driven in place. A platform consists of a steel jacket with legs fastened to the seabed and the topside, which houses the staff and equipment necessary for producing oil and gas. Each leg is fastened to the seafloor with piles that penetrate about 135 feet below the surface. The piles serve as drilling slots and conductor pipe. Offshore drilling units that may be used during the production phase include:

- Rigid platforms
  - Steel-jacket platform (piles; >1,000 feet water)
  - Concrete gravity platforms
  - Steel-caisson platform (tide and ice resistant; Cook Inlet)
- Compliant platforms (moves with wind, currents and waves)
  - Guyed-tower platforms (guy wires, clump weights)
  - Tension-leg platforms (steel tubes to bottom, tensioned by buoyancy).
- Islands
  - Man-made.
  - Natural barrier islands.

Production facilities will likely include several production wells, water injectors, gas injection wells, and a waste disposal well. Wellhead spacing may be as little as 10 feet. A separation facility removes water and gas from the produced crude, and pipelines carry the crude to the onshore storage and terminal facilities. Some of the natural gas produced is used to power equipment on the platform, well pad, or processing facility but most is re-injected to maintain reservoir pressure in those reservoirs that have a surplus of produced gas. Produced water is also reinjected into an oil producing formation to maintain reservoir pressure. Often, seawater is treated and injected into the reservoir in addition to produced water in order to maintain pressure, improve recovery, and replace produced fluids.

Oil and gas production facilities found on the topside of a platform include gas and oil processing facilities to remove some of the water produced with the petroleum, water and sewage treatment equipment, power generators, a drilling rig that can move between legs, housing for about 75 workers, and a helipad. Island facilities would have a similar array of equipment, structures, and housing similar to platforms. Onshore support facilities include a production facility to receive and treat or transport the oil and gas to markets, refineries, or for trans-shipment to other processing facilities in the lower 48 states. Other support facilities may include a supply base and vessels to provide the platform with cement, mud, water, food, and other necessary items, and a helicopter base. Islands used for development would have a similar supply base and would use ice roads, barges, and helicopters, similar to platforms.

Onshore and offshore production operations for natural gas generally follow these steps:

- Natural gas flows through a high-pressure separator system where any liquids (water, condensate, etc.) are removed. Produced oil goes through a separator to remove the natural gas from the oil.
- The gas is compressed if necessary.
- The gas is dehydrated to lower its water content.
- The gas is then metered, i.e. the amount of gas produced is measured.
- The gas is transported to an onshore facility where it passes through a water precipitator to remove any liquid.

Onshore and offshore oil production steps are:

- Produced crude oil goes through a separator to remove water and gas from the oil stream.
- The oil moves to an onshore processing facility via a pipeline.
- The gas removed from the oil may be used to power production facilities or compressed and reinjected to keep the pressure up in the producing formation to assist in oil production.

At the preliminary best interest finding phase it is impossible to predict what a full development scenario will entail. The final project parameters will depend on the surface location, size, depth, and geology of a specific commercial discovery.

4. Oil and Gas Infrastructure on the North Slope/Beaufort Sea

The North Slope hosts an extensive network of petroleum production, development, and support facilities, all leading to the TAPS gathering facility, into the pipeline, and, ultimately, the TAPS terminal in Valdez. Prudhoe Bay continues to function as the hub of activity for the 35 fields and satellites on the Slope and in the Beaufort Sea, extending outward via roads, pipelines, production and processing facilities, gravel mines, and docks. Deadhorse houses an industry-support community and airport. Thus far, all oil and gas facilities are onshore or in state waters, with none sited in the OCS.

As exploration and development have continued, oil companies – and regulatory agencies – have capitalized on technological advances and existing infrastructure, thus minimizing further environmental impacts. For example, The Liberty field is located in federal OCS waters approximately 5 miles offshore in the Beaufort Sea, southeast of the Endicott field. BPX plans to develop Liberty using extended reach drilling from the Endicott Satellite Drilling Island, thus eliminating the need for building a new gravel island or causeway or siting an offshore drill rig.

5. Oil and Gas Lease Sales on the North Slope and in the Beaufort and Chukchi Seas

Many factors contribute to the outcome of oil and gas lease sales in Alaska. These include national and world economies, exploration budgets of oil and gas companies, oil and gas potential of the area, technological advances, the number of tracts available for lease, and the number of expired and relinquished tracts.

Since the first North Slope lease sale (Sale 13) in December 1964, the state has held 56 oil and gas lease sales involving North Slope and Beaufort Sea acreage (Table 6.3). More than 11.5 million acres in 3,065 tracts have been leased (Table 6.4). Some of this acreage has been leased more than once, as leases expired or were relinquished. Historically, only about half of the tracts offered in state oil and gas lease sales have been leased. Of the leased tracts, 407 (about 13 percent) were drilled and only 292 tracts, or about 10 percent of those leased, have been commercially developed. From 1944 through 2008, 506 exploration wells were drilled on the North Slope. During this period, the number of exploration wells drilled annually has ranged from 0-35. From 2004 through 2008, in a time of climbing oil prices, the number of exploration wells drilled annually has ranged from 9-15, averaging 12 per year and within historical ranges.

MMS has held 10 lease sales in the Alaska OCS over 30 years. A February 2008 lease sale in the Chukchi Sea attracted a record setting $3.4 billion in bids. High bids added up to nearly $2.7 billion on 2.76 million acres, with Shell Oil and ConocoPhillips showing the most interest (Joling 2008).

MMS is considering holding sales in federal OCS waters of the Beaufort Sea in 2009 and 2011, as well as the Chukchi Sea in 2010 and 2012 (MMS 2008, Vol. I). As of November 1, 2008 there were 281 active leases on federal submerged lands in the Beaufort Sea (MMS 2008, Vol. I, Chapter Three).

Table 6.3. Summary of state competitive lease sales on the North Slope/Beaufort Sea.

Date	Sale Number	Sale Name and Description
12/9/1964	13	Prudhoe West; offshore/uplands
7/14/1965	14	Prudhoe West to Canning R.; offshore/uplands
1/24/1967	18	Katalla, Prudhoe; offshore/uplands
9/10/1969	23	Colville to Canning R.; offshore/uplands
12/12/1979	30	Beaufort Sea (joint federal & state sale): offshore Milne Pt. east to Flaxman Is.
9/16/1980	31	Prudhoe Uplands: Kuparuk R. to Mikkelsen Bay
5/26/1982	36	Beaufort Sea: Pt. Thomson area; offshore/uplands
9/28/1982	34	Prudhoe Uplands: Sagavanirktok R. to Canning R.
5/17/1983	39	Beaufort Sea: Gwydyr Bay to Harrison Bay; offshore/uplands
5/22/1984	43	Beaufort Sea: Pitt Point east to Harrison Bay; offshore
5/22/1984	43A	Colville R. Delta/Prudhoe Bay Uplands Exempt: West of Kavik R.; offshore/uplands
9/24/1985	45A	North Slope Exempt: Canning R. to Colville R.; offshore/uplands
9/24/1985	47	Kuparuk Uplands: South of Prudhoe Bay
2/25/1986	48	Kuparuk Uplands: South of Kuparuk oil field
2/25/1986	48A	Mikkelsen Exempt: Mikkelsen Bay, Foggy Is. Bay; offshore/uplands
1/27/1987	51	Prudhoe Bay Uplands: Canning R. to Sagavanirktok R.
6/30/1987	50	Camden Bay: Flaxman Is. to Hulahula R.; offshore
9/28/1988	55	Demarcation Point: Canning R. to U.S./Canadian border; offshore
9/28/1988	69A	Kuparuk Uplands Exempt: Canning R. to Colville R.
1/26/1988	54	Kuparuk Uplands: Colville River Delta
1/24/1989	52	Beaufort Sea: Pitt Point to Tangent Point; offshore
1/24/1989	72A	Oliktok Point Exempt: Uplands
1/29/1991	70A	Kuparuk Uplands Exempt: Canning R. to Colville R.

-continued-

Table 6.3. Page 2 of 2.

Date	Sale Number	Sale Name and Description
6/4/1991	64	Kavik: Canning R. to Sagavanirktok R.; uplands
6/4/1991	65	Beaufort Sea: Pitt Point to Canning R.; offshore
1/22/1992	61	White Hills: Colville R. to White Hills; uplands
6/2/1992	68	Beaufort Sea: Nulavik to Tangent Point; offshore
12/8/1992	75	Kuparuk Uplands: Between NPRA and Sagavanirktok R.; Colville R. Delta ASRC Islands
5/25/1993	70A-W	Kuparuk Uplands Reoffer: Between Canning R. and Kavik R.; onshore
9/21/1993	75A	Colville River Exempt: Colville River Delta onshore
12/5/1995	80	Shaviovik: Sag R. to Canning R., southern Kuparuk Uplands, Gwydyr Bay, Foggy Island Bay, onshore/offshore
10/1/1996	86A	Colville River Exempt: Colville R, offshore, state/ASRC onshore/offshore
11/18/1997	86	Central Beaufort Sea: Harrison Bay to Flaxman Island
6/24/1998	87	North Slope Areawide: state acreage between NPRA and ANWR north of the Umiat Baseline
2/24/1999		North Slope Areawide 1999 state acreage between NPRA and ANWR north of the Umiat Baseline
11/15/2000		North Slope Areawide 2000 state acreage between NPRA and ANWR north of the Umiat Baseline
11/15/2000		Beaufort Sea Areawide 2000 state acreage within the 3-mile limit, between Dease Inlet and Barter Island
10/24/2001		North Slope Areawide 2001 state acreage between NPRA and ANWR north of the Umiat Baseline
10/24/2001		Beaufort Sea Areawide 2001 state acreage within the 3-mile limit, between Dease Inlet and Barter Island
10/24/2002		North Slope Areawide 2002 state acreage between NPRA and ANWR north of the Umiat Baseline
10/24/2002		Beaufort Sea Areawide 2002 state acreage within the 3-mile limit, between Dease Inlet and Barter Island
10/29/2003		North Slope Areawide 2003 state acreage between NPRA and ANWR north of the Umiat Baseline
10/29/2003		Beaufort Sea Areawide 2003 state acreage within the 3-mile limit, between Dease Inlet and Barter Island
10/27/2004		North Slope Areawide 2004 state acreage between NPRA and ANWR north of the Umiat Baseline
10/27/2004		Beaufort Sea Areawide 2004 state acreage within the 3-mile limit, between Dease Inlet and Barter Island
3/1/2006		North Slope Areawide 2006 state acreage between NPRA and ANWR north of the Umiat Baseline
3/1/2006		Beaufort Sea Areawide 2006 state acreage within the 3-mile limit, between Dease Inlet and Barter Island
10/25/2006		North Slope Areawide 2006A state acreage between NPRA and ANWR north of the Umiat Baseline
10/25/2006		Beaufort Sea Areawide 2006A state acreage within the 3-mile limit, between Dease Inlet and Barter Island
10/24/2007		North Slope Areawide 2007 state acreage between NPRA and ANWR north of the Umiat Baseline
10/24/2007		Beaufort Sea Areawide 2007 state acreage within the 3-mile limit, between Dease Inlet and Barter Island
10/22/2008		North Slope Areawide 2007 state acreage between NPRA and ANWR north of the Umiat Baseline
10/22/2008		Beaufort Sea Areawide 2007 state acreage within the 3-mile limit, between Dease Inlet and Barter Island

Table 6.4. Current lease activity, North Slope and Beaufort Sea.

Lease Sale Areas	Number of Leases	On-Shore Acreage	Off-Shore Acreage	Total Acreage
North Slope	716	2,100,853.78	82,510.99	2,183,364.77
Beaufort Sea	224	53,337.09	561,940.34	615,277.43
Active Leases	940	2,154,190.87	644,451.33	2,798,642.20

BLM has leased onshore federal lands as well, in NPRA. The most recent sale was held in September 2008 and leased 150 of the 450 tracts offered (BLM 2008a). These 1,656,754 acres add to the 335 existing NPRA leases, totaling 3,086,492 acres (BLM 2008a*).* Oil and gas is also estimated to occur in the Arctic National Wildlife Refuge and the Teshekpuk Lake area of NPRA. ANWR is closed to development and BLM has deferred for 10 years the potential leasing of lands north and east of Teshekpuk Lake, from the lake to the coast (BLM 2008d).

E. Likely Methods of Oil and Gas Transportation

AS 38.05.035(g) directs that best interest findings shall consider and discuss the method or methods most likely to be used to transport oil or gas from the lease sale area, and the advantages, disadvantages, and relative risks of each.

The question of how best to transport oil or gas discovered in offshore areas of Alaska's northern coast has been studied for many years. Numerous options have been identified and periodically updated to incorporate technological improvements. The method for bringing offshore oil to shore that is generally most favored by the U.S. Army Corps of Engineers is through directional drilling from onshore locations. There are, however, limits to directional drilling. Factors such as the location of the oil deposit in relation to the drilling rig, the size and depth of the deposit, and most importantly, the geology of the area are all critical elements in determining if directional drilling is feasible (see Appendix C).

If directional drilling is not feasible, oil produced from offshore tracts in the Beaufort Sea could be brought onshore by a number of methods that are discussed below. However, the economic feasibility of development cannot be precisely addressed at the lease sale stage because the existence, location, and extent of any future discovery are not known before exploration. Ultimately, strategies used to transport potential petroleum resources depend on many factors, most of which are unique to an individual discovery. The location and nature of oil or gas deposits determine the type and extent of facilities necessary to develop and transport the resource. ADNR and other state, federal, and local agencies will review the specific transportation system when it is actually proposed. Modern oil and gas transportation systems usually include the following major components: pipelines, marine terminals, and tank vessels. Shallow waters in the proposed lease sale area will likely preclude the use of marine terminals or tankers to transport oil. Oil and gas produced in the proposed lease sale area would most likely be transported by pipeline, depending on the type, size, and location of the discovery.

If commercial quantities of oil are found in the proposed lease sale area, the oil will go to market via the trans-Alaska pipeline system (TAPS), a 798-mile pipeline from Prudhoe Bay to Valdez. From Valdez, the oil is transported to markets in Cook Inlet, the U.S. West Coast, and the U.S. Gulf Coast using tankers. In-field gathering lines bring the oil from individual well sites to processing facilities for injection into TAPS.

The mode of transport from a discovery will be an important factor in determining whether future discoveries can be economically produced – the more expensive a given transportation option is, the larger a discovery will have to be in order to be economically viable.

Portions of the proposed lease sale area lie offshore of ANWR and NPR-A. While BLM has conducted oil and gas lease sales in NPR-A, it has imposed a 10-year deferral of leasing in the area north and east of Teshekpuk Lake, upland from the proposed lease sale area. Securing permits for siting oil and gas facilities in NPR-A will require an EIS; siting facilities in ANWR is unlikely to be approved. The status of ANWR could change if Congress amends federal law to permit petroleum exploration and development or if the Secretary of Interior allows a pipeline right-of-way. However, this transportation analysis is based on the assumption that ANWR will not be available for onshore support of a transportation system.

Pipeline crossing the Kuparuk River.

1. Pipelines

A pipeline is considered all the components of a total system of pipe to transport crude oil or natural gas or hydrocarbon products for delivery, storage, or further transportation. It includes all pipe, pump or compressor stations, station equipment, tanks, valves, access roads, bridges, airfields, terminals and terminal facilities, operations control center for both the upstream part of the and all other facilities used or necessary for an integral line of pipe transportation (AS 38.35.230).

Jurisdictional authority over pipelines depends on many factors such as design, pipe diameter, product transported, or whether it meets state or federal designation, e.g., transmission line, gathering line, or distribution line, and other attributes as specified in regulations. Generally, the design, maintenance, and preservation of transmission pipelines transporting hydrocarbon products are under the authority and jurisdiction of the Pipeline and Hazardous Materials Safety Administration (PHMSA) and specific regulations for natural gas (49 CFR 192) and hazardous liquids (49 CFR 195). Both regulations prescribe the minimum requirements that all operators must follow to ensure the safety of their pipelines and piping systems. The regulations not only set requirements, but also provide guidance on preventive and mitigation measures, establish time frames for upgrades and repairs, and incorporate other relevant information such as standards incorporated by reference developed by various industry consensus organizations.

On December 29, 2006, the “Pipeline Inspection, Protection, Enforcement, and Safety Act of 2006” (Pipes Act H.R. 5782) was signed into law. The Pipes Act issued a final rule requiring hazardous liquid pipeline operators to develop integrity management programs for transmission pipelines.

Basic requirements for an Integrity Management Plan include:

- Periodic integrity assessment of pipelines that could affect high consequence areas (HCAs). Integrity assessments are performed by in-line inspection (also referred to as “smart pigging”), hydrostatic pressure testing, or direct assessment. Through these assessment methods, potentially injurious pipeline defects that could eventually weaken the pipe, or even cause it to fail, are identified early and can be repaired, thus improving the pipe’s integrity.
- Development and implementation of a set of safety management and analytical processes, collectively referred to as an integrity management program (IMP). The purpose of the program is to assure pipeline operators have systematic, rigorous, and documented processes in place to protect HCAs. (PHMSA 2008).

Integrity management programs reflect significant improvements to pipeline safety and have unique aspects depending on service characteristics for natural gas and liquid hydrocarbons.

- For gas pipelines, the Gas Transmission IM Rule (49 CFR 192, Subpart O) the “Gas IM Rule,” as it is commonly referred to, became effective in February 2004, and represents a significant enhancement to PHMSA’s existing pipeline safety regulations. The Gas IM Rule specifies how pipeline operators must identify, prioritize, assess, evaluate, repair, and validate - through comprehensive analyses - the integrity of gas transmission pipelines that, in the event of a leak or failure, could affect High Consequence Areas (HCAs) within the United States. These HCAs include certain populated and occupied areas. The framework for an integrity management system are covered in Subpart O - Gas Transmission Pipeline Integrity Management (49 CFR 192.907) and integrity program elements are in 49 CFR 192.911, which invoke ASME/ANSI B31.8S by reference.
- For liquid hydrocarbon (oil and product) pipelines, Pipeline Integrity Management in High Consequence Areas for Hazardous Liquid Operators (49 CFR 195.450 and .452). The “Liquid IM Rule,” as it is commonly referred to, represents a significant enhancement to PHMSA's existing pipeline safety regulations. The Liquid IM Rule specifies how pipeline operators must identify, prioritize, assess, evaluate, repair, and validate-through comprehensive analyses—the integrity of hazardous liquid pipelines that, in the event of a leak or failure, could affect High Consequence Areas (HCAs) within the United States. These HCAs include population areas (like Nuiqsut and Deadhorse), drinking water and ecological resources that are unusually sensitive to environmental damage, and commercially navigable waterways.

a. <u>Offshore Pipelines</u>

i. Subsea Pipelines

Subsea pipelines are the most likely system for transporting oil or gas from new offshore development areas to loading or processing facilities. The Beaufort Sea’s first subsea pipeline carries oil 6 miles offshore from Northstar to onshore pipe in Prudhoe Bay. The Oooguruk development also uses a subsea pipeline to carry oil from a gravel island 5 miles offshore in 5 feet of water. Offshore pipelines that are properly designed and maintained do not hinder water circulation and minimally affect fish and wildlife habitat. If offshore pipelines are not buried, they can hinder or disrupt normal water circulation. Pipelines may be buried in trenches in shallower waters, as was done at Oooguruk, to avoid creating a navigational hazard, being damaged by a ship's anchor or sea ice, or being caught in fishing nets. In deeper water, the pipelines may become silted-in or self-buried. The risk of spills from subsea pipelines is considerably less than for tankers (MMS 1992). However, subsea pipelines are expensive to build and maintain. Although significant advances have been made in recent years, they can also be difficult to monitor for leaks, defects, and corrosion problems. See Section F(2)(a) below for further information on leak detection methods.

Although much more expensive than an onshore pipeline across a portion of the ANWR Coastal Plain or through NPR-A, a main offshore pipeline that completely avoids ANWR and NPRA can be constructed to transport oil from leases offshore from these areas. A careful analysis of the economics and environmental risks would have to be performed to determine which transportation method would be best. This can only be done after a discovery is made and evaluated.

One method of subsea pipeline construction involves winter excavation of a trench in the sea bottom using a plow, dredge, jetting action, or a shovel-type device. The trench could be cut using a plow, dredge, jetting action, or shovel type device, depending on water depths and soil characteristics. The depth of the trench is dictated by the depth of the water, local soil conditions, equipment limitations, and projected hazards expected over the life of the pipeline. Pipe is then laid in the trench, and the trench is back-filled.

In the Beaufort Sea, subsea pipelines come ashore at the nearest suitable approved landfall and pass through the nearshore permafrost transition zone inside of or on top of short causeways, through directionally drilled tunnels, or in insulated pipes bedded in gravel-filled trenches. Of the various options for bringing an offshore pipeline through the nearshore permafrost transition zone, installing the pipeline in a dredged trench appears to be the most suitable method, based on current technology. Other methods, such as the use of a causeway, may also be appropriate depending on the length of the shore approach zone, oil temperatures, and the permafrost sensitivity of the local soils (Brown 1984).

A major design consideration for both deep and shallow subsea pipelines in the Arctic Ocean is the risk of damage due to ice and strudel scouring. The ice scour process begins when a floating ice mass with a deep keel is driven against the ocean bottom. These ice masses are driven by environmental forces, including winds, ocean currents, waves, or moving pack ice. Ice scour may not only directly damage pipe, but may damage subsea pipe by causing large shear strain in the soil (Schoonbeek et al. 2006). Once scouring begins, it will continue until soil or seabed resistance exceeds the strength of the ice keel or the forces pushing the ice (Been et al. 1990). Subsea pipelines will also experience external loading forces due to ice piling up on the sea floor above the pipeline. The extent to which ice can accumulate on the sea floor above the pipeline will depend on water depth, seasonal weather conditions, and local sea floor conditions. Consequently, where this potential exists, pipelines must be designed to accommodate this additional external force. New computer modeling techniques that analyze extreme seabed deformation undergoing ice gouging may facilitate engineering and environmental considerations of burying pipe (Offshore 2008). MMS has completed a study on seabed scour and pipeline deformation; the final report, which includes recommendations regarding the minimum required burial depth to protect pipe from ice scour, is under preparation (Kinnas et al. 2008b).

Strudel scour occurs when melting snow and ice on land flow over sea ice as the water is discharged from the river deltas. This fresh water over-flooding can extend several miles seaward from the river deltas and typically occurs in late May to early June. The weight of the fresh water depresses the sea ice where the ice is not bottom fast and causes the ice to crack. The fresh water drains through these cracks. If sufficient static head of fresh water exists, the water drains through the cracks/holes with enough velocity to form a whirlpool waterjet that can scour the seafloor. Individual strudels can vary in size and are typically circular in shape. Strudel scour depths and diameters vary depending on location. In the vicinity of the Northstar pipeline right-of-way, they reach depths up to 13 feet below the seabed and diameters vary in size from a few feet up to 89 feet measured at seabed elevation. Northstar pipelines where this potential exists must have adequate strength to span the potential strudel scour conditions in the area (SPCO 1999).

Subsea pipelines in the Beaufort Sea must also be designed to withstand earthquakes. Both TAPS and subsea pipelines in the area have been designed to avoid damage from earthquakes. For more on geophysical hazards, see Section A of this Chapter and Section F of Chapter Three.

Subsea pipelines are expensive to construct and maintain. A hot oil pipeline buried through the nearshore permafrost transition zone must be designed for upheaval, bucking, and thaw settlement. It could also be subject to damage during conditions of severe ice scouring. If a subsea pipeline rupture were to result in an oil spill, detection, containment, and cleanup would be more difficult than if the pipeline was on a causeway above the surface of the water or ice. Moreover, maintenance and repair costs for a subsea pipeline are high, as access to the pipeline route maybe limited to winter ice roads or barges during the open water period.

Potential nearshore impacts from subsea pipelines can also be significant. Construction of a pipeline in shallow water and through shoreline areas involves dredging, canal building, or construction of a short causeway out to a deeper water area. These operations have the potential to alter the environment. Although pipeline burial is normally desirable, it is more difficult with certain types of sediment. For example, if the pipeline traverses frozen sediment and the pipeline is not properly insulated, heat transfer from the pipe could result in slumping or the creation of mobile slurries (Baker 1987). Pipeline burial, inspection, and maintenance operations can also create significant noise disturbance and changes in water quality that may adversely affect marine mammals. However, there is no evidence of population changes in those species that can be attributed to the much higher and more persistent levels of industrial noise from similar activities in the Canadian Beaufort Sea (USACOE 1984). Dredging and pipe laying activities may also disturb birds, but to a lesser extent and for a shorter duration than under the causeway alternatives (USACOE 1984).

Although TAPS is an onshore pipeline, the construction and operation of the TAPS line has provided valuable information on the construction of pipelines in permafrost areas and in the choice of materials to use in arctic conditions. Similarly, the construction of buried pipelines in the now-producing fields on the North Slope has also provided valuable construction and design parameters that can be used in the design of offshore Arctic pipelines.

Subsea pipelines have been successfully constructed using current technology in both shallow and deep water areas around the world. The unique conditions present in the Arctic present engineering challenges. Site specific and project specific ice studies, ice loading studies, soil condition analyses, permafrost studies, water current and wave studies, ice and strudel scour studies, external and internal pipeline stress studies, and corrosion control studies will have to be completed in order to design and construct a subsea pipeline.

For the Northstar development project, BPX built a 6-mile subsea pipeline from Seal Island to landfall. A slot was cut in the ice along the subsea pipeline route and a trench was excavated in the seafloor for pipeline installation. The trench walls are approximately vertical in the area of landfast ice and trapezoidal in floating ice areas. Trench depth ranges from 7 to 12 feet. The bottom of the trench was cut to the desired final grade by use of a hydraulic excavator, which discharged the excavated material back into the trench. Tracked equipment towed pipeline strings to the side of the trench where they will be welded together and lowered through the opening into the seafloor trench. The pipeline was coated with fusion-bonded epoxy to protect against exterior wall pipeline corrosion. In addition, a cathodic protection system consisting of anodes attached to the pipelines helps prevent corrosion. (USACOE 1999). BPX estimated the maximum depth of ice scour to be 2 feet along the pipeline route. To help prevent thawing of the permafrost, oil is cooled to a temperature of 50˚ F (from 175˚ F) before being sent through the pipeline (Gipson Undated).

ii. Elevated Pipeline

Elevated pipelines are essentially a series of bridges that support a pipeline, and have the least potential to interfere with lateral fish movements or water circulation (USACOE 1984). Elevated pipelines allow visual monitoring for leaks and maintenance checks. Soil conditions are less of a limiting factor because pilings can be driven through problem soils; and heat transfer to thaw-unstable soils is minimized because the pipeline is not buried in the seabed. However, none have been built in the Beaufort Sea.

Several difficulties accompany the use of elevated pipelines in the Beaufort Sea. Access to the pipeline for maintenance and repairs may be difficult during storms, surges, and broken ice conditions in the fall and spring. The pipeline will need to be elevated off the surface of the water because of the potential for ice or wave damage. This significantly adds to the cost of constructing the pipeline and complicates access for maintenance and repairs. In the nearshore permafrost transition zone, the pilings could be subject to jacking and subsidence, both of which could threaten the integrity of the pipeline. Pilings will also be subject to increased stress resulting from ice collisions and ice sheer in deep water areas. A pile-supported pipeline could lead to higher marine noise levels than other transportation alternatives because noise will be conducted into the water through the steel structures supporting the pipeline. However, the effects of pipeline-created noise disturbance on marine mammals will be negligible because of the shallow water depths in the proposed lease sale area (noise propagates poorly in shallow water) and because marine mammals generally inhabit deeper waters farther from shore (USACOE 1984). Finally, depending on its location, an elevated pipeline could create a significant navigational hazard.

iii. Gravel Causeway

A proven method, gravel causeways are generally cost effective. However, because of the high cost of transporting gravel to these remote Beaufort Sea areas, even this relatively low cost type of structure can be prohibitively expensive for the development of marginal fields far offshore (i.e., fields with relatively small reserves, high development costs or a combination of the two) or in deeper waters. As water depths increase, the amount of gravel required to construct a causeway increases significantly. For example, a given length causeway in 15 feet of water requires almost 10 times as much gravel as the same structure in 5 feet of water. Consequently, the feasibility of using gravel in progressively deeper waters depends on the size of the oil reserve.

Transporting oil by means of a continuous solid fill gravel causeway in nearshore areas has several advantages. Pipelines used for transporting oil may be buried in or placed on top of a causeway to facilitate visual inspection and provide a stable operations and logistics base for containing and cleaning up any spills that may occur. Solid gravel causeways can also support the heaviest loads on a year-round basis and provide the additional benefit of year-round access to offshore production facilities. Moreover, causeways, like the one at West Dock, are capable of serving as loading and off-loading points for barges bringing fuel, supplies, and equipment into the exploration and production area. They may also be used as corridors for pipelines bringing seawater ashore for reinjection into the ground to maintain onshore oil field pressures.

Although a causeway can cause changes in water circulation patterns affecting temperature and salinity, it is not expected that the deeper water food sources eaten by ringed seals and whales would be affected by these changes (USACOE 1984). Based upon experiences with causeways at West Dock and Endicott, proper siting of causeways can minimize the risk of important habitat loss.

Longer nearshore causeways are considered by some to be environmentally unacceptable because of their potential to alter tidal and nearshore currents, water exchanges, water salinity and temperature. It is feared that alterations of this nature could have significant and long term effects on fishery resources. Depending on where they are sited, causeways, if not properly marked and maintained, can also present a navigational hazard or obstacle where none previously existed. For more on effects of causeways on fish, birds, and marine mammals, see Chapter Eight.

The state of Alaska discourages the use of continuous fill causeways. Environmentally preferred alternatives for field development include use of buried pipelines, onshore directional drilling, or elevated structures. If approved, causeways must be designed, sited, and constructed to protect water quality, nearshore fish passage, and nearshore oceanographic circulation patterns.

The construction of continuous fill causeways can have adverse environmental effects depending on the length, orientation, and the specific location of the structure. Disturbance of marine mammals and birds may occur during the construction phase because of noise (USACOE 1984; Dames and Moore 1988). Placement of gravel in nearshore waters may also result in temporary turbidity plumes (USACOE 1984) that can affect marine organisms and their habitat. When ice flexes and rides up on a causeway the resultant breaks in the ice may provide an entry point for water and promote strudel scour. Solid-fill causeways may also have an adverse effect on marine and anadromous fish passage, and can alter primary (plankton) production regimes in nearshore estuarine habitat. However, proper siting of causeways can minimize the risk of habitat loss. Although the post-construction environmental effects of continuous solid fill causeways are the subject of differing opinions, it is generally accepted that nearshore causeways have little or no effect on marine mammals. Bowhead and gray whales are occasionally sighted in nearshore areas of the arctic coast but they normally inhabit deeper water further from the shore. The noise level from a causeway is also relatively low, and noise propagates poorly in shallow waters where causeways would normally be constructed.

A breached causeway is essentially the same type of structure as described above except that the gravel fill is interrupted by one or more openings of varying length to allow for greater ocean water circulation and fish movement. The Endicott and West Dock causeways are examples of this type of design and construction. Although numerous studies have been initiated to determine the environmental impacts of each of these existing structures, there is little consensus concerning the findings. Studies of fish, marine mammals, and sea birds have produced findings from different reviewers ranging from little or no impact to significant habitat degradation or alteration. Studies concerning water quality have also varied in their findings. However, it is generally accepted that during certain periods of the open water season, there are transient changes in nearshore water temperature and salinity. Whether there are adverse environmental impacts resulting from the observed changes remains the subject of controversy.

Breaching a causeway minimizes disruption of water circulation patterns and any resulting changes in water quality that may occur. Detailed studies are available concerning the breached causeways for the West Dock and Endicott projects. In shallower waters, culverts may be used to form the breach, thus reducing overall costs.

Although breaching a causeway reduces the risks of environmental harm from disruption of water circulation patterns, it has certain disadvantages. For example, in comparison to unbreached causeways, breached causeways have higher construction and maintenance costs. The superstructure across the breach, unless the breach is formed by culverts, cannot support unrestricted loads. This could pose safety problems in the event of a well blowout or oil spill, which might require rapid movement of very heavy equipment to or from the scene.

iv. Elevated Causeway

This transportation alternative is similar to an elevated pipeline, but would include an accompanying road surface built on the pipeline supports. The road surface would allow for easier year-round maintenance, inspection, and access to offshore production sites serviced by the structure; but the initial costs associated with construction of the roadway would be substantial.

Like the elevated pipeline alternative discussed above, this option provides for uninterrupted water circulation and improved visual monitoring of the pipeline for leaks. The bridge roadway could also be designed to provide limited containment of small spills on the causeway, and all but the heaviest types of equipment could be transported between shore and production islands on a year-round basis.

The difficulties with the use of an elevated causeway are similar to those discussed above with regard to elevated pipelines, and none have been constructed in the Beaufort Sea. Although access to the pipeline for routine maintenance is improved by the presence of the road surface, access to the supporting superstructure for major repairs may be complicated by broken ice conditions in the fall and spring. The causeway would require the same elevation standard as an elevated pipeline, because of the potential for ice or wave damage. This would substantially add to the cost of constructing the causeway.

Elevated causeways share the same concerns as elevated pipelines. These are the risks of jacking-up and subsidence of the pilings supporting the causeway and increased stress on the pilings caused by ice collisions and ice shear. It is also possible that a pile-supported causeway could lead to higher marine noise levels by conducting noise into the water through the steel structures supporting the road and pipeline. More importantly, noise from traffic on the road could enter the water beneath the bridge. Thus, airborne noise could now enter the water directly, rather than be absorbed by the gravel causeway (USACOE 1984). As with elevated pipelines, however, the effects on marine mammals are expected to be negligible because the water depths where the structure would be located in the proposed lease sale area are extremely shallow and the marine mammals tend to inhabit deep water farther from shore. This type of causeway cannot support unrestricted loads. Access restrictions (weight and size limitations) would limit the loads that could be safely transported over the causeway. Like other causeway alternatives, an elevated causeway could present a navigational hazard.

Construction and maintenance costs are high for this option. During the construction phase, disturbance of birds may occur if pile-driving or other construction work on or near the shore occurs during the summer. Construction of an elevated pipeline would also result in temporary turbidity plumes (USACOE 1984: 4-184). For its Alpine development project, ARCO constructed an oil pipeline under the Colville River. The Colville River pipeline is designed for a minimum service life of 20 years. The pipeline was installed at a depth of approximately 80 ft or greater beneath the river bed using horizontal directional drilling methods (Parametrix 1996). The pipeline is insulated and is operated such that the oil temperature will ensure that thaw settlement will be within tolerable limits. The leak detection system employs real-time monitoring supplemented by the use of inspection pigs.

2. Tankers

Tankers are currently used in Alaska to transport oil to and from Cook Inlet and from the Alyeska Terminal in Valdez, the terminus of TAPS. Use of tankers brings the risk of a large oil spill, such as the 1989 *Exxon Valdez* spill in Prince William Sound (see Section F below). Shallow waters in the proposed lease sale area mean nearshore tanker traffic is not a viable option.

3. Mitigation Measures and Other Regulatory Protections

Any product ultimately produced from proposed lease sale tracts will have to be transported to market; however, it is important to note that the decision to lease oil and gas resources does not authorize the transportation of any product. If and when oil or gas is found in commercial quantities and production is proposed, final decisions on transportation will be made through the local, state, and federal application and permitting processes. Those processes will consider any required changes in oil spill contingency planning and other environmental safeguards, and will involve public participation. The state has broad authority to withhold, restrict, and condition its approval of transportation facilities. In addition, boroughs, municipalities, and the federal government have jurisdiction over various aspects of any transportation alternative. Measures are included in this preliminary best interest finding to mitigate potential negative effects of transporting oil and gas (see Chapter Nine). Additional site-specific and project-specific mitigation measures may be imposed as necessary if exploration and development take place.

F. Oil Spill Risk, Prevention, and Response

The risk of a spill exists any time crude oil or petroleum products are handled.

1. Oil Spill History and Risk

The National Research Council (MMS 2008, Vol. I, Chapter Three) reports that accidental discharges into the sea from exploration and production account for 2 percent of the total release of petroleum spilled into North American seas. Oil consumption accounts for 32 percent and marine transportation 3 percent. The largest source of oil in the sea is natural seeps (63 percent of total inputs).

The nine largest spills of crude oil and process water in the North Slope Subarea, those over 1,000 bbl (42,000 gal), are listed in Table 6.5; these are the largest spills in the Subarea since 1995. Since July 1995, there has been one spill involving over 1,000 bbl of crude oil; the other spills involved produced water or seawater. Since 1995, there have been 80 spills of crude oil and process water over 23.81 bbl (1,000 gal) in the North Slope subarea. Most spills are much smaller; about 85 percent of crude spills (since 1995) (ADEC 2009) are less than 2.381 bbl (100 gal) and about 55 percent of process waters spills are less than 2.381 bbl (100 gal). The smallest recorded crude spill in ADEC's spill database is .063 gallons spilled in May 1997 when equipment at Pump Station 2 failed (Stephens 2009). Process water – seawater and produced water, the water pumped with oil and gas from wells – may contain crude oil; hence, these spills are included here.

Oil spills associated with the exploration, development, production, storage, and transportation of crude oil may occur from well blowouts or pipeline or tanker accidents. Petroleum activities may also generate chronic low volume spills involving fuels and other petroleum products associated with normal operation of drilling rigs, vessels, and other facilities for gathering, processing, loading, and storing of crude oil. Spills may also be associated with the transportation of refined products to provide fuel for generators, marine vessels, and other vehicles used in exploration and development activities. A worst case oil discharge from an exploration facility, production facility, pipeline, or storage facility is restricted by the maximum tank or vessel storage capacity or by a well's ability to produce oil. Companies do not store large volumes of crude at their facilities on the North Slope; rather, produced oil is processed and transported as quickly as possible. This reduces the possible size of a potential spill on the North Slope.

The oil and gas industry has been actively exploring and producing North Slope resources for more than 3 decades. In this time, the vast majority of oil, produced fluid, seawater, and other industry-related spills have been less than .238 bbl (10 gal), with very few larger than 10,000 bbl (42,000 gal) (see Table 6.5). MMS estimates the mean number of a large, 1,000 bbl (42,000 gal) spill in its preparation for its proposed Beaufort Sea sales as small: the estimated mean number of spills over the life of production is less than one (.30 or one third of a spill) (MMS 2008, Vol. I, Chapter Four). The 2003 National Research Council report *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope*, completed before the corrosion-caused spills in 2006, discussed below, concluded that, while small spills have occurred in the fields, the spills have not been large or frequent enough to have accumulated effects (NRC 2003).

Table 6.5. Large spills (over 1,000 barrels) of crude oil or process water in the North Slope subarea, July 1995 to January 2009.

Date	Location	Facility Type	Substance	Gallons Released	Barrels Released
3/17/97	Drill Site 14	Oil Production Onshore	Seawater	995,400	23,700
3/2/06	Flowline between GC1 and GC2	Oil Production Crude Oil Transmission Line	Crude	267,000	6,357
12/19/06	Gathering Center 2 (GC-2)	Oil Production Field Processing	Produced Water/Crude (Crude 6,300 gal; 150 bbl)	241,038	5,739
12/25/08	1 L Pad Well 22	Oil Production Flow Lines	Produced Water	94,920	2,260
4/15/01	Kuparuk, from CPF1 to Drill Site 1B	Oil Production Field Processing	Produced Water	92,400	2,200
1/10/98	Kuparuk, ARCO DS 1A	Oil Production	Produced Water	63,000	1,500
11/3/08	Drill Site 11	Oil Production Onshore	Seawater	61,626	1,467
3/26/05	Drill Site 2-H	Oil Production Field Processing	Produced Water	51,198	1,219
6/16/08	Skid 50	Oil Production Onshore	Source Water	49,387	1,176

Source: Adapted from Stephens 2009.

2. Exploration and Production

Spills related to petroleum exploration and production must be distinguished from those related to transportation because the phases have different risk factors and spill histories. Exploration and production facilities in the proposed lease sale area may include onshore gravel pads; offshore gravel islands or causeways; drill rigs; pipelines; and facilities for gathering, processing, storing, and moving oil. These facilities are discussed below. When spills occur at these facilities, they are usually related to everyday operations, such as fuel transfers. Large spills are rare at the exploration and production stages because spill sizes are limited by production rates and by the amount of crude oil stored at the exploration or production facility. A well can only spill as much oil as it can produce without assistance. Some wells cannot produce without mechanical assistance, and if an accident occurs, oil ceases to flow.

The most dramatic form of spill can occur during a well blowout, which can take place when high pressure gas is encountered in the well and sufficient precautions, such as increasing the weight of the drilling mud, are not effective. The result is that oil, gas, or mud is suddenly and violently expelled from the well bore, followed by uncontrolled flow from the well. Blowout preventers, which immediately close off the open well to prevent or minimize any discharges, are required for all drilling and work-over rigs and are routinely inspected by the AOGCC.

Blowouts are extremely rare in Alaska and their numbers decline as technology, experience, and regulation impact drilling practices (ADN 2008). A blowout that results in an oil spill has never occurred in Alaska. Natural gas blowouts have occurred, About 5,570 wells have been drilled on the North Slope; it’s been over 13 years since the last gas blowout (ADN 2008). Since 1976, there have been six documented instances of loss of secondary well control with a drill rig on the well. This equates to 1.8 blowouts per 1000 wells (Mallary 1998). A gas blowout occurred at the Cirque No. 1 well in 1992. The accident occurred while ARCO workers were drilling an exploratory well and hit a shallow zone of natural gas. Drilling mud spewed from the well and natural gas escaped. It took 2 weeks to plugs the well (Times 1992). In 1994, a gas kick occurred at the Endicott field I-53 well. BP Exploration was forced to evacuate personnel and shut down most wells on the main production island. No oil was released to the surface, as the well had not yet reached an oil-bearing zone. There were no injuries, and the well was killed 3 days later by pumping heavily weighted drilling muds into it (Schmidt 1994; ADN 1994a).

The largest spill in the region is the March 1997 spill of almost a million gallons of process water (seawater) that seeped from nine wellheads at Drill Site 9 (Meggert 2009; ADEC 2009). The water was channeled directly into an old reserve pit and frozen in place. It was chipped up, melted, and re-injected at another water flood injection well. Seawater spills that reach tundra are significant because salty water can kill vegetation.

The most recent spill of produced water and crude occurred on January 12, 2009 at Milne Point's Central Facilities Pad. A sand slurry tank and secondary containment overflowed when the automated flow control system failed, spilling an estimated 575 bbl (24,150 gal) of crude and produced water (ADEC 2009). An electronic component of the tank's automatic flow control system failed, releasing oil and produced water into the containment basin and onto the gravel pad (Bluemink 2009b).

a. Pipelines

Both state and federal agencies have oversight of pipelines in Alaska. State agencies include the Petroleum Systems Integrity Office (PSIO) and DO&G within DNR; the State Pipeline Coordinator's Office; and DEC. federal agencies include the Pipeline and Hazardous Materials Safety Administration (PHMSA) within the U.S. Department of Transportation; and MMS.

The pipeline system that transports North Slope crude includes flow lines, gathering lines, and pipelines that carry the crude to processing facilities and to Pump Station 1, where the oil enters TAPS for transport to the port of Valdez. Pipelines vary in size, length, and amount of oil contained. A 14-inch pipeline can store about 1,000 bbl per mile of pipeline length. Under static conditions, if oil were lost from a 5-mile stretch of this pipeline (a hypothetical distance between emergency block valves), a maximum of 5,000 bbl of oil could be discharged if the entire volume of oil in the segment drained from the pipeline.

Oil spills in 2006 and, most recently, December of 2008, have made the oil and gas industry, local, state, and federal regulators, and the public acutely aware of potentially widespread pipeline corrosion issues on the North Slope. On March 2, 2006, 6,357 bbl (267,000 gal) from a transit line in Prudhoe Bay spilled over approximately 2 acres of tundra – the largest spill in Prudhoe history (ADEC 2009; ADN 2006a). The cause of the leak was internal microbiological corrosion the pipeline (Bailey 2006). A one-quarter inch hole formed in the bottom of the pipeline in a section than had been buried under a caribou crossing. The snow covered the leak, causing delayed detection; ultimately, the odor exposed the leak to a worker. An ADEC report issued in April 2006 stated that spill alarms went off for 4 consecutive days in late February; however, the alarms were dismissed by operators monitoring the system as false (ADN 2006a). Crews recovered over 1,428 bbl (60,000 gal) of the spilled oil, and, after the $6 million cleanup was completed, ADEC estimated the tundra suffered minimal environmental damage (Loy 2006; ADN 2006a). BP Exploration Alaska, the Prudhoe Bay operator, had not pigged the pipeline that leaked to test for internal corrosion since 1998 (ADN 2006a).

Additionally, on March 9, 2006, spill responders found 12 bbl (500 gal) of oil water that had leaked from a gathering line in the Kuparuk unit and another 4.8 bbl (200 gal) were collected in a catch basin (Loy 2006). The cause of the leak was also determined to be holes caused by internal corrosion.

On August 6, 2006, BP announced that it needed to shut down the Prudhoe Bay field in order to address pipeline corrosion issues (Nelson 2006). A corrosion test detected a small leak in a transit line and the entire eastern operating area was completely shut in. In a response to the August 2006 shutdown, transit lines were pigged weekly and continuous corrosion inhibitor was added to the transit lines (Nelson 2007a). Undertaking a multi-year, $500 million project, BP replaced the 16-mile transit pipeline system in the Prudhoe Bay area (except for Lisburne), completing it in December of 2008 (Quinn 2009).

On December 19, 2006, 234,738 gallons of produced water and 150 bbl (6,300 gal) of crude were spilt at Gathering Center 2 (ADEC 2009). The loss was attributed to tank corrosion caused by mechanical failure. Misalignment of an agitation jet caused a hole to erode through the bottom of the tank. All of the oil was recovered (ADEC 2009). One to 2 gallons of produced water flowed through a hole in the containment liner to the gravel pad.

On Christmas day of 2008, a corroded water injection pipe at Kuparuk released 2,260 bbl (94,920 gal) of produced water (ADEC 2009). The spill sprayed nearly 3 acres of tundra with a light misting of oily water and contaminated 2 acres of gravel at the well pad (Bluemink 2009a).

After the 2006 spills, addressing issues of corrosion and pipeline monitoring became a state priority. Increased state and national awareness resulted in a number of changes in the public and private sectors. First, operators assert they are now monitoring corrosion more closely, including pigging transit and common carrier lines on a regular basis, and updating and strictly enforcing best industry standards for routine maintenance practices. The state has also examined pipeline corrosion issues closely and has expanded efforts to monitor and regulate both gathering and common carrier lines. ADEC promulgated new regulations regarding education, preparation for spills, and spill response; these regulations went into effect in December 2006.

On December 29, 2006, the “Pipeline Inspection, Protection, Enforcement, and Safety Act of 2006” (Pipes Act H.R. 5782) was signed into law. Under the Pipes Act, hazardous liquid pipeline operators are required to develop integrity management programs for transmission pipelines.

b. <u>Tankers</u>

Shallow nearshore waters prevent the use of tankers for transporting oil from the North Slope. However, Alaska’s most catastrophic spill is the March 1989 *Exxon Valdez* tanker spill, and no discussion of Alaska’s spill history is complete without its inclusion. The *Exxon Valdez* spill, the largest recorded in U.S. waters, spilled nearly 261,900 bbl. Oil from the *Exxon Valdez* contaminated fishing gear, fish, and shellfish; killed numerous marine birds and mammals; and led to the closure or disruption of many Prince William Sound, Cook Inlet, Kodiak, and Chignik fisheries (Alaska Office of the Governor 1989). Effects of oil spills on fish and other wildlife are discussed in Chapter Eight.

Large tanker spills include the 1987 tanker *Glacier Bay* spill of 2,350-3,800 bbl of North Slope crude oil being transported into Cook Inlet for processing at the Nikiski Refinery (ADEC 1988). Less than 10 percent of the oil was recovered, and the spill interrupted commercial fishing activities in the vicinity of Kalgin Island during the peak of the sockeye salmon run.

The oil spills from the *Glacier Bay* and the *Exxon Valdez* were not effectively contained, and the effectiveness of the cleanup efforts remains the subject of controversy. In the case of the *Glacier Bay* oil spill in Cook Inlet, cleanup was hampered by tidal currents and confusion concerning who would respond to the spill. In the *Exxon Valdez* oil spill in Prince William Sound, the sheer size of the spill quickly overtaxed available cleanup resources at a time when response plans had not been kept current. Although not on the scale of the *Exxon Valdez* spill, the *Glacier Bay* spill focused attention on oil spill response and cleanup capabilities in Cook Inlet.

Both incidents demonstrated that preventing catastrophic tanker spills is easier than cleaning them up and focused public, agency, and legislative attention on the prevention and cleanup of oil spills. Numerous changes were effected on both the federal and state levels. At the state level, new statutes created the oil and hazardous substance spill response fund (AS 46.08.010), established the Spill Preparedness and Response (SPAR) Division of ADEC, (AS 46.08.100), and increased financial responsibility requirements for tankers or barges carrying crude oil up to a maximum of $100 million (AS 46.04.040(c)(1)). Regulations and laws regarding oil spills are discussed later in this Chapter.

c. Alaska Risk Assessment of Oil and Gas Infrastructure

In May 2007, the Alaska Risk Assessment (ARA) project was launched. The purpose of the 3-year, $5 million initiative is to evaluate Alaska’s oil and gas infrastructure for its ability to operate safely for another generation. It is expected that oil and gas infrastructure on the North Slope and Cook Inlet, and the Trans-Alaska Pipeline, will be included (ADEC 2008).

The ARA will provide status of existing infrastructure, components, systems, and hazards. The likelihood and consequences of possible failures in Alaska's oil and gas infrastructure will be examined, and potential failures that could affect the reliability of the system or its ability to sustain production without unplanned interruptions, will identified and prioritized. Rankings will be based on consequences to state revenue, safety, and the environment. Mitigation measures will be recommended based on identified risks (ADEC 2008).

3. Oil Spill Prevention

A number of measures contribute to the prevention of oil spills during the exploration, development, production, and transportation of crude oil. Some of these prevention measures are presented as mitigation measures in Chapter Nine, and some are discussed in this Chapter. Prevention measures are also described in the oil discharge prevention and contingency plans that the industry must prepare before beginning operations. Thorough training, well-maintained equipment, and routine surveillance are important components of oil spill prevention. For example, changes in technology, experience, and regulation are attributed by the Alaska Oil and Gas Conservation Commission as reducing the number of blowouts in Alaska (ADN 2008).

Technical design of pipelines and other facilities reduces the chance of oil spills. As discussed in Chapter Three, Section F, national industry standards, and federal, state, and local codes and standards, help assure the safe design, construction, operation, maintenance, and repair of pipelines and other facilities. A quality assurance program with adequate inspection of the pipelines to identify any safety or integrity concerns; regular maintenance, including installing improved cathodic protection, and using corrosion inhibitors; and continuing regular visual inspections to ensure safe and reliable operation. If and when oil or gas is found in commercial quantities and production is proposed, final decisions on transportation will be made through the local, state, and federal application and permitting processes. Those processes will consider any required changes in oil spill contingency planning and other environmental safeguards, and will involve public participation.

The oil industry employs, and is required to employ, many techniques and operating procedures to help reduce the possibility of spilling oil, including:

- Use of existing facilities and roads;
- Water body protection, including proper location of onshore oil storage and fuel transfer areas;
- Use of proper fuel transfer procedures;
- Use of secondary containment, such as impermeable liners and dikes;

- Proper management of oils, waste oils, and other hazardous materials to prevent ingestion by bears and other wildlife;
- Consolidation of facilities;
- Placement of facilities away from fishbearing streams and critical habitats;
- Siting pipelines to facilitate spilled oil containment and cleanup; and,
- Installation of pipeline leak detection and shutoff devices.

a. Blowout Prevention

Each well has a blowout prevention program that is developed before the well is drilled. Operators review bottom-hole pressure data from existing wells in the area and seismic data to learn what pressures might be expected in the well to be drilled. Engineers use this information to design a drilling mud program with sufficient hydrostatic head to overbalance the formation pressures from surface to the total depth of the well. They also design the casing strings to prevent various formation conditions from affecting well control performance. Blowout prevention (BOP) equipment is installed on the wellhead after the surface casing is set and before actual drilling begins. BOP stacks are routinely tested in accordance with government requirements (BPX 1996).

Wells are drilled according to the detailed plan. Drilling mud and well pressures are continuously monitored, and the mud is adjusted to meet the actual wellbore pressures. The weight of the mud is the primary well control system. If a kick (sudden increase in well pressure) occurs, the well is shut-in using the BOP equipment. The BOP closes off and contains fluids and pressures in the annulus and in the drill pipe. Technicians take pressure readings and adjust the weight of the drilling mud to compensate for the increased pressure. BOP drills are performed routinely with all crews to ensure wells are shut-in quickly and properly. Rig foremen, tool pushers, drillers, derrick men and mud men all have certified training in well control that is renewed annually (BPX 1996).

If well control is lost and there is an uncontrolled flow of fluids at the surface, a well control plan is devised. The plan may include instituting additional surface control measures, igniting the blowout, or drilling a relief well. Regaining control at the surface is faster than drilling a relief well and has a high success rate. A blowout may bridge naturally due to the pressure drop across the formations. Under these conditions, reservoir formations flow to equalize pressure and the resulting bridging results in decreased flow at the surface. The exact mechanical surface control methods used depend on the individual situation. Operators may pump mud or cement down the well to kill it; replace failed equipment, remove part of the BOP stack and install a master valve; or divert the flow and install remotely-operated well control equipment (BPX 1996).

While operators consider mechanical surface control methods, they also begin planning to drill a relief well by assessing the situation and determining the location for the relief well. Additionally, logistical plans to move another drill rig to the site are necessary. Conditions may require the construction of an ice or gravel pad and road. The operator will look for the closest appropriate drill rig. If the rig is in use, industry practice dictates that, when requested, the operator will release the rig for emergency use. Arranging for and drilling a relief well could take from 10 to 15 weeks depending on weather, cause of the blowout, choice of surface location and depth of the well (BPX 1996).

b. Leak Detection

In warmer climates offshore pipeline leaks are often detected when workers spot an oil sheen on the water during routine flights to offshore platforms (MMS 2008, Vol. I, Chapter Four). The presence of ice in the Beaufort Sea makes this impractical for much of the year, requiring the use of technology to detect leaks quickly.

External pressure on pipe in deepwater applications may limit concern for subsea leaks; in most cases, seawater will flow into the pipe instead of oil leaking out (Scott and Barrufet 2003).

Leak detection systems and effective emergency shut-down equipment and procedures are essential in preventing discharges of oil from any pipeline that might be constructed in the proposed lease sale area. Once a leak is detected, valves at both ends of the pipeline, as well as intermediate block valves, can be manually or remotely closed to limit the amount of discharge. The number and spacing of the block valves along the pipeline will depend on the size of the pipeline and the expected throughput rate (Nessim and Jordan 1986). Industry on the North Slope has used the volume balancing method, which involves comparing input volume to output volume.

The technology for monitoring pipelines is continually improving. Leak detection methods have been categorized as hardware-based (optical fibers or acoustic, chemical, or electric sensors) or software-based (to detect discrepancies in flow rate, mass, and pressure) (Scott and Barrufet 2003). Leak detection methods include acoustic monitoring, pressure point analysis, ultrasound, radiographic testing, magnetic flux leakage, the use of coupons, regular ground and aerial inspections, and combinations of some or all of the different methods. The approximate location of a leak can be determined from the sensors along the pipeline. A computer network is used to monitor the sensors and signal any abnormal responses. In recent years, computer-based leak detection through a Real-Time Transient Model has come into use, to mathematically model the fluid flow within a pipe (Scott and Barrufet 2003). This technology can minimize spills from both new and old pipelines (Yoon and Mensik 1988).

Pressure Point Analysis (PPA) measures changes in the pressure and velocity of the fluid flowing in a pipeline to detect and locate leaks. PPA has successfully detected holes as small as 1/8-inch in diameter within a few seconds to a few minutes following a rupture (Farmer 1989). Automated leak detection systems such as PPA operate 24 hours per day and can be installed at remote sites. Information from the sensors can be transmitted by radio, microwave, or over a hardwire system.

Three systems can be employed that detect leaks down to 0.12 percent of rated capacity (100 bbl per hour). These include line volume balance, deviation alarms, and transient volume balance.

Line volume balance (LVB) checks the oil volume in the pipeline every 30 minutes. The system compares the volume entering the line with the volume leaving the line, adjusting for temperature, pressure, pump station tank-level changes, and slackline conditions.

There are three types of deviation alarms: pressure, flow, and flow rate balance. Pressure alarms are triggered if the pressure at the suction or discharge of any pump station deviates beyond a certain amount. Flow alarms are triggered if the amount of oil entering a pump station varies too much from one check time to the next. Flow rate balance alarms are triggered if the amount of oil leaving one pump station varies too much from the amount entering the next pump station downstream. This calculation is performed on each pipeline section about six times a minute.

Transient volume balance (TVB) can detect whether a leak may be occurring and identify the probable leak location by segment, especially with larger leaks. While the LVB leak detection system monitors the entire pipeline, the TVB system individually monitors each segment between pump stations. Because the TVB indicates in which area a leak may be occurring, focused reconnaissance, and earlier response mobilization are possible (Alyeska Pipeline Service Company 1999).

There are several other leak detection systems. Leck Erkennung und Ortangs System (LEOS) is a leak detection and location system manufactured by Siemens AG. The system has been in use for 21 years and in over 30 applications. LEOS consists of a three-layer gas-sensor tube that is laid next to the pipeline. The inner layer is a perforated gas transport tube of modified PVC (polyvinyl chloride). A diffusion layer of EVA (ethylene vinyl acetate) surrounds and allows gasses to enter the inner tube. A protective layer of braided plastic strips forms the outer layer. The tube is filled with fresh air, and the air is evacuated through a leak detector at regular intervals. If a leak occurs, hydrocarbon gasses associated with the leak enter the tube and are carried to the gas detector. The system is totally computer controlled, self-checking, and re-setting. Background gasses are calibrated at setup and checked regularly. The system will pick up previous contamination and organic decomposition. The location of the leak is determined by monitoring the time that leaked gas arrives at the detection device. The sensor allows determination of the size and location of the leak (NRC 2003). The system is very low maintenance and will last the life of the pipeline. Special protective adaptations are made if the system will operate in cold temperatures and for the backfill installation method used to install the pipeline. The tube is placed in a protective cover, and the system is tested continuously as the segments are installed. LEOS is strapped to the oil pipeline next to the poly spacers that separate the gas line from the oil line. The system detects leaks from both lines, and operators are able to tell the difference between the two. Engineers estimate that it takes about 5 to 6 hours for leaked molecules to migrate to the LEOS tube. The air inside the tube is evacuated and tested every 24 hours. LEOS is being used at Northstar (Scott and Barrufet 2003).

Design and use of “smart pigs,” data collection devices that are run through the pipeline while it is in operation, have greatly enhanced the ability of a pipeline operator to detect internal and external corrosion and differential pipe settlement in pipelines. Pigs can be sent through the pipeline on a regular schedule to detect changes over time and give advance warning of any potential problems. The Trans-Alaska Pipeline System operation has pioneered this effort for Arctic pipelines. The technique is now available for use worldwide and represents a major tool for use in preventing pipeline failures. Although some older pipelines cannot facilitate smart pigs, the PIPES Act of 2006 requires the development of integrity management programs for pipelines in high consequence areas. The Pipeline and Hazardous Materials Safety Administration has jurisdiction over cross-country pipelines. Basic requirements for an Integrity Management Plan include periodic integrity assessment of pipelines that could affect high consequence areas (HCAs). Integrity assessments are performed by in-line inspection (also referred to as “smart pigging”), hydrostatic pressure testing, or direct assessment. Through these assessment methods, potentially injurious pipeline defects that could eventually weaken the pipe, or even cause it to fail, are identified early and can be repaired, thus improving the pipe’s integrity.

The Forward Looking InfraRed (FLIR) pipeline monitoring program assists in detecting pipeline leaks and corrosion in the Kuparuk oil field. Originally developed by the military (NRC 2003), FLIR uses Infrared sensors to sense heat differentials. A leak shows up as a “hot spot” in an FLIR video, in both daytime and night time images (MMS 2008, Vol. I, Chapter Four**)**. In addition, water-soaked insulation surrounding a pipeline is visible because of the heat transfer from the hot oil to the water in the insulation and finally to the exterior surface of the pipeline. FLIR is also effective in discovering water-soaked insulation areas that have produced corrosion on the exterior wall of the pipeline (ARCO 1998).

FLIR also has applications in spill response. Infrared photography can be used to quickly and accurately determine the area of the spill, distinguishing between oil and substances that might look like oil to human eyes (NRC 2003). This allows swift and accurate reporting of the spill parameters to the appropriate agencies. The incident command team is able to receive information near real-time, and can therefore make timely decisions.

For the Northstar project, the pipeline is monitored on a continuous basis by the Supervisory Control and Data Acquisition (SCDA) system and operators are provided with real-time information on pipeline status. Both USDOT and MMS require SCDA for sub-sea pipelines. This system can detect changes in flow rate to 0.15 percent of daily flow volume. To obtain early warning of potential leak points, pipelines are checked periodically by inspection pigs. Visual surveys detect chronic leaks below the threshold of the SCADA system.

When initially proposed, the Liberty project included a 6.12 mile subsea pipeline from shore to an island site in 22 feet of water inside of Beaufort Sea barrier islands (including onshore pipe, the total length would have been 7.5 miles); the project has since been modified to drill from the Endicott Satellite Drilling Island. While the project will no longer feature a subsea pipeline, a study considering design alternatives for the project concluded that steel pipe-in-pipe designs have less risk of failure. The study found that spill risk was affected by water depth of the hazard, the failure mode (rupture, crack, pinhole), performance of the monitoring system, third-party activities, and operational failures. The study also considered hazards posed by ice gouging, strudel scour, permafrost thaw settlement, thermal loads leading to upheaval buckling, corrosion, operational failures, and third party incidents. It was presumed that Liberty would have been fitted with a pressure point analysis/mass balance line pack compensation monitoring system. PPA/MPLPC would detect a rupture or crack but not pinhole seepage – and confirm it within one minute. The operator would review the alarm, shutdown the pump, and isolate the line. Oil flow into the line would stop when Liberty's valves at shore and on the island were closed, which would have taken about 8.5 minutes. Oil would continue to leak until the crack or rupture is repaired and the line is purged of oil. The study found that steel pipe-in-pipe, with its secondary containment, posed less risk than other designs. The study also found that operational failures and third-party activities were the most significant hazards for all designs. Ice gouging frequency, subgouge soil displacement algorithms, strudel scour generation rates and size, corrosion, occurrence probabilities for thaw subsidence, and upheaval buckling were less sensitive risk parameters (Dinovitzer et al. 2004).

ARCO studied the use of vertical loops at Alpine in lieu of block valves and concluded that, in conjunction with emergency pressure let down valves or direct valves, vertical loops are better than manual block valves for reducing catastrophic failures. A vertical loop is an artificial high point in a pipeline. If pipe leaks, the vertical loop becomes the high point and the oil cascades from one vertical loop to the next, creating a vapor space and isolating the fluid on the uphill side from the leak (Cederquist 2000). BLM (BLM 2008c) reports that vertical loops greatly reduce the environmental effects on tundra, provide for a safer line, and lessen the probability of spillage due to river induced pipeline damage - and acknowledge the placement of a pipeline at depth beneath a river could make detection and cleanup of a spill in the buried segment difficult.

Autonomous Underwater Vehicles (AUVs) and Remotely Operated Vehicles (ROVs) offer new pipeline monitoring and spill response technology. AUVs and ROVs can carry out unmanned underwater investigations. AUVs can be equipped with video cameras and used to inspect subsea pipelines or survey the underside of ice to look for pooled oil. AUVs are currently limited to daylong missions but technological changes are expected to expand that timeframe to 6 months. ROVs are tethered to the surface, limiting their mobility, but they can transmit real time data. (Danielson and Weingartner 2007).

Research continues on remote sensing of spills in solid and broken ice conditions (ACS 2009b; MMS 2008, Vol. I). Alaska Clean Seas, the North Slope cleanup cooperative, has tested the use of Ground Penetrating Radar (GPR) to locate oil under solid ice; experiments in Norway have show GPR to be an effective tool (MMS 2008, Vol. I). In 2009 ACS intends to study the feasibility of using airborne GPR (ACS 2009b).

If pipelines were used in the development of the proposed lease sale area, operators would follow the appropriate American Petroleum Institute recommended practices. They would inspect the pipelines regularly to determine if any damage was occurring and would perform regular maintenance. Preventive maintenance includes installing improved cathodic protection, using corrosion inhibitors, and continuing regular visual inspections.

4. Oil Spill Response

By law, the responsible party (RP) is responsible for preventing and responding to oil spills, including notifying federal, state, and local authorities. ADEC regulations (18 AAC 75.400) require that oil companies prepare Oil Discharge Prevention and Contingency Plans. Plans must set forth measures designed to prevent spills and must have sufficient resources available to contain or control and clean up that occur. A key component of a plan is ready access to trained personnel and equipment. Spill preparedness and response practices are driven by the state's Unified Plan, the North Slope Subarea Plan, and the practices developed by the North Slope's oil spill response cooperative.

Regardless of the nature or location of a spill, the North Slope Subarea Plan sets these objectives for all response actions:

- Ensure safety of responders and the public.
- Stop the source of the spill.
- Deploy equipment to contain and recover the spilled product.
- Protect sensitive areas (environmental, historic properties, and human use).
- Track the extent of the spill and identify affected areas.
- Cleanup contaminated areas and properly dispose of wastes.
- Notify and update the public. Provide avenues for community involvement where appropriate. (ADEC 2007a)

a. Incident Command System

Oil spill responders are required to activate and use an Incident Command System (ICS) in the event of an actual or potential oil or hazardous material spill. The ICS system is designed to organize and manage responses to incidents involving a number of interested parties in a variety of activities. Because oil spills usually involve multiple jurisdictions, the joint federal/state response contingency plan incorporates a unified command structure in the oil and hazardous substance discharge ICS. The unified command consists of the Federal On-Scene Coordinator, the State On-Scene Coordinator, the Local On-Scene Coordinator, and the Responsible Party On-Scene Coordinator. The ICS is organized around five major functions: command, planning, operations, logistics, and finance/administration (ADEC 2007a).

The Unified Command jointly makes decisions on objectives and response strategies; however, only one Incident Commander is in charge of the spill response. The Incident Commander is responsible for implementing these objectives and response strategies. If the Responsible Party is known, the Responsible Party Incident Commander may remain in charge until or unless the On-Scene Coordinator with jurisdictional authority decides that the Responsible Party's response to the spill is unsatisfactory (ADEC 2007a).

b. Response Teams

The Alaska Regional Response Team (ARRT) monitors the actions of the Responsible Party. The Team is composed of representatives from 15 federal agencies and one representative agency from the state. The ARRT is co-chaired by the U.S. Coast Guard and Environmental Protection Agency. ADEC represents the State of Alaska. The team provides coordinated federal and state response policies to guide the Federal On-Scene Coordinator in responding effectively to spill incidents and has developed a Unified Plan (ARRT 1999). The Statewide Oil and Hazardous Substance Incident Management System Workgroup, which consists of ADEC, industry, spill cooperatives, and federal agencies, published the *Alaska Incident Management System* (AIMS) for oil and hazardous substance response

(ADEC 2006a). The ARRT has developed guidelines regarding wildlife, in-situ burning, the use of dispersants, and the protection of cultural resources, which include archaeological and historic sites (ARRT 1999). Each operator identifies a spill response team (SRT) for their facility, and each facility must have an approved spill contingency plan. Company teams provide on-site, immediate response to a spill event. The SRTs are integrated into the North Slope Spill Response Team (NSRT), comprised of 115 field responders per day. The North Slope operators who furnish the SRTs from their employee and contractor staffs have committed to make the SRTs available on a North Slope-wide basis for up to 72 hours upon call-out (Morris 2009b).

First, responders attempt to stop the flow of oil and may deploy booms to confine oil that has entered the water. The responders may deploy booms to protect major inlets, wash-over channels, and small inlets. Finally, deflection booming would be placed to enclose smaller bays and channels to protect sensitive environmental areas. If the nature of the event exceeds the facility's resources, the Responsible Party calls in its response organization. The Spill Response Team (SRT):

- identifies the threatened area;
- assesses the natural resources, i.e., environmentally sensitive areas such as major fishing areas, spawning or breeding grounds;
- identifies other high-risk areas such as offshore exploration and development sites and tank-vessel operations in the area;
- obtains information on local tides, currents, prevailing winds, and ice conditions; and,
- identifies the type, amount, and location of available equipment, supplies, and personnel.

The next action would be containment. It is especially important to prevent oil spills spreading rapidly over a large area. Cleanup activities continue as long as necessary, without any time frame or deadline.

c. Training

Individual members of the SRT train in basic spill response. Alaska Clean Seas, the North Slope's oil spill cleanup cooperative, offers dozens of classes in topics ranging from Incident Command to Fate and Behavior [of oil], Skimmer Types and Applications, Detection of Oil in Winter, and Behavior of Oil in Broken Ice. Alaska Clean Seas provides spill response training each week in 2 to 4 hour sessions to each of the North Slope Spill Response Teams (ACS 2009b). ACS has five labor categories (ACS 2008, Vol. I). Entry level General Laborers may have minimal or no experience and perform tasks associated with mobilizing, deploying, and supporting cleanup. Over time, each General Laborer will receive additional training and be brought to at least the next training level, Skilled Technicians. These Skilled Technicians receive specific training or experience in spill response; they operate skimmers and other equipment used to retrieve spilled oil. Team Leaders have additional responsibilities and may be charged with managing portions of a response. ACS's two remaining labor categories relate to Vessel Operation.

d. Response Organizations

Alaska Clean Seas (ACS) is an industry-sponsored, not-for-profit organization that provides the oil spill response function in support of petroleum-related activities on the North Slope and in the coastal and OCS waters off the coast of the North Slope of Alaska. The organization was originally established in Prudhoe Bay in 1979 under the name of ABSORB (Alaskan Beaufort Sea Oilspill Response Body) to support offshore exploration ventures in the Alaskan Beaufort Sea. In 1990, ACS owner companies expanded the mission to include response operations both offshore and onshore. Member companies pay an initiation fee and annual fee, daily rig fees when engaging in drilling, and annual production fees for facilities in production (ACS 2009b).

The operating area includes the North Slope, the Alyeska Pipeline from Pump Station 1 to Milepost 167, and Beaufort Sea nearshore and select OCS waters. Members include Alyeska Pipeline Service Company, Anadarko Petroleum Corporation, BP Exploration (Alaska) Inc., Brooks Range Petroleum Corporation, Chevron, ConocoPhillips Alaska Inc., Eni Petroleum, ExxonMobil Production Company, FEX L.P., Pioneer Natural Resources (USA), and Shell Exploration and Production Company (ACS 2009b).

i. ACS Responders and Mutual Aid Agreements

Members may call upon ACS for assistance with both spill planning and response. Members may also engage in Mutual Aid Agreements with other ACS members, providing each other with shared resources, both personnel and equipment, in the event of a spill. ACS provides manpower and equipment resources from its main base in Deadhorse and from within each of the operating oilfield units to assist in spill containment and recovery. ACS has 76 full time staff on the North Slope and in Anchorage; about half of ACS' employees and contractors are located on the North Slope and all are available for response operations. Including trained volunteers, ACS has available a minimum of 115 spill response personnel on the North Slope each day (ACS 2009b).

ACS personnel are on call 7 days a week, 24 hours a day while they are on-shift. The time necessary to arrive at a spill site with the appropriate equipment depends on a number of variables. As a general guide, immediate response to small spills in the nearshore area of the Beaufort Sea will be available within the first few hours using pre-staged response resources and personnel from within the responsible party's unit. With offshore boom, vessels, and skimmer systems pre-staged at West Dock, an offshore first-response task force consisting of ACS personnel and equipment could be on site within hours of notification, depending on weather conditions. In the event of a catastrophic spill requiring full mobilization of North Slope resources, oil spill response barges would be equipped and placed into service to assist with containment, recovery, transfer, and lightering operations.

North Slope operating companies coordinate with ACS to ensure a pool of trained personnel is available for an extended response. Over 500 trained employees, contractors, and ACS-trained Village Response Teams are available for response, with a minimum of 115 trained responders immediately available on a daily basis via mutual aid agreements. All on-shift members of the North Slope Spill Response Team (NSSRT) are available for call-out. ACS also manages existing contracts with several spill response and service contractors. Contracted response services include labor and equipment, aviation support, telecommunications services, and computerized mapping (ACS 2008, Vol. I). ACS has 76 full time staff on the North Slope and in Anchorage (ACS 2009b); about half of ACS' employees and contractors are located on the North Slope and all are available for response operations. ACS has available a minimum of 115 spill response personnel on the North Slope each day (ACS 2009b).

ACS trains North Slope village teams to support oil spill response capability. Intensive training courses for village team members include winter and summer oil spill operations, hazardous waste operations, oil spill post-emergency response, oil spill assessment, tracking and detection of oil, skimmer operations, incident command, and basic radio voice procedures. The teams take part in field exercises and the annual North Slope mutual aid response exercises. While ACS does not clean up spills in the villages, the village responders have the training to do so.

ii. Initiation of the Incident Management Team

Response actions vary greatly with the nature, location, and size of the spill. General response activities may include:

- Locate and stop the spill if possible;
- Estimate the spill amount, determine the substance's chemistry, and estimate the trajectory;

- Determine what equipment would most effectively recover spilled oil;
- Mobilize appropriate equipment to confine spilled oil or to protect especially sensitive areas from oiling; and,
- Assess the damage to oiled areas, develop a plan for cleanup, and implement it.

Response equipment might include boats, earth-moving equipment, airplanes, helicopters, boom, skimmers, sorbents, and in-situ burning equipment. The responsible party and its contractors usually perform response activities with assistance and monitoring by federal and state agencies.

iii. Equipment

ACS has purchased and maintains a spill response equipment inventory valued in excess of $25 million and ACS members have built corresponding inventories capable of meeting the immediate response needs of their respective units, bringing the value of inventory to $50 million. This equipment is designed to respond to spills within the defined area of operations, under all environmental conditions. Members share resources in the event of a significant spill within any of the North Slope operating units. To assist with this task, ACS manages the combined inventory of all dedicated North Slope spill response assets in a single, computerized maintenance and job order system (ACS 2008, Vol. I). Additional equipment and trained personnel are available through ACS' agreements with contractors or master services agreements.

Spill response equipment warehouses, storage yards, and satellite areas are strategically located in each operating field and at three separate locations in Deadhorse (ACS 2009a). With assistance from ACS Base, field assigned ACS technicians support the operating area facilities and sites, while the Deadhorse locations are managed by ACS Base personnel. ACS Base in Deadhorse contains a small Emergency Operations Center for use by the member companies. Emergency Operations Centers are also located at Alpine, Kuparuk, Milne Point, and the Prudhoe Bay Operations Center and are available through the Mutual Aid Agreement (ACS 2009b). Mobile facilities are also available.

Major equipment assets owned by ACS and its member companies (ACS 2009b):

- Over 287,000 feet of oil containment boom, plus about 19,000 feet of fire boom;
- 185 skimmers, which may remove 7,301 bbl/hour of spilled oil;
- 8 helitorch aerial ignition systems;
- 96 vessels;
- 2 128-barrel and 12 249-barrel mini-barges; and one 650-barrel barge;
- Various sizes of storage tanks and bladders;
- Wildlife hazing and stabilization equipment;
- Pumps, powerpacks, and support equipment specifically designed to augment spill response;
- Telecommunications system that supports both day-to-day and spill response, including three mobile command centers with full radio, phone, and fax capabilities;
- Contracts with off-slope companies to provide over 300 additional, qualified spill responders;
- A small Emergency Operations Center at ACS' base in Deadhorse, plus Emergency Operations Centers at Alpine, Kuparuk, Milne Point, and Prudhoe Bay Operations Center;
- Specialized equipment to conduct alternative response measures, including conducting in-situ burning operations; and

Courtesy Alaska Clean Seas

Alaska Clean Seas oil spill drill.

- Mobile facilities and support equipment for the capture, cleaning, and rehabilitation of oiled birds.

Within the state of Alaska, there are other spill response organizations, each with their respective areas of operation and commitment. Cook Inlet Spill Prevention and Response, Inc. (CISPRI) in the Cook Inlet and Alyeska Pipeline's SERVS (Ship Escort Response Vessel System) in Prince William Sound are two of the major Alaskan organizations with which ACS has developed close working relationships to facilitate immediate support of a major spill response effort anywhere within Alaska. Should it become necessary, ACS can request additional equipment from these other cooperatives and industry sources (ACS 2008, Vol. I).

ACS established a central Incident Command Post at Deadhorse as a control point for oil spill response radio and telephone systems for the entire North Slope area, extending into the Beaufort Sea. This radio and telephone communications system is capable of being rapidly deployed by sea, land, or air to local and remote areas in support of onshore or offshore oil spill response actions. Remote control circuits for 14 permanent Very High Frequency (VHF) repeaters and marine coast stations, installed at strategic locations in the production area and pipeline corridor, are routed via private microwave circuits into the system (ACS 2008, Vol. I). Other High Frequency (HF) and Ultra High Frequency (UHF) radios are also connected to the system. Communication is then possible among all users, whether marine-based radios, company headquarters or supply depots, ICP, hand held portable radios, or aircraft radios. This gives each member company access to all of the radio systems, regardless of the type of radio it is using. ACS also has mobile VHF and UHF radios, base and mobile stations, satellite telephones with data capabilities, and portable repeaters for field use in its oil spill response program (ACS 2008, Vol. I).

Other operational equipment includes INMARSAT satellite telephone systems, operating independently of wires and separate from the VHF, UHF, and other radio systems, at Deadhorse on the

North Slope. The name INMARSAT is derived from "international, marine, satellite." The system can reach anywhere in the world via satellite. An INMARSAT system can be mounted on a boat, in such a way that, regardless of heavy seas or other disturbance, the antenna beam cannot be shaken off the satellite and communication disconnected. Ships, barges, aircraft, oil spill response agencies, ground personnel, and anyone with a telephone can be reached via this system.

iv. Response

ACS and the North Slope operators employ a "tiered system" for responding to spills. Small, non-emergency spills are cleaned up by the Operator or ACS personnel. Spills requiring the resources of ACS and the responsible party's SRT are considered Tier I spills. If a spill requires more than the resources of ACS and the responsible party (RP), it is considered a Tier II spill. Other North Slope operators share their resources, both personnel and equipment. Mutual aid is a system that utilizes SRTs from companies other than that of the responsible party. Such spills usually require some longer-term cleanup.

An extremely large spill or an incident lasting several months may require resources available off the North Slope and is classified as a Tier III spill. ACS may enlist assistance from spill responders from Cook Inlet (CISPRI) and Prince William Sound (SERVS) or from its subcontractors (Master Service Agreements) (ACS 2009b), as well from across the U.S. and other countries (ACS 2008, Vol. I). Response strategies are set forth in ACS' Technical Manual, providing specific scenarios for environmental and seasonal conditions found on the North Slope.

v. Research and Development

Building on studies done regarding Arctic oil spill response, ACS wrote a technical manual for spill response on the North Slope and Beaufort Sea (ACS 2008, Vol. I, II, III). The three-volume manual was revised in 2008. The manual and the background documents supporting it are a compilation of the latest research and best available technology regarding oil spill response in the Arctic. The response tactics in the manual are designed to be used as building blocks for operators to prepare facility-specific response scenarios in their oil discharge prevention and contingency plans. The manual describes key response planning parameters for a variety of climatic and environmental conditions that may be encountered. It is intended to provide direction and consistency in developing generic scenarios for a variety of receiving environments, and eliminate the need for individual plans to repeat technical details. The manual consists of three volumes: Tactics Descriptions, Map Atlas, and North Slope Incident Management System and will augment the C-plans that each operator must prepare before beginning operations. The manual represented a major advance in the organization and coordination of spill response planning and preparedness on the North Slope. The reader is referred to the Technical Manual for a thorough description of response activities.

ACS acts as a facilitator for much of the research and development related to responding to spills in the Arctic. Research focuses on recovery techniques in, on, and under ice, and during various broken ice conditions, as well as viscous oil pumping, detecting and tracking oil under ice, and alternative response options (ACS 2009b). ACS also manages research and development projects for BP Exploration (Alaska), Inc., and ConocoPhillips Alaska, Inc., to meet the requirements to the Charter for Development of the Alaskan North Slope commitment to the State of Alaska. Over 10 years an average of $200,000 annually will be devoted to Arctic spill response research and development. ACS is considered an industry leader in the research of in-situ burning techniques and in-situ burning of emulsified oil (ACS 2009b).

ACS recently completed or is currently engaged in research projects (ACS 2009b):

- Testing Ground Penetrating Radar (GPR) to detect oil in and under snow and ice and is considering testing airborne deployment.

- Participating in a multi-year research and development project by SINTEF to test mechanical and non-mechanical responses to spills in ice, providing fire boom for field testing and expertise to the Mechanical Recovery Working Group, In-Situ Burn Working Group, and Generic Contingency Plan Working Group.
- Completed "Produced Water Spills on the North Slope of Alaska, An Experimental Design for Winter Cleanup" plan. Seawater spills can injure fragile Arctic tundra, but cleanup measures may also damage tundra. The test plan was developed to help determine the pH levels of salt concentrations that would not cause unacceptable injury to the underlying tundra.
- Completed the "Winter Crude Oil Releases on the North Slope Snow Covered Tundra, An Experimental Cleanup Strategy" plan, to help develop cleanup standards for lightly oiled snow.
- Joined in a project to test new high volume oleophilic skimmers, which recover smaller quantities of water, thus decreasing the need for storage of recovered oil and water.

Research and development projects proposed for 2009 include:

- Continuation of research and development Program for Oil Spill Response in Ice Infested and Arctic Waters
- Continuation of High Volume Oleophilic Skimmer Tests
- Airborne Ground Penetrating Radar
- Nuclear Magnetic Resonance
- Improving Methods for Recovering Residues from In-Situ Burning of Marine Oil Spills
- Tundra Treatment Guidelines Update
- Suitcase Remote Sensing.

e. <u>Geographic Response Strategies</u>

A component of the state's spill contingency plans, Geographic Response Strategies (GRS) provide priorities and response strategies for the protection of selected sensitive areas to assist first responders to an oil spill. The GRS are intended to list the sensitive resources of a particular area and the response tactics, equipment, personnel, and logistical information necessary to protect these sensitive resources. The North Slope Subarea does not presently have any official GRS. Instead, the subarea plan relies on Alaska Clean Seas' *Technical Manual,* which presents ACS' maps of priority protection sites. ACS has mapped sites from Point Hope east to the Canadian border (ACS 2008, Vol. II).

In the example included in Figure 6.4, for an area at Prudhoe Bay, ACS identifies two priority protection sites and the times of year those areas are most sensitive. It also identifies general sensitivities, air access, vessel access and hydrographic conditions, countermeasure considerations, and the location of staging areas and pre-staged equipment.

Sensitivity Information

PRIORITY PROTECTION SITES

SITE NO.	DESCRIPTION	SENSITIVITY	TACTIC	EST. BOOM
PS10	Creek mouth north of LGI	Most sensitive during open water season. Inundated low-lying tundra shoreline.	C-13 or C-14	100'
PS11	Tidal inlet, west side of West Dock base	Most sensitive during open water season, when oil could drift into inlet. Inundated low-lying tundra shoreline.	C-13 or C-14	1,000'

GENERAL SENSITIVITIES

- Coastal areas support high concentrations of breeding, nesting, brood-rearing, and molting waterbirds during the summer.
- Concentrations of swans, ducks, geese, and shorebirds are present here in June before open water is present elsewhere.
- Shoreline and offshore areas support molting Oldsquaws and elders, and brood-rearing elders. This is also a staging area for migrating Phalaropes (shorebirds). Birds are present in June through September.
- High concentrations of brood-rearing and molting Snow Geese are present in July and August.
- This is a Brant nesting, brood-rearing, and molting area. Birds are present from May through August.
- Pairs of Spectacled Elders have been found in this area.
- Plan to deploy bird-hazing systems during the open-water season.

ACS Tech. Manual Vol. 2, 12/03 *NOTE: All values given on these pages are for planning purposes only.*

-continued-

Figure 6.4. ACS priority protection site at Prudhoe Bay.

Response Considerations

AIR ACCESS*

- Deadhorse airport (Sheet 78) is located approximately 10 miles south of LGI.

VESSEL ACCESS* AND HYDROGRAPHIC CONDITIONS

- Outer portions of Prudhoe Bay have water depths of 6 to 9 ft and afford good holding anchorage with protection from all but northwest winds. Inner bay has shoals across most of the entrance, with water depths of 2 to 6 ft.
- The best marine access route to Prudhoe Bay parallels the west shore at a distance of 0.4 mile and has depths of 4 ft.
- There are boat launches at West Beach State and at the south end of West Dock.
- There is high sediment transport in westerly direction along shore due to Sagavanirktok River discharge.
- Eddies and reduced current velocities in Prudhoe Bay cause extensive shoaling and migration of barrier islands.

COUNTERMEASURES CONSIDERATIONS

- Sand-gravel beaches on the interior of Prudhoe Bay are quite narrow and interrupted by vegetated shorelines, making large machinery impractical.

STAGING AREAS AND PRESTAGED EQUIPMENT

- The West Dock Staging Pad is a staging area.

PRESTAGED EQUIP. AREA	LOCATION	ITEM	QUANTITY	TYPE
EOA-3	West Beach State	Boom Anchor System	2,000' 1	8" x 6" river

*See the latest *Supplement, Alaska* and United States Coast Pilot for current information on air and vessel access, respectively.

NOTE: All values given on these pages are for planning purposes only.

-continued-

Figure 6.4 Page 2 of 3.

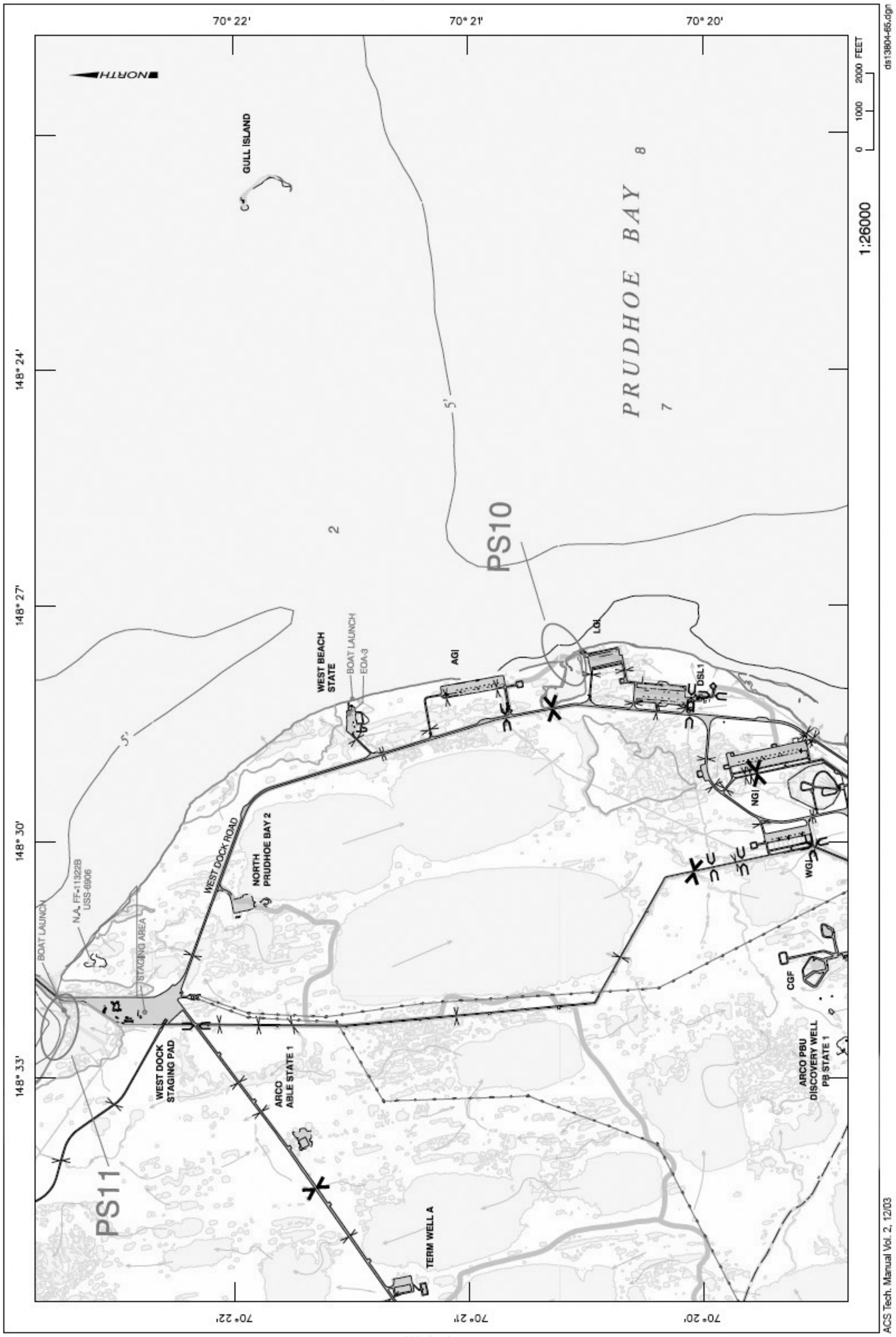


Figure 6.4 Page 3 of 3.

5. Cleanup and Remediation

The state's priorities for oil spill response are

- Safety of all persons involved in the spill;
- Protecting public health from contamination of drinking water, air, and food;
- Protecting the environment, natural and cultural resources, and biota from direct and indirect effects of contamination;
- Ensuring adequate containment, control, cleanup, and disposal by the responsible party, leading to the state assuming control of the incident, if necessary;
- Assessing contamination and damage and restoration of property, natural resources, and the environment; and
- Recovering costs and penalties (ADEC 2007a).

Cleanup plans, regardless of the location and nature of the spill, must balance the objectives of maximizing recovery and minimizing ecological damage. Many past cleanup operations have caused as much or more damage than the oil itself. All oils are not the same, and knowledge of the chemistry, fate, and toxicity of the spilled oil can help identify cleanup techniques that can reduce the ecological impacts of an oil spill. Hundreds of laboratory and field experiments have investigated the fate, uptake, toxicity, behavioral responses, and population and community responses to crude oil.

Plans must also address the complications of working in the Arctic–extreme cold, ice, and darkness. The North Slope/Beaufort Sea can present extremes that might make it difficult to effectively contain and clean up a major spill. Cold-weather, in particular, can challenge both personnel and machinery. Conversely, ice and snow can act as natural barriers and facilitate cleanup (ADEC 2007a). However, spills that occur during the summertime risk impacting the diverse species that use North Slope habitats. Plans address specific steps to accommodate these conditions. The effects on the sensitive environments of the region could be severe if they are not mitigated.

a. <u>**Fate and Behavior of Spilled Oil**</u>

Quick response and recovery greatly affect the efficacy of any spill cleanup. After a spill, the physical and chemical properties of the individual constituents in the oil begin to be altered by the physical, chemical, and biological characteristics of the environment; this is called weathering–spreading, evaporation, dispersion, dissolution, and emulsification (BLM 2008b, Vol. II, Chapter IV). Oil spreads quickly, with wind waves and water turbulence being principal factors (Doyle et al. 2008). Evaporation allows lighter components of oil to evaporate; evaporation increases as oil spreads and in rougher seas and higher temperatures. Dispersion occurs when waves and turbulence break up the oil slick into droplets and smaller slicks. Droplets may remain in the water column or rise to the surface and combine with other droplets to form a new slick. Emulsification occurs when oil and another liquid (seawater) combine, with seawater suspended within the oil; turbulence promotes emulsification. The resulting emulsion is viscous and more persistent than the original oil. Dissolution is the process wherein water soluble compounds dissolve into water. The passage of time before the start of recovery allows oil to spread, expanding the affected area and thus requiring more response resources. The longer the oil remains exposed to the elements the more weathered it becomes, making it more viscous and more likely to form water in oil emulsions that can limit the effectiveness of skimmers, increase on-water storage requirements, and negatively impact the oil's ability to burn (MMS 2008, Vol. I, Chapter Four).

Upland spills follow topography; oil flows downhill. If released to tundra, summertime spills penetrate soil and foul tundra. Wintertime spills may be constrained, or facilitated, by snow and ice.

Oil on water spreads and quick intervention is critical. The fate and behavior of oil spilled in the Beaufort Sea could be affected by the presence or developing presence of ice. Evaporation is the only significant weathering process at the time of freeze-up. Oil under ice may be trapped, or encapsulated, and will not evaporate; as ice melts in the spring, the oil rises to the surface and, if the ice moves, oil will appear at a different location than the spill (NRC 2003). Broken ice promotes emulsification more rapidly than open water (NRC 2003). Ice can also prevent oil from spreading.

The factors that are most important during the initial stages of cleanup are the evaporation, solubility, and movement of the spilled oil. As much as 40 percent of most crude oils may evaporate within a week after a spill. Over the long term, microscopic organisms (bacteria and fungi) break down oil (Jorgenson and Carter 1996). Understanding these processes is critical to decisions about cleaning spilled oil.

b. Cleanup Techniques

The best techniques are those that quickly remove volatile aromatic hydrocarbons. This is the portion of oil that causes the most concern regarding the physical fouling of birds and mammals. To limit the most serious effects, it is desirable to remove the maximum amount of oil as soon as possible after a spill. The objective is to promote ecological recovery and not allow the ecological effects of cleanup to exceed those caused by the spill itself. Table 6.6 lists cleanup objectives and techniques that may be applicable to each objective. Table 6.7 compares the advantages and disadvantages of cleanup techniques for crude oil in terrestrial and wetland ecosystems (Jorgenson and Carter 1996).

Cleanup phases include initial response, remediation, and restoration. During initial response, the responsible party: gains control of the source of the spilling oil; contains the spilled oil; protects the natural and cultural resource; removes, stores and disposes of collected oil; and assesses the condition of the impacted areas. During remediation, the responsible party performs site and risk assessments; develops a remediation plan; and removes, stores, and disposes of more collected oil. Restoration attempts to re-establish the ecological conditions that preceded the spill and usually includes a monitoring program to access the results of the restoration activities (Jorgenson and Carter 1996).

Spill recovery techniques are generally considered mechanical (e.g., boom and skimmers) or non-mechanical (in-situ burning and dispersants); one or more techniques may be used together. The location of the spill–open water, protected water, on land, wetlands, broken ice–and weather are critical factors determining the techniques employed. ACS’ Technical Manual examines North Slope/Beaufort Sea ecosystems and presents cleanup tactics for each (ACS 2008).

Containment booms used in conjunction with skimmers are the most commonly used mechanical method for removing oil from water. Booms float on water and corral the oil and then skimmers are used to remove the concentrated oil. Some booms have been adapted for use in icy waters (NRC 2003). Skimmers of choice for arctic waters are oleophilic brush, rope mop, or drum/disc skimmers (MMS 2008, Vol. I, Chapter Four) that collect oil when it adheres to the surface of the brush or rope. Oil is then scraped off into a sump and pumped to a storage tank. These skimmers efficiently recover oil while limiting the amount of water collected, extending on-water storage. Containment and recovery may be slow and may not remove all the oil.

Table 6.6. Objectives and techniques for cleaning up crude oil in terrestrial and wetland ecosystems.

Objectives	Cleanup Techniques
Minimize:	
Movement of oil	Absorbent booms Sand bagging Sheet piling
Surface-water contamination	Same as above
Soil infiltration	Flood surface
Soil and vegetation contact and oil adhesion	Flood surface Use surfactants to reduce adhesion
Vegetation damage	Use boardwalks to reduce trampling Use flushing instead of mechanical techniques Perform work when vegetation is dormant
Thawing of Permafrost	Avoid vegetation and surface disturbance
Wildlife contact with oil	Fencing to prevent wildlife from entering site Plastic sheeting to prevent birds from landing on site Guards to haze wildlife Devices to haze wildlife
Acute and chronic toxicity of oil to humans, fish, and wildlife	Removal of oil Enhance biodegradation of remaining oil
Waste disposal	Use flushing Avoid absorbents and swabbing
Cost	Remove oil as fast as possible Achieve acceptable cleanup level quickly to minimize monitoring
Liability	Achieve acceptable cleanup level
Maximize:	
Recovery potential of tundra ecosystems	All of the above Add nutrients to aid recovery of plants
Worker safety	Air testing, training, clothing

Source: Jorgenson and Carter 1996.

Table 6.7. Advantages and disadvantages of techniques for cleaning up crude oil in terrestrial and wetland ecosystems.

Technique	Advantage	Disadvantage	Recommended
Wildlife			
Fencing	Keeps out large mammals	Does not keep out birds	Yes
Plastic sheeting	Keeps out both birds and mammals	Can no longer work area	Sometimes
Wildlife guard	Flexibility to respond	Higher cost	Sometimes
Devices	Lower cost	Animals become habituated	No
Containment			
Absorbent booms	Contains floating oil, quickly deployed	Misses water soluble oil	Yes
Sand bags	Contains both floating and soluble fractions, follows tundra contours	Slower to mobilize, some leakage	Yes
Sheet piling	Maximum containment	Slow to install, doesn't fit contours well	Sometimes
Earthen berms	Can easily be adapted to terrain, heavy equipment rapidly can create berms	Destroys existing vegetation and soil	No
Snow/ice berms	Can be used during winter cleanup or to prevent runoff during breakup	Can only be used during freezing periods	Yes
Contact			
Flooding	Keeps heavy oil suspended	Spreads out oil	Yes
Surfactants	Reduces stickiness, aids removal, and reduces volatilization	Reduces effectiveness of rope mop skimmer	Yes
Thickening agents	Untried, aids physical removal	Must be well drained, physical removal more difficult	No
Access			
Boardwalks	Reduces trampling	None	Yes
Removal			
Complete excavation	Eliminates long-term liability	Eliminates natural recovery, disposal costs	Sometimes
Partial excavation	Quickly reduces oil levels, less waste to dispose of than complete excavation	Causes partial ecological damage, disposal costs, still long-term liability	Sometimes
Burning	Low cost, high removal rate	Little testing, ecological damage	Sometimes
Flushing, high pressure	High removal rate	High ecological damage	No
Flushing, low pressure, cold	Moderate removal rate, little damage, easy waste disposal	Spreads oil, not as effective as warm water	No
Flushing, low pressure, warm	High removal rate, little vegetation damage, easy disposal of waste	Spreads oil	Yes
Aeration	Accelerates volatilization	Volatiles lost to air, may pose risk to humans	Yes
Raking	Can target hot spots	Partial vegetation damage	Sometimes
Cutting and trimming	Targets hot spots, reduces stickiness	Partial vegetation damage	Sometimes
Swabbing	Targets hot spots	Not very effective, adds to waste disposal, adds to trampling	No
Oil skimmers and rope mops	Removes heavier oil, works well with flooding, lowers disposal costs	Requires personnel to push oil to skimmer, adds to trampling	Yes
Vacuum pumping	Removes surface and miscible oil, works well with flooding, lowers disposal cost	None	Yes
Biodegradation	Removes low levels of hydrocarbons, non- destructive, lowers disposal costs	Long-term monitoring, site maintenance, may require wildlife protection	Yes

Source: Jorgenson and Carter 1996.

Dispersants and in-situ burning are non-mechanical techniques. Dispersants chemically treat oil while it floats on the water surface. Dispersants do not remove the oil, but break it into very small droplets that mix into the upper water column, promoting rapid degradation. In Alaska dispersants are only used to clean up on-water spills (ADEC 2006b) and are not used on broken or solid ice. Use of dispersants must be approved in advance in certain coastal areas, by the Unified Command and by the EPA. Choosing dispersants as a recovery technique is influenced by water depth and distance from the shoreline; its use usually is not permitted in areas where the water depth is less than 10 meters (MMS 2008, Vol. I, Chapter Four). ACS and the North Slope operators do not store dispersants or application equipment on the North Slope, because offshore activities to date have occurred in shallow nearshore waters (MMS 2008, Vol. I, Chapter Four).

In-situ burning involves collecting or concentrating oil, performing a controlled burn, and then removing the residue. It is most effective when used early in the cleanup process, before oil has emulsified. On open water, this technique may involve special booms, igniting agents, and methods to deliver them. Burning can be effective in the Arctic, where ice may help contain a spill. ADEC's revised burning guidelines function as ARRT's policy on in-situ burning and present the required Federal and State On-Scene Coordinators approval process (ADEC et al. 2008). MMS considers in-situ burning the preferred method of non-mechanical response for icy waters (MMS 2008, Vol. I, Chapter Four).

Burning rapidly removes oil from the environment, particularly when compared to shoreline cleanup activities that may take months or even years. The principle disadvantages of using in-situ burning are smoke plumes and the narrow timeline associated with it. Oil is most volatile before it evaporates or emulsifies, so waiting too long makes in-situ burning ineffective. Burning may also leave toxic residues. If they sink, they may be ingested by the species that use the waters. However, residue cools slowly, allowing time to recover it (ADEC et al. 2008). Samples collected after the Newfoundland Offshore Burn Experiment were tested for toxicity to three aquatic species. Neither the residue nor the oil was toxic and the burn residue was no more toxic than the oil itself (ADEC et al. 2008). ADEC's guidelines require that approved burns have a plan for residue collection.

Ice, present in the nearshore Beaufort Sea for over 280 days of each calendar year, may both facilitate and constrain cleanup. Broken ice, ice coverage of more than 10 percent and wave height of less than 1 foot, may hinder the use of containment boom, leading to boom failure and the likelihood of loss due to ice encounters (ADEC 2006b). In an oil spill under the ice, oil can be absorbed within the ice matrix. Landfast ice is mobile, so ice may melt or breakup far removed from the location where the oil was entrained, releasing the oil in the new location (Danielson and Weingartner 2007). Oil spilt during freeze-up or break-up may be particularly difficult to clean up (ADEC 2007a). ACS, the industry's oil spill cleanup cooperative, continues to participate in research on effective cleanup in and on ice (ACS 2009b).

The North Slope Borough has discouraged development in the Beaufort Sea because of its concern about risks to subsistence and its concern that there are insufficient resources and technology to stop, recover, and cleanup an offshore spill at any time of year (NSB 2005). In its 2005 Background Report for NSB's Comprehensive Plan, the North Slope Borough disagreed with findings, like the ones contained here and in MMS's most recent DEIS for the Beaufort Sea (MMS 2008), about the behavior of spilled oil in and on ice and broken ice and industry's ability to contain and clean up a spill. Specifically, the borough disagreed that

- Spills onto ice would be prevented from spreading rapidly by snow and ice roughness;
- Spills in broken ice conditions would not spread as rapidly as on open water; and
- Oil leaks under nearshore sea ice would likely not spread until breakup due to slow under ice currents (NSB 2005).

The borough expressed concerned that under-ice currents would impact the spread of oil and that ice would substantially limit boat-based cleanup. The borough said there have been no oil spill recovery techniques that have been effectively designed or tested to clean up oil in spring broken ice conditions, fall freeze-up conditions, or under solid ice and that resources and technology to stop, recover, and clean up an oil spill in an offshore environment are lacking. The borough expressed concern about the lack of an ice-breaking barge on the North Slope for oil spill response and stated there are limited resources and techniques available for handling under-ice spills. The borough's concerns led it to suggest that development activities, particularly drilling, be seasonally limited to avoid certain conditions (offshore during broken ice, freeze-up and slush ice; under ice in frozen conditions; and onshore during summer, unless drilling occurs on an onshore gravel pad) (NSB 2005).

It is possible that some of the borough's concerns will be alleviated by technological advances in monitoring and constructing pipelines (see Sections F(2)(a) and F(3)(b)) and ongoing oil spill response research and development studies (see also Section F(4)(d)(v)). These projects have studied oil and ice interactions over the last 30 years. Beginning with the research conducted offshore in the Canadian Beaufort Sea and followed by projects in the Alaskan and Norwegian Arctic, scientists and responders have studied oil behavior and developed and tested methods and tools to mitigate the effects of an oil spill in, on, or under ice. Arctic spill research projects have explored, under various ice conditions, aspects including oil weathering characteristics, spreading under ice, encapsulation and migration, remote sensing, trajectory modeling, and the testing of in-situ burning, dispersants, and conventional containment and recovery equipment (ACS 2009b).

State regulations require that operators be able to mechanically entrain and recover, within 72 hours, a response planning standard (RPS) volume of oil (18 AAC 75.434). For exploration facilities, the RPS is a minimum of 16,500 bbl plus 5,500 bbl for each of 12 days beyond 72 hours. For production facilities, the RPS is, at a minimum, 3 times the annual average daily production for the maximum producing well at the facility. If well data demonstrate a lower RPS is appropriate, it may be adjusted accordingly. Conventional booms and skimmers have difficulty working efficiently among the broken ice (ADEC 2007b). MMS is providing funding for a multi-national industry/government sponsored oil in ice response test in Norway which will provide additional data on spill responses in broken ice conditions (MMS 2008, Vol. I, Chapter Four).

6. Regulation of Oil Spill Prevention and Response

a. <u>Federal Statutes and Regulations</u>

Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 USC § 9605), and §311(c)(2) of the Clean Water Act, as amended (33 USC §1321(c)(2)) require environmental protection from oil spills. CERCLA and the Clean Water Act require a National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR §300; 33 USC § 1321(d)). Under these regulations, the spiller must plan to prevent and immediately respond to oil and hazardous substance spills and be financially liable for any spill cleanup. If the pre-designated Federal On-Scene Coordinator (FOSC) determines that neither timely nor adequate response actions are being implemented, the federal government will respond to the spill, and then seek to recover cleanup costs from the responsible party.

The Oil Pollution Act of 1990 (OPA 90) requires the development of facility and tank vessel response plans and an area-level planning and coordination structure to coordinate federal, regional, and local government planning efforts with the industry. OPA 90 amended the Clean Water Act (§311(j)(4); 33 USC § 1231(j)) and established area committees and area contingency plans as the primary components of the national response planning structure. In addition to human health and safety, these area committees have three primary responsibilities:

- Prepare an area contingency plan;

- Work with state and local officials on contingency planning and preplanning of joint response efforts, including procedures for mechanical recovery, dispersal, shoreline cleanup, protection of sensitive areas, and protection, rescue and rehabilitation of fisheries and wildlife; and,
- Work with state and local officials to expedite decisions for the use of dispersants and other mitigating substances and devices.

In Alaska, the area committee structure has incorporated state and local agency representatives, and the jointly prepared plans coordinate the response activities of the various governmental entities that have responsibilities regarding oil spill response. The area contingency plan for Alaska is the Unified Plan. Since Alaska is so large and geographically diverse, the federal agencies have found it necessary to prepare sub-area contingency plans, also discussed in the Government Contingency Plans section below. OPA 90 also created two citizen advisory groups: the Prince William Sound and the Cook Inlet Regional Citizens Advisory Councils. These non-profit organizations provide citizen oversight of terminal and tanker operations that may affect the environment in their respective geographic areas. They also foster a long term partnership between industry, government, and citizens and carry out responsibilities identified in section 5002 of OPA 90. The groups provide recommendations on policies, permits, and site-specific regulations for terminal and tanker operations and maintenance and port operations, monitoring terminal and tanker operations and maintenance, and reviewing contingency plans for terminals and tankers and standards for tankers.

b. Alaska Statutes and Regulations

As discussed above and in Chapter Seven, ADEC is the agency responsible for implementing state oil spill response and planning regulations under AS 46.04.030. In 2006, ADEC adopted new regulations (18 AAC 75) for oilfield flowlines, new construction, and maintenance standards that apply to oil tanks and pipeline facilities. Additionally, ADEC is placing increased emphasis on oil spill prevention training.

ADF&G and ADNR support ADEC in these efforts by providing expertise and information. The industry must file oil spill prevention and contingency plans with ADEC before operations commence. ADNR reviews and comments to ADEC regarding the adequacy of the industry oil discharge prevention and contingency plans (C-plans).

c. Industry Contingency Plans

C-plans for exploration facilities must include a description of methods for responding to and controlling blowouts, the location and identification of oil spill cleanup equipment, the location and availability of suitable drilling equipment, and an operations plan to mobilize and drill a relief well. If development and production should occur, additional contingency plans must be filed for each facility before commencement of activity, as part of the permitting process. Any vessels transporting crude oil from the potential development area must also have an approved contingency plan.

AS 46.04.030 provides that unless an oil discharge prevention and contingency plan has been approved by ADEC, and the operator is in compliance with the plan, no person may:

- Operate an oil terminal facility, a pipeline, or an exploration or production facility, a tank vessel, or an oil barge; or
- Permit the transfer of oil to or from a tank vessel or oil barge.

Parties with approved plans are required to have sufficient oil discharge containment, storage, transfer, cleanup equipment, personnel, and resources to meet the response planning standards for the particular type of facility, pipeline, tank vessel, or oil barge (AS 46.04.030(k)). Examples of these requirements are:

- The operator of an oil terminal facility must be able to “contain or control, and clean up” a spill volume equal to that of the largest oil storage tank at the facility within 72 hours. That volume may be increased by ADEC if natural or manmade conditions exist outside the facility that place the area at high risk (AS 46.04.030(k)(1)).
- Operators of exploration or production facilities or pipelines must be able to “contain, control, and clean up the realistic maximum oil discharge within 72 hours” (AS 46.04.030(k)(2)). The “realistic maximum oil discharge” means the maximum and most damaging oil discharge that [ADEC] estimates could occur during the lifetime of the tank vessel, oil barge, facility, or pipeline based on (1) the size, location, and capacity; (2) ADEC’s knowledge and experience with such; and (3) ADEC’s analysis of possible mishaps (AS 46.04.030(r)(3)).

Discharges of oil or hazardous substances must be reported to ADEC on a time schedule depending on the volume released, whether the release is to land or to water, and whether the release has been contained by a secondary containment or structure. For example, 18 AAC 75.300(a)(1)(A)-(C) requires the operator to notify ADEC as soon as it has knowledge of the following types of discharges:

- Any discharge or release of a hazardous substance other than oil;
- Any discharge of or release of oil to water; and,
- Any discharge or release, including a cumulative discharge or release, of oil in excess of 55 gallons (1.31 bbl) solely to land outside an impermeable secondary containment area or structure.

The discharge must be cleaned up to the satisfaction of ADEC, using methods approved by ADEC. ADEC will modify cleanup techniques or require additional cleanup techniques for the site as ADEC determines to be necessary to protect human health, safety, and welfare, and the environment (18 AAC 75.335(d). ADF&G and ADNR advise ADEC regarding the adequacy of cleanup.

A C-plan must describe the existing and proposed means of oil discharge detection, including surveillance schedules, leak detection, observation wells, monitoring systems, and spill-detection instrumentation (AS 46.04.030; 18 AAC 75.425(e)(2)(E)). A C-plan and its preparation, application, approval, and demonstration of effectiveness require a major effort on the part of facility operators and plan holders. The C-plan must include a response action plan, a prevention plan, and supplemental information to support the response plan (18 AAC 75.425). These plans are described below.

The Response Action Plan (18 AAC 75.425(e)(1)) must include an emergency action checklist of immediate steps to be taken if a discharge occurs. The checklist must include:

- Names and telephone numbers of people within the operator’s organization who must be notified, and those responsible for notifying ADEC;
- Information on safety, communications, and deployment and response strategies;
- Specific actions to stop a discharge at its source, to track the location of the oil on open water, and to forecast the location of its expected point of shoreline contact to prevent oil from affecting environmentally sensitive areas;
- Procedures for boom deployment, skimming or absorbing, lightering, and estimating the amount of recovered oil;
- Plans, procedures, and locations for the temporary storage and ultimate disposal of oil contaminated materials and oily wastes;
- Plans for the protection, recovery, disposal, rehabilitation, and release of potentially affected wildlife; and,

- If shorelines are affected, shoreline cleanup and restoration methods.

The Prevention Plan (18 AAC 75.425(e)(2)) must:

- Include a description and schedule of regular pollution inspection and maintenance programs;
- Provide a history and description of known discharges greater than 55 gallons (1.31 bbl)that have occurred at the facility, and specify the measures to be taken to prevent or mitigate similar future discharges;
- Provide an analysis of the size, frequency, cause, and duration of potential oil discharges, and any operational considerations, geophysical hazards, or other site-specific factors, which might increase the risk of a discharge, and measures taken to reduce such risks; and,
- Describe existing and proposed means of discharge detection, including surveillance schedules, leak detection, observation wells, monitoring systems, and spill-detection instrumentation.

The Supplemental Information Section (18 AAC 75.425(e)(3)) must:

- Include a facility description and operational overview, describing oil storage, transfer, exploration, or production activities; the number and type of oil storage containers and the type and amount of oil stored; the normal routes of oil cargo vessel; procedures for loading or transferring oil; and a description of flow and gathering lines and processing facilities;
- Show the response command system; the realistic maximum response operation limitations such as weather, sea states (roughness of the sea), tides and currents, ice conditions, and visibility restrictions; the logistical support including identification of aircraft, vessels, and other transport equipment and personnel;
- Include a response equipment list including containment, control, cleanup, storage, transfer, lightering, and other related response equipment;
- Provide information regarding non-mechanical response, such as in-situ burning or dispersants, including an environmental assessment of such use;
- Provide information regarding the oil spill primary response action contractor;
- Include a detailed description of the training programs for discharge response personnel;
- Provide a plan for protecting environmentally sensitive areas and areas of public concern; and,
- Include any additional information and a bibliography.

The Best Available Technology Section (18 AAC 75.425(e)(4)) must:

- Identify technologies applicable to the applicant’s operation that are not subject to response planning or performance standards;
- For each applicable technology listed, the plan must identify and analyze all available technologies; and,
- Include a written justification that the technology proposed to be used is the best available for the applicant’s operation.

The Response Planning Standard Section (18 AAC 75.425(e)(5)) must include a calculation of the applicable response planning standards, including a detailed basis for the calculation of reductions, if any, to be applied to the response planning standards.

The current statute allows the sharing of oil spill response equipment, materials, and personnel among plan holders. ADEC determines by regulation the maximum amount of material, equipment, and personnel that can be transferred, and the time allowed for the return of those resources to the original plan holder (AS 46.04.030(o)). The statute also requires the plan holders to “successfully demonstrate the ability to carry out the plan when required by [ADEC]” (AS 46.04.030(r)(2)(E)). ADEC regulations require that exercises (announced or unannounced) be conducted to test the adequacy and execution of the contingency plan. No more than two exercises are required annually, unless the plan proves inadequate. ADEC may, at its discretion, consider regularly scheduled training exercises as discharge exercises (18 AAC 75.485(a) and (d)).

d. Financial Responsibility

Operators must provide proof of financial ability to respond in damages (AS 46.04.040). Financial responsibility may be demonstrated by one or a combination of 1) self-insurance; 2) insurance; 3) surety; 4) guarantee; 5) approved letter of credit; or 6) other ADEC-approved proof of financial responsibility (AS 46.04.040(e)). Operators must provide proof of financial responsibility acceptable to ADEC as follows:

- Crude oil terminals: $50,000,000 in damages per incident
- Non-crude oil terminals: $25 per incident for each barrel of total non-crude oil storage capacity at the terminal or $1,000,000, whichever is greater, with a maximum of $50,000,000
- Pipelines and offshore exploration or production facilities: $50,000,000 per incident.
- Onshore production facilities:

  $20,000,000 per incident if the facility produces over 10,000 bbl per day of oil;
  $10,000,000 per incident if the facility produces over 5,000 bbl per day of oil;
  $5,000,000 per incident if the facility produces over 2,500 bbl per day but not more than 5,000 bbl per day of oil; and,
  $1,000,000 per incident if the facility produces 2,500 bbl per day or less of oil.
- Onshore exploration facilities: $1,000,000 per incident.
- Crude oil vessels and barges: $300 per incident, for each barrel of storage capacity or $100,000,000, whichever is greater
- Vessels and barges carrying non-crude oil: $100 per barrel per incident or $1,000,000, whichever is greater, with a maximum of $35,000,000.

The coverage amounts are adjusted every third year based on the Consumer Price Index for Anchorage (AS 46.04.045).

e. Government Contingency Plans

In accordance with AS 46.04.200, ADEC must prepare, annually review, and revise the statewide master oil and hazardous substance discharge prevention and contingency plan. The plan must identify and specify the responsibilities of state and federal agencies, municipalities, facility operators, and private parties whose property may be affected by an oil or hazardous substance discharge, as well as other parties with an interest in cleanup. The plan must incorporate the incident command system, identify actions to be taken to reduce the likelihood of a discharge of oil or a hazardous substance. Revisions are submitted for public and agency review. Announced or unannounced drills test the need for the plan’s sufficiency.

ADEC must also prepare and annually review and revise a regional master oil and hazardous substance discharge prevention and contingency plan (AS 46.04.210). The regional master plans must contain the same elements and conditions as the state master plan, but are applicable to a specific geographic area. The North Slope subarea plan was revised in April of 2007 (ADEC 2007a).

7. Mitigation Measures and Other Regulatory Protections

Recognition of the difficulties of containment and cleanup of oil spills has encouraged innovative and effective methods of preventing possible problems and handling them if they arise. Oil spill prevention, response, and cleanup and remediation techniques are continually being researched by state and federal agencies and the oil industry. Risk of effects from a spill can be avoided, minimized, and mitigated through preventive measures, monitoring, and rigorous response capability. Mitigation measures addressing the possibility of oil spills are included in this preliminary best interest finding (see Chapter Nine). Additional site-specific and project-specific mitigation measures may be imposed as necessary if exploration and development take place.

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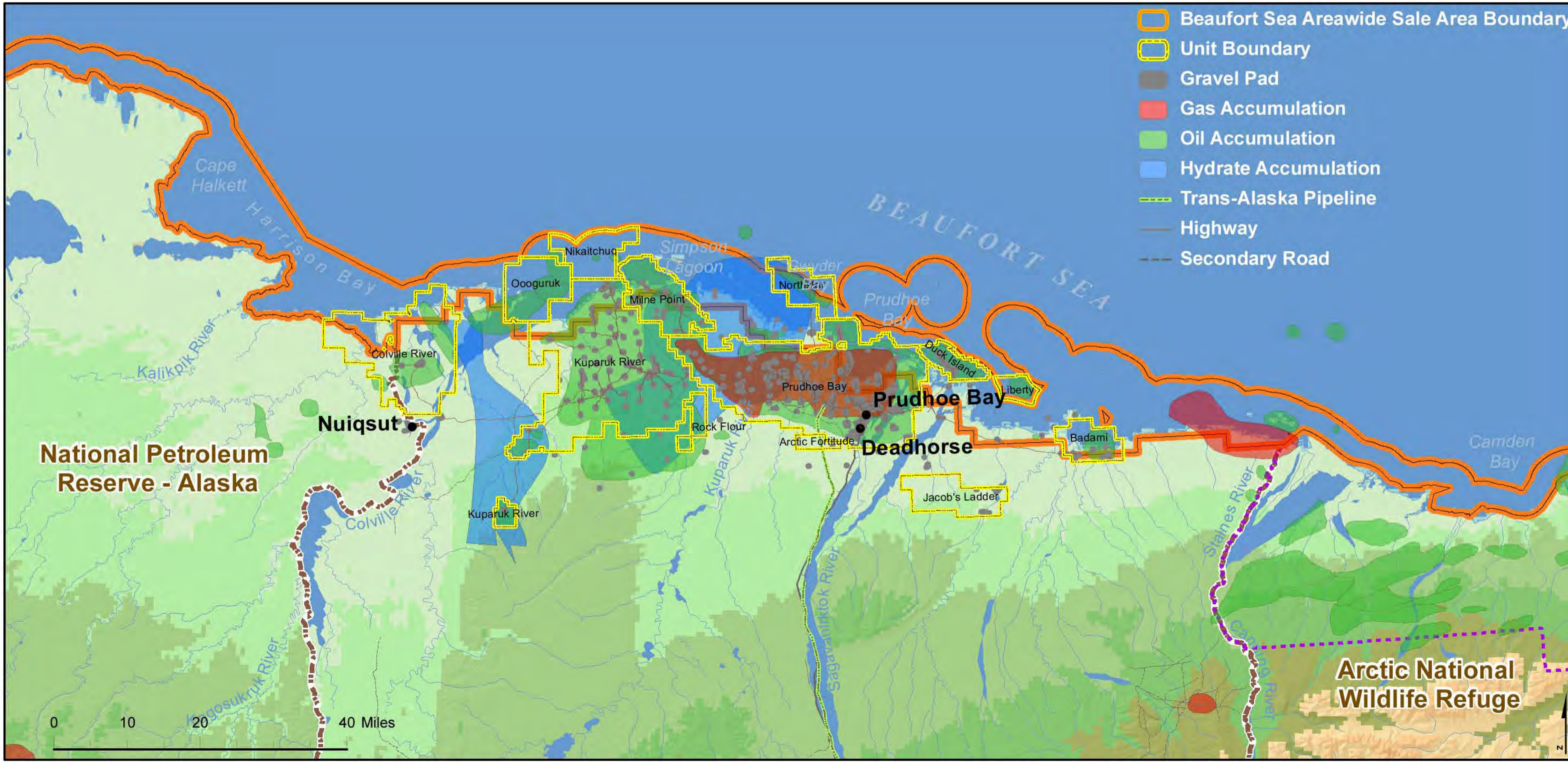
Maps



Notes: Information on this map is depicted only at a township or section level resolution. For detailed information regarding any specific area, interested individuals may consult the land records of one or more of the following agencies: ADNR, BLM, MMS, or NOAA. Discrepancies in boundary alignments are the result of merging multiple data sets from these various sources.

Map 6.1. Oil, gas, and hydrate accumulations, and infrastructure, in the Beaufort Sea area.

Chapter Seven: Governmental Powers to Regulate Oil and Gas

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Chapter Seven: Governmental Powers to Regulate Oil and Gas

All oil and gas activities (exploration, development, production, and transportation) are subject to numerous federal, state, and local laws, regulations, policies, and ordinances, with which the lessee is obligated to comply. This Chapter does not provide a comprehensive description of the multitude of laws and regulations that may be applicable to such activities, but it does illustrate the broad spectrum of authority various government agencies have to prohibit, regulate, and condition activities related to oil and gas. Important laws and regulations applicable to oil and gas activities are included in Appendix B. Each of the regulatory agencies (state, federal, and local) has a different role in the oversight and regulation of oil and gas activities, although some agencies may have overlapping authorities.

An oil and gas lease grants to the lessee the exclusive right to drill for, extract, remove, clean, process, and dispose of oil, gas, and associated substances. However, as discussed previously, except for activities that would not require a land use permit or operations undertaken under an approved unit plan of operations, a plan of operations must be approved before any operations may be undertaken on or in the leased area.

Each agency requires various permits and approvals, which are discussed below along with additional information on the review process (Figure 7.1). However, there is no “typical” project. Actual processes and terms and conditions will vary with time-certain, site-specific operations. Therefore, each agency has field monitors assigned to ensure that operations are conducted as approved. The appropriate statutes and regulations should be consulted when specifics are required.

A. Alaska Department of Natural Resources

ADNR, through the Division of Oil and Gas, Division of Mining, Land and Water, Division of Coastal and Ocean Management, the Office of Project Management and Permitting, and the State Historic Preservation Office, reviews, coordinates, conditions, and approves plans of operations or development and other permits as required before on-site activities can take place. The department monitors activities through field inspection once they have begun. Each plan of operations is site-specific and must be tailored to the activity requiring the permit. A plan of operations is required to identify the specific measures, design criteria, and construction methods and standards to be employed so as to comply with the terms of the lease. Applications for other state or federal agency authorizations or permits must be submitted with the plan of operations.

1. Alaska Coastal Management Plan (ACMP) Review

These habitats are subject to the Alaska Coastal Management Program (ACMP): offshore areas; estuaries; wetlands; tideflats; rocky islands and sea cliffs; barrier islands and lagoons; exposed high-energy coasts; rivers, streams, and lakes and the active flood plains and riparian management areas of those rivers, streams, and lakes; and important habitat. The ACMP sets standards for some of these habitats (11 AAC 112.300). For example, offshore areas must be managed to avoid, minimize, or mitigate significant adverse impacts to competing uses such as commercial, recreational, or subsistence fishing, to the extent that those uses are determined to be in competition with the proposed use. Tideflats must be managed to avoid, minimize, or mitigate significant adverse impacts to water flow and natural drainage patterns and competing uses such as commercial, recreational, or subsistence uses, to the extent that those uses are determined to be in competition with the proposed use.

The proposed Beaufort Sea areawide lease sale area encompasses habitat in the North Slope Borough's coastal zone. Therefore, lease related activities are subject to review under the Alaska Coastal Management Plan (ACMP; AS 46.40, 6 AAC 80, 6 AAC 85) and the local coastal district plan. Currently, there is no district plan in effect for the North Slope Borough. Future exploration, development, and production

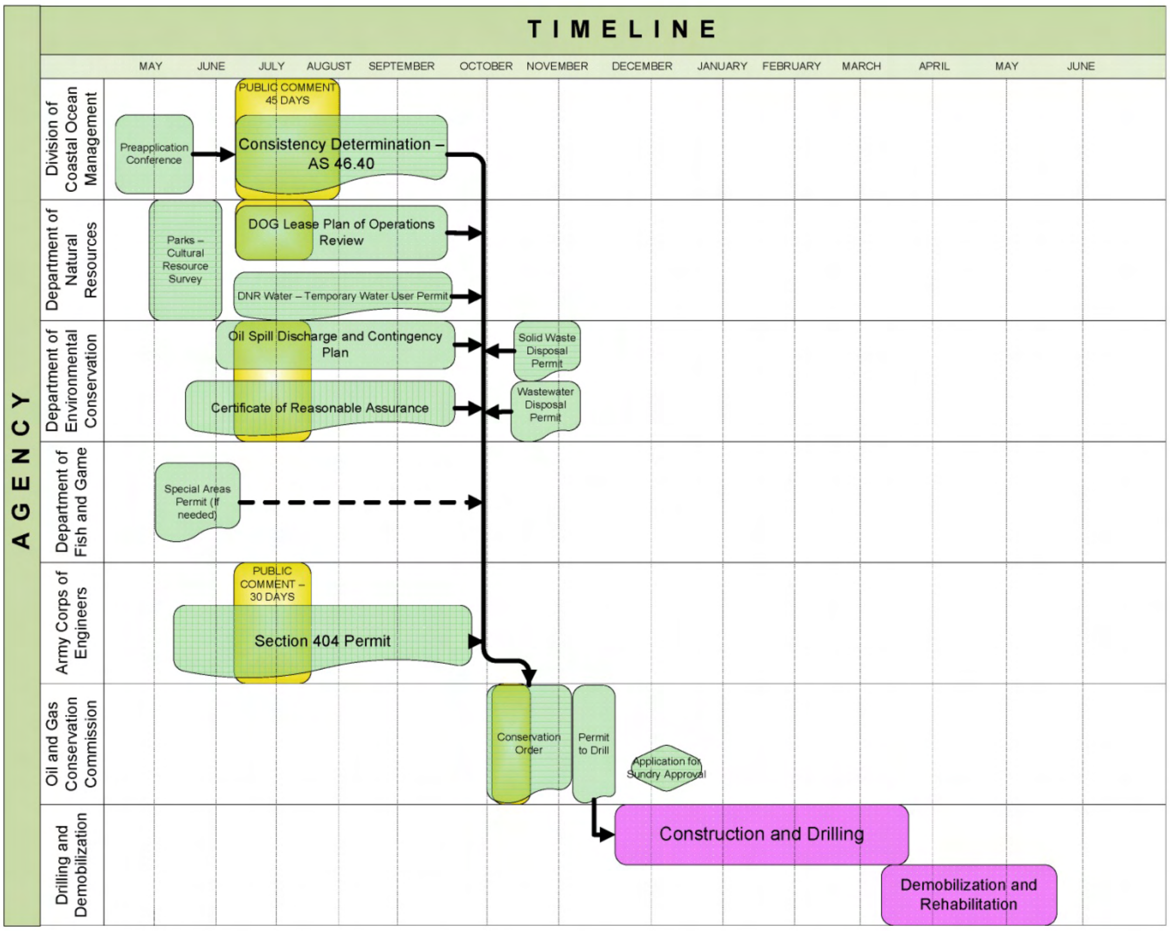

Figure 7.1. Generalized permit process.

activities requiring additional authorizations will undergo separate coastal zone consistency analyses if and when they are actually proposed. Future activities must comply with the ACMP and, once its plan is in effect, the enforceable policies of the North Slope Borough Coastal Management Program.

Permit applications for activities under the lease must be as detailed as necessary for a comprehensive agency review. If a project affects or occurs within the coastal zone, a review of the permit application will be conducted to determine whether the proposed activity is consistent with the standards of the ACMP. Following the review, each agency will approve or deny the permit and determine whether any alternative measures (changes in the project description) or permit terms are required before approval.

Most permits needed for exploration well drilling require public notice. The ACMP permitting process goes through a 30- or 50-day review and, if other agencies or offices within ADNR require approval, the review is coordinated by the Division of Coastal and Ocean Management. This process provides for coordinated agency reviews and public input and ensures that proposed activities are consistent with the ACMP and local coastal plans.

The 50-day ACMP review process is initiated when the lessee, designated operator, or Division of Coastal and Ocean Management distributes an application package to affected coastal resource districts and permitting agencies. The various agencies initiate their internal consistency reviews and must send any requests for additional information to the coordinating agency within 25 days. Public and agency review comments are due on or before Day 34, and a proposed consistency finding is issued on or before Day 44. A request for additional time to complete the review must be received on or before Day 49, and the final consistency determination is issued on Day 50. However, if a reviewing agency objects to the proposed determination, it may elevate the decision to the director. If the determination is elevated, a director's determination is issued by Day 65. The 30-day review process has shorter time periods between action points.

The consistency determination process has been streamlined through the development of A, B, and C list activities.

"A list" activities are considered "categorically consistent," do not result in significant impacts to coastal resources, and do not require a consistency review. On-pad placement of light poles, railings, electrical towers/poles, modules, and associated oil and gas buildings are examples of A list activities. A Coastal Project Questionnaire (CPQ) application is required for projects on the A list unless the A list says that a CPQ is not required.

"B list" reviews are classified as General Concurrences, and the activities are considered routine with standard alternative measures. B list activities adopting the alternative measures are consistent with the ACMP. Individual ACMP consistency reviews are not necessary for activities on the B list. However, a CPQ application is required for all projects on the B list.

The resource agency(s) will check the CPQ and plan of operations to ensure that the project qualifies for the A or B list. The coordinating agency will also review the standard alternative measures and any applicable procedures against the plan of operations submitted.

"C list" activities are activities not covered by the A or B lists, and reviews are classified as Individual Project Reviews. C list activities are subject to the 50- or 30-day review process described in this section.

2. Plan of Operations Approval

Land use activities within oil and gas leases are regulated under 11 AAC 83.158 and paragraph 10 of the lease. These require the lessee to prepare plans of operations and development that must be approved by DO&G and by any other interest holder, if ownership is shared, before the lessee may commence any activities within the leased area. Except for uses and activities appearing on the list in 11 AAC 96.020, the lessee must prepare a plan of operations and obtain all required approvals and permits for each phase of exploration, development, or production before implementation of that activity. All permit applications and plans are available for public review and public notice will be given for all development plans of operations.

An application for approval of a plan of operations must contain sufficient information, based on data reasonably available at the time the plan is submitted for approval, for the commissioner to determine the surface use requirements and impacts directly associated with the proposed operations. An application must include statements and maps or drawings setting out the following:

(1) the sequence and schedule of the operations to be conducted on or in the leased area, including the date operations are proposed to begin and their proposed duration;

(2) projected use requirements directly associated with the proposed operations, including the location and design of well sites, material sites, water supplies, solid waste sites, buildings, roads, utilities, airstrips, and all other facilities and equipment necessary to conduct the proposed operations;

(3) plans for rehabilitation of the affected leased area after completion of operations or phases of those operations; and

(4) a description of operating procedures designed to prevent or minimize adverse effects on other natural resources and other uses of the leased area and adjacent areas, including fish and wildlife habitats, historic and archeological sites, and public use areas (11 AAC 83.158(d)).

When it considers a plan of operations, ADNR often requires stipulations, in addition to the mitigation measures developed through the best interest finding. These additional stipulations address site-specific concerns directly associated with the proposed project. The lease stipulations and the terms and conditions of the lease are attached to the plan of operations approval and are binding on the lessee. The lease also requires that the lessee keep the lease area open for inspection by authorized state officials. Activities are monitored in the field by ADNR, ADEC, ADF&G, and AOGCC to ensure compliance with each agency’s respective permit terms. In addition, each permittee must post a bond before beginning operations (11 AAC 83.160). Lease operation approvals are generally granted for three years.

3. Geophysical Exploration Permit

The geophysical exploration permit is a specific type of land use permit issued by DO&G under 11 AAC 96.010. Seismic surveys are the most common activity authorized by this permit. The purpose of the permit is to minimize adverse effects on the land and its resources while making important geological information available to the state (11 AAC 96.210). Under AS 38.05.035(a)(8)(C), the geological and geophysical data that are made available to the state are held confidential at the request of the permittee. If the seismic survey is part of an exploration well program, the permit will be reviewed as part of the exploration well permit package. The application must contain the following information in sufficient detail to allow evaluation of the planned activities’ effects on the land:

(1) a map at a sufficient scale showing the general location of all activities and routes of travel of all equipment for which a permit is required;

(2) a description of the proposed activity, any associated structures, and the type of equipment that will be used. (11 AAC 96.030(a)).

Maps showing the precise location of the survey lines must also be provided, though this information is usually held confidential. A $100,000 bond is required to conduct seismic work. The bond amount for other geophysical surveys is determined when the activity is proposed.

A geophysical exploration permit contains measures to protect the land and resources of the area. The permit is usually issued for a single survey season, but may be extended. If the permit is extended, the director may modify existing terms or add new ones. The permit is revocable for cause for violation of a permit provision or of 11 AAC 96, and is revocable at will if the department determines that revocation is in the state's interest. A permit remains in effect for the term issued, unless revoked sooner. The department will give 30 days’ notice before revoking a permit at will. A revocation for cause is effective immediately. (11 AAC 96.040(a)).

4. Pipeline Rights-of-Way

Most transportation facilities within the lease area or beyond the boundaries of the lease area must be authorized by ADNR under the Right-of-Way Leasing Act (AS 38.35). This act gives the commissioner broad authority to oversee and regulate the transportation of oil and gas by pipelines that are located in whole or in part on state land, to ensure the state's interests are protected. The Right-of-Way Leasing Act process is administered by the State Pipeline Coordinator's Office.

5. Temporary Water Use Authorization

Exploration activities may require a temporary water use authorization issued by DMLW. A temporary water use authorization is required under 11 AAC 93.035 before the temporary use of a significant amount of water, if the use continues for less than five consecutive years and the water applied for is not otherwise appropriated. The authorization may be extended one time for good cause for a period of time not to exceed five years. An application must include: (1) the application fee; (2) a map indicating the section, township, range, and meridian, and indicating the location, of the property, the point of withdrawal, diversion, or impoundment, and the point of use; (3) the quantity of water to be used; (4) the nature of the water use; (5) the time period during which the water is to be used; and (6) the type and size of equipment used to withdraw the water. DMLW may issue an authorization for the temporary use of water subject to conditions, including suspension or termination, considered necessary to protect the water rights of other persons or the public interest. Information on lake bathymetry, fish presence, and fish species may be required when winter water withdrawal is proposed to calculate the appropriate withdrawal limits.

6. Permit and Certificate to Appropriate Water

Industrial or commercial use of water requires a Permit to Appropriate Water under 11 AAC 93.120. The permit is issued for a period of time consistent with the public interest and adequate to finish construction and establish full use of water. The maximum time period for which a permit will be issued for industrial of commercial use is five years, unless the applicant proves or the commissioner independently determines that a longer period is required. The commissioner may issue a permit subject to terms, conditions, restrictions, and limitations necessary to protect the rights of others, and the public interest. Under 11 AAC 93.120(e), permits are subject to conditions such as requirements: that no certificate will be issued until evidence is presented of adequate easements or other means necessary to complete the appropriation; that the permittee measure the water use and report water use information to ADNR; and that the permittee maintain, or restrict from withdrawing, a specific quantity, rate of flow or volume of water to protect fish and wildlife habitat, recreation purposes, navigation, sanitation or water quality, prior appropriators, or any other purpose the department determines is in the public interest.

A Certificate of Appropriation will be issued under 11 AAC 93.130 if the permit holder: (1) submits a statement of beneficial use stating that the means necessary for the taking of water have been developed and the permit holder is beneficially using the quantity of water to be certified, along with the required fee; and (2) has substantially complied with all permit conditions. Again, the commissioner will, in his or her discretion, issue a certificate subject to conditions necessary to protect the public interest. For example, conditions to maintain a specific quantity of water at a given point on a stream or water body, or in a specified stretch of stream, throughout the year or for specified times of the year, to protect fish and wildlife habitat, recreation, navigation, sanitation and water quality, and prior appropriators, or any other purpose the commissioner determines is in the public interest (11 AAC 93.130(c)(1)).

7. Land Use Permits

Land use permits are issued by DMLW and may be required for exploration, development, and production activities. Land use permits can be issued for periods up to five years depending on the activity, but ADNR anticipates permits issued in conjunction with the lease will likely be for a period of one year.

In accordance with 11 AAC 96.025, a generally allowed use listed in 11 AAC 96.020 is subject to the following conditions:

(1) activities employing wheeled or tracked vehicles must be conducted in a manner that minimizes surface damage;

(2) vehicles must use existing roads and trails whenever possible;

(3) activities must be conducted in a manner that minimizes

(A) disturbance of vegetation, soil stability, or drainage systems;

(B) changing the character of, polluting, or introducing silt and sediment into streams, lakes, ponds, water holes, seeps, and marshes; and

(C) disturbance of fish and wildlife resources;

(4) cuts, fills, and other activities causing a disturbance listed in (3)(A) - (C) of this section must be repaired immediately, and corrective action must be undertaken as may be required by the department;

(5) trails and campsites must be kept clean; garbage and foreign debris must be removed; combustibles may be burned on site unless the department has closed the area to fires during the fire season;

(6) survey monuments, witness corners, reference monuments, mining location posts, homestead entry corner posts, and bearing trees must be protected against destruction, obliteration, and damage; any damaged or obliterated markers must be reestablished as required by the department under AS 34.65.020 and AS 34.65.040;

(7) every reasonable effort must be made to prevent, control, and suppress any fire in the operating area; uncontrolled fires must be immediately reported;

(8) holes, pits, and excavations must be repaired as soon as possible; holes, pits, and excavations necessary to verify discovery on prospecting sites, mining claims, or mining leasehold locations may be left open but must be maintained in a manner that protects public safety;

(9) on lands subject to a mineral or land estate property interest, entry by a person other than the holder of a property interest, or the holder’s authorized representative, must be made in a manner that prevents unnecessary or unreasonable interference with the rights of the holder of the property interest.

8. Material Sale Contract

If the operator proposes to use state-owned gravel or other materials for construction of pads and roads, a DMLW material sale contract is required. The contract must include a description of the sale area, the volume of material to be removed from the sale area, the method of payment by the purchaser, the method of removal of the material, the bonds and deposits required of the purchaser, the method of scaling to be used by the purchaser, the purchaser’s liability under the contract, the improvements to and occupancy of the sale area required of the purchaser, and the reservation of material within the sale area to DMLW. A material sale contract must also include the purchaser’s site-specific operating requirements, including requirements relating to boundary markers and survey monument protection; erosion control and protection of water; fire prevention and control; roads; sale area supervision; protection of fish, wildlife, and recreational values; sale area access; and public safety. A contract must state the date upon which the severance or extraction of material under the contract is to be completed. A contract may be extended before its expiration if the director determines that the delay in completing the contract is due to unforeseen events beyond the purchaser's control, or the extension is in the best interests of the state.

In connection with a material sale, the DMLW director may require the purchaser to provide a performance bond that guarantees performance of the terms of the contract. If the director requires a performance bond, the bond amount will be based on the total value of the sale. The performance bond must remain in effect for the duration of the contract unless released in writing by the director.

9. Office of History and Archaeology

The Alaska Heritage Resources Survey (AHRS) is an inventory of all reported historic and prehistoric sites within the state and is maintained by ADNR's Office of History and Archaeology. This inventory of cultural resources includes objects, structures, buildings, sites, districts, and travel ways, with a general provision that they are over 50 years old. To date, over 22,000 sites have been reported within Alaska (however, this is probably only a small percentage of the sites that may actually exist but are as yet unreported). The fundamental use of the AHRS is to protect cultural resource sites from unwanted destruction. Before beginning a project, information regarding important cultural and historic sites can be obtained by contacting the Office of History and Archaeology.

AS 41.35.010, the Alaska Historic Preservation Act says that "It is the policy of the state to preserve and protect the historic, prehistoric, and archaeological resources of Alaska from loss, desecration, and destruction so that the scientific, historic, and cultural heritage embodied in those resources may pass undiminished to future generations." Existing statutes, which apply to both known sites and newly discovered sites, include:

> **AS 41.35.200**. Unlawful acts. A person may not appropriate, excavate, remove, injure, or destroy, without a permit from the commissioner, any historic, prehistoric, or archaeological resources of the state. "Historic, prehistoric, or archaeological resources" includes deposits, structures, ruins, sites, buildings, graves, artifacts, fossils, or other objects of antiquity which provide information pertaining to the historical or prehistorical culture of people in the state as well as to the natural history of the state (AS 41.35.230(2)).
>
> **AS 41.35.210**. Criminal penalties. A person who is convicted of violating a provision of AS 41-35.010 – 41.35.240 is guilty of a class A misdemeanor.
>
> **AS 41.35.215**. Civil penalties. In addition to other penalties and remedies provided by law, a person who violates a provision of AS 41.35.010 – 41.35.240 is subject to a maximum civil penalty of $100,000 for each violation.

10. Petroleum Systems Integrity Office

The Petroleum Systems Integrity Office (PSIO) is the lead state agency in exercising oversight of the maintenance of facilities, equipment, and infrastructure for the sustained production and transportation of oil and natural gas resources in this state, including such facilities, equipment, and infrastructure not currently within the jurisdiction of another state or federal agency. Through designated agency liaisons, PSIO leads interagency efforts to evaluate industry oversight. Designated agencies, to the extent authorized through legal authorities, require oil and gas producers and operators to provide a comprehensive description of current practices that includes the quality control, quality assurance, monitoring, inspection, and other practices used to ensure the integrity and reliability of oil and natural gas facilities, equipment, infrastructure and activities. The PSIO shall make recommendations to the commissioner of ADNR regarding ADNR enforcement actions and cases to be referred to other state, local, or federal agencies for appropriate civil or criminal penalties available under the law.

B. Alaska Department of Environmental Conservation

ADEC has statutory responsibility for controlling air, land, and water pollution, and oil spill prevention and response. ADEC implements and coordinates several federal regulatory programs in addition to state laws.

1. Air Quality Permits

ADEC administers an air quality program under a federally-approved State Implementation Plan. Through this plan, federal requirements of the Clean Air Act are met including National Ambient Air Quality Standards, New Source Review (NSR), New Source Performance Standards, National Emission Standards for Hazardous Air Pollutants, and Prevention of Significant Deterioration. ADEC also monitors air quality and compliance.

The National Ambient Air Quality Standards set limits on pollutants considered harmful to public health and the environment (EPA 2008b). Limits have been defined for principal pollutants, or criteria pollutants: carbon monoxide, lead, nitrogen dioxide, particulate matter (PM_{10}), particulate matter ($PM_{2.5}$), ozone, and sulfur dioxide. NSR, a permitting program required for new construction projects, ensures that air quality is not degraded by the new project, and that large new or modified industrial sources will be as clean as possible (EPA 2008e). New Source Performance Standards are intended to promote use of the best air pollution control technologies available, and they take into account the cost of the technology and any other non-air quality, health, and environmental impact and energy requirements (EPA 2008d). The National Emissions Standards for Hazardous Air Pollutants are set for air pollutants that are not covered by National Ambient Air Quality Standards, but that may be harmful (EPA 2008c). The standards are categorized by type of source, and require the maximum degree of reduction in emissions that is achievable, as determined by the EPA. The purpose of the Prevention of Significant Deterioration program is:

> …to protect public health and welfare; preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value; insure that economic growth will occur in a manner consistent with the preservation of existing clean air resources; and assure that any decision to permit increased air pollution…is made only after careful evaluation of all the consequences of such a decision and after adequate procedural opportunities for informed public participation in the decision making process. (EPA 2008e.)

The two primary types of permits issued to meet these requirements are Title I Construction Permits and Title V Operation Permits (EPA 2008a). Permits are legal documents that the applicant must follow. Permits specify what activities are allowed, what emission limits must be met, and may specify how the facility must be operated. Permits may contain monitoring, recordkeeping, and reporting requirements to ensure that the applicant meets the permit requirements (EPA 2008e).

a. <u>Title I (NSR) Construction Permits</u>

i. Permit Description

Title I permits incorporate air quality requirements for the Prevention of Significant Deterioration as well as other requirements of the Clean Air Act. This permit must be obtained before onsite construction can begin. Title I permits are required for projects that are new major sources for pollutants, or major modifications at existing sources. Prevention of Significant Deterioration requires installation of the "Best Available Control Technology (BACT)"; an air quality analysis; an additional impacts analysis; and public involvement (EPA 2008e).

BACT is determined on a case-by-case basis and takes into account energy, environmental, and economic impacts. BACT includes add-on control equipment, or modifications to production processes or methods. Examples include fuel cleaning or treatment, innovative fuel combustion techniques; and design, equipment, work practice, or operational standards (EPA 2008e).

An air quality analysis is required to show that new emissions will not violate air quality standards. In general, an assessment of existing air quality and predictions of future air quality that will result from the project are required (EPA 2008e).

ii. Review Process

The permitting process includes a pre-application meeting between the applicant and ADEC, several ADEC reviews and a Technical Analysis Report, and a 30-day public comment period, after which ADEC may issue a final permit. The final permit includes a final Technical Analysis Report and response to comments. The process for a Title I process can take up to three years, depending on the amount of meteorological data collection required. The permit must be obtained before construction may begin.

b. Title V Operation Permits

i. Permit Description

The federal Clean Air Act of 1970, and its subsequent 1990 revision and expansions (42 USC §§ 7401-7661), give EPA the authority to limit emissions from point sources (EPA 2007). EPA regulations require facilities that emit certain pollutants or hazardous substances to obtain a permit to operate the facility, known as a Title V permit. In Alaska, ADEC is responsible for issuing Title V permits and making compliance inspections (ADEC 2008a; 18 AAC 50, and AS 46.14). Permits are legally binding and include enforceable conditions with which the operator must comply. The permit establishes limits on the type and amount of emissions allowed, requirements for pollution control devices and prevention activities, and monitoring and record keeping requirements (EPA 2008f).

ii. Review Process

Operators have 12 months to submit their completed Title V permit after commencing their operations, which can continue while ADEC processes the application. However, significant revisions to an existing permitted facility cannot be made until the permit revision is approved by ADEC. Processing time for permit revisions can be up to 6 months. Title V permits and revisions can be processed concurrently with Title I permits.

2. Solid Waste Disposal Permit

ADEC regulates solid waste storage, treatment, transportation, and disposal under 18 AAC 60. EPA regulates RCRA hazardous wastes and UIC Class I injection wells, and the AOGCC regulates UIC Class II oil and gas wells.

For all solid waste disposal facilities regulated by ADEC, a comprehensive disposal plan is required, which must include engineering design criteria and drawings, specifications, calculations, and a discussion demonstrating how the various design features (liners, berms, dikes) will ensure compliance with regulations. Before approval, solid waste disposal permit applications are reviewed for compliance with air and water quality standards, wastewater disposal, and drinking water standards, as well as for their consistency with the Alaska Historic Preservation Act. The application for a waste disposal permit must include a map or aerial photograph (indicating relevant topographical, geological, hydrological, biological, and archaeological features) with a cover letter describing type, estimated quantity, and source of the waste, as well as the type of facility proposed. Roads, drinking water systems, and airports within a two-mile radius of the site must be identified, along with all residential drinking water wells within one-half mile. There must also be a site plan with cross-sectional drawings that indicate the location of existing and proposed containment structures, material storage areas, monitoring devices, area improvements, and on-site equipment. An evaluation of the potential for generating leachate must be presented as well. For above-grade disposal options, baseline water-quality data may be needed to establish the physical and chemical characteristics of the site before installing a containment cell.

Non-drilling-related solid waste must be disposed of in an approved municipal solid waste landfill (MSWLF). MSWLFs are regulated under 18 AAC 60.300-.398. All other solid waste (except for hazardous materials) must be disposed of in an approved monofill (18 AAC 60.400-.495). A monofill is a landfill or drilling waste disposal facility that receives primarily one type of solid waste and that is not an inactive reserve pit (18 AAC 60.990(80)). An inactive reserve pit is a drilling waste disposal area, containment structure, or group of containment structures where drilling waste has not been disposed of after January 26, 1996, and at which the owner or operator does not plan to continue disposing of drilling waste (18 AAC 60.990(62)). Closure of inactive reserve pits is regulated under 18 AAC 60.440.

Drilling waste disposal is specifically regulated under 18 AAC 60.430. Design and monitoring requirements for drilling waste disposal facilities are identified in 18 AAC 60.430(c) and (d), respectively. Under 18 AAC 60.430(c)(1), the design must take into account the location of the seasonal high groundwater table, surface water, and continuous permafrost, as well as proximity to human population and to public water systems, with the goal of avoiding any adverse effect on these resources. The facility must be designed to prevent the escape of drilling waste and leachate; be of the minimum volume necessary for drilling waste disposal and emergency relief volume; prevent overflow from, or damage to, containment structures or other waste management areas, from operations, annual average precipitation, wind or wave action; ensure that drilling waste, leachate, or eroded soil from the facility does not cause a violation of applicable water quality standards at the surface water point of compliance or at the uppermost aquifer at the groundwater point of compliance. The plans for the proposed design and construction of the drilling waste disposal facility and the fluid management plan must be approved, signed, and sealed by a registered engineer per 18 AAC 60.430(c)(5).

Presently, the preferred practice is to dispose of drilling fluids by reinjection deep into the ground; however, EPA and ADEC may authorize limited discharge of waste streams under the NPDES permit system. All produced waters must be re-injected or treated to meet Alaska Water Quality Standards before discharge. Before a well may be permitted under 20 AAC 25.005, a proper and appropriate reserve pit, also known as a solid waste disposal cell, must be constructed or appropriate tankage installed for the reception and confinement of drilling fluids and cuttings, to facilitate the safety of the drilling operation, and to prevent contamination of freshwater and damage to the surface environment (20 AAC 25.047).

Typically, a reserve pit is a containment cell lined with an impermeable barrier compatible with both hydrocarbons and drilling mud. Average dimensions are approximately 130 feet wide by 150 feet long by 12 feet deep, although specific configurations vary by site. The cell may receive only drilling and production wastes associated with the exploration, development, or production of crude oil, natural gas or hydrocarbon-contaminated solids. The disposal of hazardous or other waste in a containment cell is prohibited. After the well is deepened, the residue in the reserve pit is often dewatered and the fluids are injected into the well annulus. An inventory of injection operations including volume, date, type, and source of material injected is maintained by requirement. Following completion of well activities, the material remaining in the pit is permanently encapsulated in the impermeable liner. Fill and organic soil is placed over it and proper drainage is re-established. Surface impoundments within 1,500 feet are sampled on a periodic basis and analyzed. In addition, groundwater-monitoring wells are drilled and sampled on a regular basis. If there are uncontained releases during operations, or if water samples indicate an increase in the compounds being monitored, additional observation may be required.

Substances proposed for disposal that are classified as “hazardous” undergo a more rigorous and thorough permitting and review process by both ADEC, per 18 AAC 62 and 63, and the EPA.

3. Wastewater Disposal Permit

Domestic graywater must be disposed of properly at the surface and requires a Wastewater Disposal Permit per 18 AAC 72. Typically, waste is processed through an on-site plant and disinfected before discharge. ADEC sets fluid volume limitations and threshold concentrations for biochemical oxygen demand (BOD), suspended solids, pH, oil and grease, fecal coliform, and chlorine residual. Monitoring records must be available for inspection, and a written report may be required upon completion of operations.

4. NPDES Certification

ADEC participates in the federal National Pollution Discharge Elimination System (NPDES) program that is administered by EPA (see Section E(3) below). ADEC certifies that discharges permitted under NPDES meet state and federal water quality standards. When an application for an NPDES permit is made to EPA, a duplicate must also be filed with ADEC for certification. The permit may impose stipulations and conditions on the facility and operations, such as monitoring and/or mixing zone requirements. Once operations begin, both EPA and ADEC have the responsibility to monitor the project for compliance with the terms of the permit.

Both EPA and require opportunities for public participation (40 CFR 124.10 - .14; 18 AAC 15.140; 18 AAC 15.150).

EPA administered the NPDES program in Alaska, but on October 31, 2008, EPA approved the state’s application to assume issuing and enforcing permits for wastewater discharges issued under the Clean Water Act. Transfer of authority for the program will be phased in over three years, from November 2008 – November 2011; authority for oil and gas facilities will be transferred to ADEC by 2011 (ADEC 2008b; SOA 2008).

5. U.S. Army Corps of Engineers Section 10 and Section 404 Permit Certification

ADEC participates in the permit review process for U.S. Army Corps of Engineers Section 10 and Section 404 permits (see Section F(1)) by reviewing permit applications to ensure that proposed projects will comply with Alaska water quality standards. If it is determined that the project will comply, ADEC issues a Clean Water Act Section 401 Certification for the project.

6. Oil Discharge Prevention and Contingency Plan

Lessees must comply with the requirements of AS 46.04.010 - .900, Oil and Hazardous Substance Pollution Control. This requirement includes the preparation and approval by ADEC of an Oil Discharge Prevention and Contingency Plan (C-Plan) (AS 46.04.030; 18 AAC 75.445). Details on the contents of the plan are in Chapter Six.

C. Alaska Department of Fish and Game

ADF&G, Division of Habitat, evaluates the potential effect of any activity on fish and wildlife, their habitat, and the users of those resources.

1. Waters Important to Anadromous Fish and Fish Passage

The ADF&G, Division of Habitat administers the permitting process for activities that may affect anadromous fish streams. Under this program, a Fish Habitat Permit is required before using, diverting, obstructing, polluting, or changing the natural flow or bed of an anadromous fish water body as required in AS 16.05.871(b). A Fish Habitat Permit is likewise required for any activity that may affect the efficient passage of resident fish as per AS 16.05.841.

D. Alaska Oil and Gas Conservation Commission

AS 31.05, the Alaska Oil and Gas Conservation Act, created the Alaska Oil and Gas Conservation Commission (AOGCC). AOGCC acts to prohibit the physical waste of crude oil and natural gas, ensure a greater ultimate resource recovery, and protect the correlative rights of persons owning oil and gas interest in lands subject to Alaska's police powers. It also administers the Underground Injection Control (UIC) program for oil and gas wells in Alaska, and oversees metering operations to determine the quality and quantity of oil and gas produced in the state. AOGCC holds hearings and adjudicates decisions, which require the combined expertise of petroleum geology and petroleum engineering (AOGCC 2008).

1. Permit to Drill

a. Permit Description

In order to drill a well for oil or gas in Alaska, a person must obtain a Permit to Drill from AOGCC. This requirement applies not only to exploratory, stratigraphic test, and development wells, but also to injection and other service wells related to oil and gas activities. AOGCC does not manage or decide whether to develop state owned resources. Rather, it regulates certain oil and gas operations anywhere in Alaska, whether on state, federal, or private land.

AOGCC's oversight of drilling operations focuses on ensuring that appropriate equipment is used and appropriate practices are followed to maintain well control, protect groundwater, avoid waste of oil or gas, and promote efficient reservoir development. AOGCC is not authorized to deny a Permit to Drill on the basis of land use concerns or conflicts between surface and subsurface interests.

AOGCC is one of several state agencies that has a role in reviewing and approving oil and gas activities. AOGCC's issuance of a Permit to Drill does not relieve the applicant of any obligations to comply with the permit or regulatory requirements of other state, local, or federal agencies before drilling (AOGCC 2008).

b. Review Process

A Permit to Drill from AOGCC is often the last step in the overall approval process, and usually all of the other concerned agencies have given their approval. The application must be accompanied by the items set out in 20 AAC 25.005(c). A geologist and a drilling engineer review the entire application in detail using a multi-question checklist to ensure the application is complete, accurate, and conforms to all applicable regulations.

AOGCC will notify the operator if there are any deficiencies in the application. The operator will either supplement the original application with revised or additional information, or, in the event that substantive changes are needed, resubmit the entire application. If unanticipated exceptions to regulations or AOGCC orders are needed, such as a well spacing exception, the operator will be notified. Usually such exceptions are handled through a public notice process, with an opportunity for a hearing. If the permit is approved, it will include any operational or environmental safety stipulations identified by AOGCC (AOGCC 2008).

2. Disposal of Wastes

AOGCC must also review and take appropriate action on proposals for the underground disposal of Class II oil field wastes (20 AAC 25.252). Before receiving an approval, an operator must demonstrate that the movement of injected fluids into freshwater sources will not occur. Disposal or storage wells must be cased and the casing cemented in a manner that will isolate the disposal or storage zone and protect oil, gas, and freshwater sources.

Along with a plat showing the location of other wells within one-quarter mile, the disposal injection order application must include information about surface owners located within one-quarter mile of the injection well(s). The disposal injection order application must also contain the name, description, depth, thickness, lithologic description, and geological data of the disposal formation and adjacent confining zones. A description of the fluid to be injected, including composition, source, daily amount, and disposal pressures, and sufficient information and analysis, must be presented demonstrating that the disposal well will not initiate or propagate fractures through the confining zones that allow fluids to migrate. Under certain circumstances a freshwater aquifer exemption may be granted (20 AAC 25.440).

Following approval, liquid waste from drilling operations may be injected through a dedicated tubing string into the approved subsurface zone. The pumping of drilling wastes through the annular space of a well is an operation incidental to drilling of the well, and is not a disposal operation subject to regulation as a Class II well. AOGCC approval of annular disposal operations is required before commencing pumping operations (20 AAC 25.080).

3. Annular Injection

An AOGCC permit is required if fluid is to be injected into a well annulus. The material must be incidental to the drilling of a well (muds and cuttings). AOGCC may take all actions necessary to allow the state to acquire the primary enforcement responsibility for the control of underground disposal related to the recovery and production of oil and natural gas. ADEC considers the volume, depth, and other physical and chemical characteristics of the formation designated to receive the waste. Annular disposal is not permitted into water-bearing zones where dissolved solids or salinity concentrations fall below predetermined threshold limits. Waste not generated from a hydrocarbon reservoir cannot be injected into a reservoir.

4. Review Process

AOGCC actions that have statewide application, such as adopting regulations, are conducted in accordance with the Administrative Procedures Act. Major actions that result in conservation orders that apply to a single well or field receive public notice by publication in a newspaper and a public hearing may be held (20 AAC 25.540). In addition, a public mailing list is maintained for the purpose of sending appropriate notices, orders, and publications to persons who request to be put on these lists (20 AAC 25.545).

E. U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) protects human health and the environment by implementing, administering, or overseeing programs and regulations promulgated in federal environmental legislation. These programs, some of which are delegated to the states, safeguard the air, land, and water environments.

1. Air Quality Permits

The federal Clean Air Act includes a number of air quality standards and requirements, including National Ambient Air Quality Standards, New Source Review (NSR), New Source Performance

Standards, National Emission Standards for Hazardous Air Pollutants, and Prevention of Significant Deterioration. The two primary types of permits are issued to meet these requirements: Title I Construction Permits, which must be obtained before onsite construction can begin, and Title V Operation Permits, which regulate facilities that emit certain pollutants or hazardous substances.

ADEC administers an air quality program under a federally-approved State Implementation Plan that applies these standards. See Section B(1) for further details.

2. Hazardous Waste (RCRA) Permits

The federal Resource Conservation and Recovery Act (RCRA) established a program for managing hazardous wastes to ensure the protection of human health and the environment, with the EPA as the regulatory authority. Regulations established by the EPA direct procedures for transporting, storing, and disposing of hazardous wastes, and for designing and operating treatment, storage, and disposal facilities safely. A corrective action program guides investigations and cleanups of contaminated air, groundwater, surface water, or soil. Regulations are enforced through inspections, monitoring of waste handlers, taking legal action for noncompliance, and providing compliance incentives and assistance (EPA 2008h).

States may receive authorization to implement the program, which requires that the state standards be at least as strict as the federal standards. Alaska is not authorized for this program, and therefore it is implemented by the EPA in Alaska.

3. NPDES Permit

a. Permit Description

Effluents discharged by the oil and gas industry into waters and wetlands are regulated through EPA's NPDES program as required by the federal Clean Water Act. The NPDES program, which covers other industries and waters as well, ensures that state and federal clean water quality standards are maintained by requiring a permit to discharge wastes into the nation's waters (EPA 2008j). NPDES permits specify the type and amount of pollutant, and include monitoring and reporting requirements, to ensure that discharges are not harmful to water quality and human health (EPA 2008f). Some permits may be subject to procedures of the National Environmental Policy Act (EPA 2008g). Alaska is in the process of gaining implementation authority for the program. EPA is scheduled to transfer authority for the program in phases over three years, from November 2008 – November 2011 (ADEC 2008b).

NPDES covers a broad range of pollutants, which are defined as "any type of industrial, municipal, and agricultural waste discharged into water" (EPA 2008j). Examples of oil and gas industry effluents regulated by NPDES include drilling muds, cuttings and wash water, deck drainage, sanitary and domestic wastes, desalination unit waste, blow-out preventer fluids, boiler blowdown, fire control system test water, non-contact cooling water, uncontaminated ballast and bilge waters, excess cement slurry, water flooding discharges, produced waters, well treatment fluids, and produced solids.

There are two basic types of NPDES permits: general permits and individual permits. General permits cover multiple facilities that are similar, for example, oil and gas facilities on the North Slope. General permits are efficient and cost effective because they eliminate redundancy of multiple permits for the same type of facility and discharges (EPA 2008j). They also ensure consistency among similar facilities. Individual permits apply to a specific facility and are tailored to that facility's characteristics. Individual permits are issued for a defined time period, not exceeding five years, and the facility must reapply for the permit before it expires (EPA 2008j).

b. Review Process

The process for issuing a general permit begins when it is determined that there is a group of facilities in an area that share similar characteristics and discharges. The permitting authority develops a draft permit and fact sheet, which documents the decision-making process for developing effluent limits (EPA 2008j). The permitting authority then issues a public notice, providing opportunity for interested parties to submit comments on the draft permit. After considering public input, the permitting authority issues the final permit. The process for an individual permit is similar.

After a general permit is issued, facilities wishing to be included under the general permit submit a “Notice of Intent” to the permitting authority. Additional information describing the facility may be required. The facility may be notified that it is covered by the general permit or the facility may be required to apply for an individual permit (EPA 2008j).

4. UIC Class I and II Injection Well Permits

EPA is responsible for regulating injection wells, which are used to dispose of fluid wastes by injecting the waste underground (EPA 2008i). Authorized as part of the federal Safe Drinking Water Act of 1974, EPA’s Underground Injection Control (UIC) program protects underground sources of drinking water from contamination by injection wells. Injection wells are categorized into five classes; Class I and II are most common in the oil and gas industry. EPA may delegate authority for implementing the program to states that meet federal standards. Authority for Class II oil and gas wells has been delegated to AOGCC in Alaska (see Section D(2)); EPA implements the program in Alaska for Class I wells.

All injections falling into Class I must be authorized through EPA’s UIC Class I program. Class I wells must operate under a permit that is valid for up to 10 years. Permits stipulate requirements such as siting, construction, operation, monitoring and testing, reporting and record keeping, and closure. Requirements differ for wells depending on whether they accept hazardous or non-hazardous wastes (EPA 2008i).

5. Spill Response Plan (C-Plan)

Owners or operators of non-transportation-related onshore and offshore facilities engaged in drilling, producing, gathering, storing, processing, refining, transferring, distributing, or consuming oil and oil products must prepare a spill prevention control and countermeasures plan (C-Plan) in accordance with 40 CFR § 112. The definition of facility includes drilling rigs and pipelines. The purpose of the C-Plan is to prevent discharges of oil into navigable waters of the U.S. and the adjoining shorelines. The plan must address three areas:

- operating procedures installed by the facility to prevent oil spills;
- control measures installed to prevent a spill from entering navigable waters; and
- countermeasures to contain, clean up, and mitigate the effects of an oil spill that impacts navigable waters.

The C-Plan is facility-specific and is part of the required documentation that must be present at the facility for inspection. The owner or operator must have the plan certified by a registered engineer but does not submit it to EPA for approval before the beginning of operations. If the facility discharges more than 1,000 gallons or harmful quantities of oil in one event or experiences more than two discharges in a twelve-month period, the operator must submit the C-Plan to the EPA and ADEC for review. The C-Plan differs from the facility response plans (FRP) required by the federal Oil Pollution Act of 1990 in that the C-Plan focuses on prevention and the FRP focuses on response.

F. U.S. Army Corps of Engineers

1. Section 10 and Section 404 Permits

a. Permit Description

The U.S. Army Corps of Engineers (Corps) has regulatory authority over construction, excavation, or deposition of materials in, over, or under navigable waters of the United States, or any work which would affect the course, location, condition, or capacity of those waters (Rivers and Harbors Acts of 1890 [superseded] and 1899 [33 USC 401, et seq.; Section 10 [33 USC 403]; USACOE 2008b). Termed Section 10 permits, oil and gas activities requiring this type of authorization include exploration drilling from jack-up drill rigs and installation of production platforms.

Section 404 of the Clean Water Act established a program to regulate the discharge of dredged and fill material into waters and wetlands of the United States. This program is administered by the Corps, which is authorized to issue Section 404 permits for discharging dredge and fill materials.

Individual permits (issued for specific projects) are the basic type of permit issued. General permits (including programmatic, nationwide, and regional general permits) authorize activities that are minor and will result in minimal individual and cumulative adverse effects. General permits carry a standard set of stipulations and mitigation measures. Letters of permission, another type of project authorization, are used when the proposed project is minor, will not have significant individual or cumulative environmental impact, and appreciable opposition is not expected. The process for these authorizations is similar (USACOE 2008a, b).

b. Review Process

Section 404 and Section 10 permits follow a similar three-step review process: pre-application consultation (for major projects), formal project review, and decision making.

During the pre-application consultation, the applicant meets with Corps staff from the local district, interested resource agencies (federal, state, or local), and at times, interested public. These meetings provide informal discussions about the proposal before the applicant commits resources such as funds and detailed designs to the project; provide the applicant with possible alternatives and measures for reducing project impacts; and provide the applicant with information about factors the Corps considers in the permitting process (USACOE 2008a, b).

After receiving a formal application, the first step in the Corps' project review is to obtain public input, which is central to the permitting process. The project is public noticed, and comments and information are requested that will assist with evaluating the positive and negative effects on the public interest. Public hearings may be held if substantial issues are raised that warrant additional public input. USFWS, NMFS, ADNR, and ADF&G may also submit comments to the Corps (USACOE 2008a, b).

Next, the Corps evaluates the project's impacts, considers all comments received, negotiates changes to the project as required, and drafts documentation supporting a recommended permit decision including environmental impacts of the project, findings of public input, and other special evaluations depending on the type of project (USACOE 2008a, b).

In making a final decision on whether to issue a permit, the Corps weighs all relevant factors, which can include conservation, economics, aesthetics, wetlands, cultural values, navigation, fish and wildlife values, water supply, water quality, and other factors judged important to the needs and welfare of the people (USACOE 2008a, b).

The process for letters of permission is abbreviated. In this situation, the proposal is coordinated with fish and wildlife agencies and adjacent property owners who might be affected by the project, but the public at large is not notified (USACOE 2008a, b).

ADEC participates in the permit review process by reviewing the permit application to ensure that the proposed project will comply with Alaska water quality standards. ADEC then approves of the permit through a Clean Water Act Section 401 Certification. Permits may also receive review by other agencies, such as the USFWS and NMFS, to ensure compliance with other laws such as the Endangered Species Act, the National Environmental Policy Act, and Essential Fish Habitat Provisions of the Magnuson-Stevens Act.

G. Pipeline and Hazardous Materials Safety Administration

The federal Office of Pipeline Safety (OPS) in the Pipeline and Hazardous Materials Safety Administration (PHMSA), an agency of the U.S. Department of Transportation, is responsible for regulating movement of hazardous materials by pipe (PHMSA 2008). OPS develops regulations and other approaches to risk management to assure safety in design, construction, testing, operation, maintenance, and emergency response of pipeline facilities (PHMSA 2008). Alaska is not a member of OPS' national pipeline inspection and enforcement program.

H. North Slope Borough

The North Slope Borough has adopted a comprehensive plan and land management regulations under Title 29 of the Alaska Statutes (AS 29.40.020-040). These regulations are Title 19 of the NSB Municipal Code and require borough approval for certain activities necessary for exploration and development of oil and gas leases. The borough may assert its land management powers to the fullest extent permissible under law to address any outstanding concerns regarding impacts to the area's fish and wildlife species, habitat, and subsistence activities.

I. Other Requirements

1. Native Allotments

Lessees must comply with applicable federal law concerning Native allotments. Activities proposed in a plan of operations must not unreasonably diminish the use and enjoyment of lands within a Native allotment. Before entering onto lands subject to a pending or approved Native allotment, lessees must contact the Bureau of Indian Affairs (BIA) and the Bureau of Land Management (BLM) and obtain approval to enter.

2. U.S. Coast Guard

The U.S. Coast Guard has authority to regulate offshore oil pollution under 33 CFR §§ 153-157 and to make a determination of a hazard to navigation under 33 CFR § 64.31.

3. Rehabilitation Following Lease Expiration

Upon expiration or termination of the lease, paragraph 21 of the lease contract requires the lessee to rehabilitate the lease area to the satisfaction of the state. The lessee is granted one year from the date of expiration or termination to remove all equipment from the lease area and deliver up the lease area in good condition.

4. Applicable Laws and Regulations

In addition to existing laws and regulations applicable to oil and gas activities, DO&G requires, under paragraph 26 of the state's standard lease contract, that leases be subject to all applicable state and federal statutes and regulations in effect on the effective date of the lease. Leases will also be subject to all future laws and regulations placed in effect after the effective date of the leases to the full extent constitutionally permissible and will be affected by any changes to the responsibilities of oversight agencies.

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Chapter Eight: Reasonably Foreseeable Effects of Leasing and Subsequent Activity

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Chapter Eight: Reasonably Foreseeable Effects of Leasing and Subsequent Activity

Until leases are sold and discoveries are made, DO&G cannot predict whether and when any oil and gas activity might occur, or the type, location, duration, or level of those potential activities. In addition, methods to explore for, develop, produce, and transport petroleum resources will vary depending on the area, lessee, operator, and discovery. Best interest findings are not required to speculate about such possible future effects (AS 38.05.035).

Potential effects of oil and gas lease sales can be both positive and negative. Most potentially negative effects on fish and wildlife species, habitats, and their uses, on subsistence uses, and on local communities and residents can be avoided, minimized, or mitigated. A full listing of proposed mitigation measures can be found in Chapter Nine.

This preliminary best interest finding does not speculate about possible future effects subject to future permitting that cannot reasonably be determined until the project or proposed use is more specifically defined (AS 38.05.035). The effects of future exploration, development, or production will be considered at each subsequent phase, when various government agencies and the public review permit applications for the specific activities proposed at specific locations in the lease sale area.

It is important to note that all post-leasing activities are also subject to local, state, and federal statutes, regulations, and ordinances, many of which are listed as other regulatory requirements (lessee advisories) in Chapter Nine (see also Chapter Seven and Appendix B). Additional project-specific and site-specific mitigation measures will be required by permitting agencies if exploration and development proposals are submitted.

Leasing activities alone are not expected to have any effects, other than to provide initial revenue to the state. Post-lease activities could affect the terrestrial, freshwater, and marine habitats and fish and wildlife of the proposed lease sale area. These activities could include seismic surveys related to exploration, development, and production; environmental and other studies; excavation of material sites; construction and use of support facilities such gravel pads, staging areas, roads, airstrips, pipelines, and housing; transportation of machinery and labor to the site; and construction of drill sites and ongoing production activities. Unintended occurrences such as oil spills would also have effects.

A. Effects on Air Quality

1. Potential Cumulative Effects

Air quality throughout the proposed lease sale area is good; concentrations of regulated pollutants are below the maximum allowed under the National Ambient Air Quality Standards. In order to ensure maintenance of air quality standards, emissions of nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone, and particulate matter are closely watched under the provisions of the Prevention of Significant Deterioration Program, which is administered by ADEC (ADEC 2007a).

Oil and gas exploration, development, and production activities may produce emissions that potentially affect air quality. Equipment that could produce pollutants includes boilers, diesel engines, drilling equipment, flares, glycol dehydrators, natural gas engines and turbines, and fugitive emissions (leaks from sealed surfaces associated with process equipment) (MMS 2004a, b).

Greenhouse gas emissions (CO_2 and CH_4) are another potential source of air pollution. These emissions come primarily from the burning fossil fuels in generators, vehicles, heavy construction equipment, aircraft, and camp operations, as well as the flaring and venting of natural gas. Fugitive sources account for a significant percentage of CH_4 emissions from oil and gas operations. Beaufort Sea sources of anthropogenic greenhouse gas emissions represent a negligible contribution ($\leq$ .02 percent) to U.S. greenhouse gas emissions (MMS 2008).The Alaskan oil and natural gas industry emitted an estimated 3.0 million metric tons of greenhouse gases statewide in 2005, contributing about 6 percent of the state's total greenhouse gas emissions (Roe et al. 2007). This is a decrease from 1990 and 2000, and continued decreases are expected through 2020. There are significant uncertainties with these estimates. These estimates are for fugitive emissions, which are released during the production, processing, transmission, and distribution of oil and gas. Fugitive emissions include methane and carbon dioxide released from leakage and venting at oil and gas fields, processing facilities, and pipelines. Estimates of emissions resulting from fuel combustion are only available for residential, commercial, and all industries combined, and are not available for the oil and gas industry separately (Roe et al. 2007).

Air emissions from seismic operations arise primarily from the main engines and generators of the seismic and support vessels. Marine seismic operations would cause only a short-term, local increase in the concentration of criteria pollutants. In addition, because emissions would be from mobile sources, they would be spread over a substantially larger area and are expected to be rapidly dispersed by prevailing offshore winds. The potential impacts to air quality from marine seismic work are considered negligible (MMS 2007c).

On-road and off-road vehicles, heavy construction equipment, and earth-moving equipment would produce emissions from engine exhaust and dust. Sources of air emissions during drilling operations include rig engines, camp generator engines, steam generators, waste oil burners, hot-air heaters, incinerators, and well test flaring equipment. Emissions would be generated during installation of pipelines and utility lines, excavation and transportation of gravel, mobilization and demobilization of drill rigs, and during construction of gravel pads, roads, and support facilities. Emissions would also be produced by engines, turbines, and heaters used for oil/gas production, processing, and transport. In addition, aircraft, supply boats, personnel carriers, mobile support modules, as well as intermittent operations such as mud degassing and well testing, would produce emissions (MMS 2008).

Other sources of air pollution include evaporative losses of volatile organic compounds (VOC) from oil/water separators, tanks, pump, compressor seals, and valves. Venting and flaring could be an intermittent source of VOC and sulfur dioxide (MMS 2008). Gas blowouts, evaporation of spilled oil, and burning of spilled oil may also affect air quality. Gas or oil blowouts may ignite. A fire could deposit a light, short-term coating of particulates over a localized area. In-situ burning of spilled oil must be pre-approved by ADEC and EPA and/or the US Coast Guard (ADEC et al. 2008); controlled in-situ burning of spilled oil is only allowed if it is located a safe distance from populated areas. Approved burn plans require removal of particulates.

The probability of a gas blowout is considered low. If a gas blowout did occur, it is estimated that it would not persist more than 1 day and that it would release less than 2 tons of volatile organic compounds (MMS 2003b).

Other effects on air quality include possible damage to vegetation, acidification of nearby areas, and atmospheric visibility impacts. Effects could be short term (hours, days, or weeks) or long term (seasons or years), local (near the activity only) or regional (North Slope) (BLM 2005).

2. Mitigation Measures and Other Regulatory Protections

Although oil and gas activities subsequent to leasing could potentially affect air quality, federal and state air quality regulations, particularly the Clean Air Act (42 USC §§ 7401-7661), 18 AAC 50, and AS 46.14, are expected to avoid, minimize, and mitigate those potential effects. Therefore, additional mitigation measures are not included.

Because industrial emissions such as those listed above can have negative environmental effects, the federal Clean Air Act of 1970 and subsequent amendments regulate air quality across the U.S., including in Alaska (EPA 2007). Although the EPA is the primary federal agency responsible for controlling air pollution, monitoring air quality, and inspecting facilities (EPA 2007), many of these authorities in Alaska have been delegated to ADEC under a federally-approved State Implementation Plan (ADEC 2008). State and federal regulations require facilities that emit certain pollutants or hazardous substances to obtain a permit: new facilities are required to obtain a permit before construction (Title I, NSR permit); existing facilities must have an operating (Title V) permit. Permits are legally binding and include enforceable conditions. The permit limits the type and amount of emissions and requires pollution control devices, prevention activities, monitoring, and record keeping (EPA 2008a).

ADEC also operates ambient air quality monitoring networks to assess compliance with the National Ambient Air Quality Standards (NAAQS) for carbon monoxide, particulates, nitrogen dioxide, sulfur oxide, and lead; assesses ambient air quality for ambient air toxics level; provides technical assistance in developing monitoring plans for air monitoring projects; and issues air advisories to inform the public of hazardous air conditions (ADEC 2008).

Operators in Alaska are required to minimize the volume of gas released, burned, or permitted to escape into the air (20 AAC 25.235(c)). Operators must report monthly to AOGCC any flaring event lasting over an hour. AOGCC investigates these incidents to determine if there was unnecessary waste (AOGCC 2004).

Additional information about air quality regulations and permits is found in Chapter Seven.

B. Effects on Water

1. Potential Cumulative Effects

Cumulative effects on marine water quality would be due primarily to three factors: discharges of drilling muds, cuttings, and produced waters; increased turbidity from construction of gravel islands and subsea pipeline trenches; and oil spills. Increased turbidity, caused by increases in suspended particles in the water column, could result from repairing a pipeline or constructing a gravel island or pipeline. The effects of discharges and offshore construction activities are expected to be short term, lasting as long as the individual activity, and would have the greatest impact in the immediate vicinity of the activity (MMS 2007a).

Water quality characteristics that may be altered by oil and gas activities include: pH, total suspended solids, organic matter, calcium, magnesium, sodium, iron, nitrates, chlorine, and fluoride. Potential activities that may alter surface water quality parameters include accidental spills of fuel, lubricants, or chemicals; increases in erosion and sedimentation causing elevated turbidity and suspended solids concentrations; and oil spills.

Onshore geophysical exploration with tracked seismic vehicles is not expected to alter water quality because seismic surveys are conducted in winter and permit conditions mitigate potential damage. Under standard ADNR permit conditions for winter seismic exploration, the use of ground-contact vehicles for off-road travel is limited to areas where adequate ground frost and snow cover prevent damage to the ground surface. Operations are restricted to winter.

Seismic equipment, other than vessels, must not enter open-water areas of a watercourse during winter, and any roads, bridges, or approach ramps constructed near river, slough, or stream crossings must be free of extraneous material before breakup. Alterations of the banks of a watercourse are prohibited. Adherence to these conditions avoids or minimizes post-seismic increases in erosion, turbidity, and suspended solids in a drainage area.

Marine water quality could be affected by accidentally spilled lubricating oil or diesel fuel from vessels and equipment associated with seismic survey operations. MMS concluded the effect of spilling a few barrels or gallons probably would be un-measurable. MMS assessed the effects of a 1,000-bbl spill, concluding that the effects would be low regionally, but moderate locally (MMS 2007b).

The extent and duration of water quality degradation resulting from accidental spills depends on the type of product, the location, volume, season, and duration of the spill or leak, and the effectiveness of the cleanup response. Heavy equipment, such as trucks, tracked vehicles, aircraft, and tank trucks, commonly use diesel fuel, gasoline, jet fuel, motor oil, hydraulic fluid, antifreeze, and other lubricants. Spills or leaks could result from accidents, during refueling, or from corrosion of lines (ADEC 2007b). Under standard ADNR permit conditions for off-road activity, fuel and hazardous substances must have secondary containment apparatuses. A secondary containment or surface liner must be placed under all container or vehicle fuel tank inlet and outlet points. Appropriate spill response equipment must be on hand during any transfer or handling of fuel or hazardous substances. Vehicle refueling is prohibited within annual floodplains (ADGC 1995). Impacts and cleanup of crude oil spills are discussed in Chapter Six.

Other standard ADNR land use permit conditions serve to protect water quality from facility construction and operation. Work areas must be kept clean. Trash, survey markers, and other debris that may accumulate in camps or along seismic lines and travel routes that are not recovered during the initial cleanup must be picked up and properly disposed. All solid wastes, including incinerator residue, must be backhauled to an approved solid waste disposal site. Vehicle maintenance, campsites, and the storage or stockpiling of material on the surface of lakes, ponds, or rivers is prohibited (ADGC 1995).

The federal Clean Water Act established National Pollutant Discharge Elimination System (NPDES) permits to regulate discharges of pollutants into U.S. waters by “point sources,” such as industrial and municipal facilities. Administration of NPDES permits is being transferred from EPA to ADEC over a three-year time period. Permits are designed to maximize treatment and minimize harmful effects of discharges as water quality and technology improvements are made. ADEC certifies that these discharge permits will not violate the state’s water quality standards.

ADEC also certifies U.S. Army Corps of Engineers permits to dredge and fill wetlands and navigable waters, to ensure compliance with state water quality standards.

ADEC issues industrial and municipal wastewater permits and monitors wastewater discharges and the water quality of water bodies receiving the discharges. ADEC certifies federal wastewater permits with mixing zones that allow industrial and municipal facilities to meet state water quality standards. Industrial and municipal wastewater facilities are inspected annually. ADEC provides technical assistance for design, installation, and operation of industrial and municipal wastewater systems.

<u>Drilling Muds and Produced Water</u>: Drilling muds, cuttings, produced waters, and other effluents from oil and gas exploration, development, and production can have short- and long-term negative effects on aquatic life, including fish and benthic organisms (Olsgard and Gray 1995). Effects can be lethal, or sub-lethal effects may subtly reduce or impair physiological and reproductive fitness (Davis et al. 1984). Sedentary animals, such as oysters, clams, and mussels, are more susceptible to

releases of petroleum products than fish and shellfish such as crabs and shrimps, which are capable of active avoidance (Davis et al. 1984). MMS monitoring in the Beaufort Sea has determined that drilling sites have not accumulated hydrocarbons or heavy metals; amphipods and clams analyzed at Northstar and other coastal Beaufort Sea sites showed no differences (MMS 2003b). Oil spills or impairments to water quality could have detrimental effects on mariculture industries (ADF&G 2007). Type and extent of effects depend on a myriad of factors, including habitat involved, species, life history stage, migration patterns, nursery areas, season, type of chemical, amount and rate of release, time of release, duration of exposure, measures used for retaining the chemical, and use of counteracting or dispersing agents (Davis et al. 1984). Cumulative impacts from exploration and development activities could adversely affect water quality; however, the impacts are expected to be local and temporary because of dilution, settling, and other natural altering and regenerative processes (MMS 2008).

Byproducts of drilling and production activities include muds and cuttings, produced water, and associated wastes. During drilling and after a well is in production, water comes to the surface mixed with oil and gas and must be separated before further refining. Drilling employs the use of carefully mixed fluids, called muds. Cuttings are small fragments of rock up to an inch across that are dislodged and carried to the surface by drill muds. Drilling muds are mostly water-based mixtures of clay and other earthen materials, such as almond husks, which are used to cool and lubricate the drilling bit, facilitate the drilling action, flush out cuttings within the well bore, seal off cracks in down-hole formations to prevent the flow of drilling fluids into these formations, and maintain reservoir pressure. Chemicals may be added to maximize the effectiveness of drilling and casing. Oil-based muds and synthetic-based muds may also be used, depending on the well depth, well diameter, and subsurface formations (NRC 1983;Veil et al. 1996). According to a 1993 EPA report, the use of water-based muds generates 7,000 to 13,000 barrels of waste per well. Depending on the depth and diameter of the well, 1,400 to 2,800 of these barrels are cuttings. Oil-based mud volumes are generally used less than water-based muds, because they are more efficient, may be reconditioned, reused, and re-sold. Technological advances in drilling mud systems have developed mud systems less toxic to the environment (NRC 2003). Newer synthetic-based muds produce even less waste, improve drilling efficiency, are reusable, and have advantages in environmental protection over oil or water-based muds (Wojtanowicz 2008). Synthetic muds are more expensive and are typically reconditioned instead of discharged (BLM 2008b). Discharge of untreated oil-based muds into any water column violates federal and state pollution laws.

Produced water contains natural occurring substances such as clay, sand, oil, water, and gas. These substances are found in the subterranean strata. Produced waters are usually saline with some level of hydrocarbons. Associated wastes are other production fluids such as tank bottom sludge, well work-overs, gas dehydration processes, tank wastewater, and other residues that are considered non-hazardous (low-toxicity) by the EPA. Like drilling muds, chemicals may be added to produced water to remove harmful bacteria, halt corrosion, break up solids, prevent buildup of scale, and break oil/water emulsions (EPA 1995).

Most drilling wastes from onshore and nearshore operations are disposed of under ADEC's solid waste disposal program. Re-injection is the preferred method for disposal of drilling fluid. Disposal of drilling muds and cuttings requires permit approval. Most oil field wastes are considered non-hazardous and waste fluids are recycled, filtered, and treated before reinjection or disposal. Cuttings and waste fluids must be made non-hazardous before injection. Produced water is treated using heat, gravity settling, and gas flotation devices to remove hydrocarbons. After treatment, produced water is reinjected into either the oil-bearing formation to maintain pressure and enhance recovery or into an approved disposal well. Cuttings disposal is done through grinding and injecting on-site, or cuttings are transported to an approved disposal site. Cuttings disposal can cost more than the total cost to drill a well. Wastewater, including sanitary and domestic graywater, is also treated to meet effluent guidelines before discharge.

The AOGCC ensures proper and safe handling and disposal of drilling wastes. The AOGCC functions as the regulatory agency overseeing the underground operation of the Alaska oil industry on private and public lands and waters. The commission administers the Underground Injection Control (UIC) Program for oil and gas wells, acts to prevent waste of oil and gas resources and ensure maximum recovery, and protects subsurface property rights. All disposal wells inject fluids deep beneath any drinking water aquifers.

2. Mitigation Measures and Other Regulatory Protections

Although oil and gas activities subsequent to leasing could potentially have cumulative effects on marine habitats, fish, and wildlife, measures proposed in this preliminary best interest finding, along with laws and regulations imposed by other state, federal and local agencies, are expected to avoid, minimize, and mitigate any potential effects.

For example, because of the potential effects discussed above, effluents discharged by the oil and gas industry into marine waters of the Beaufort Sea are regulated through EPA's NPDES program (see Chapter Seven). This program, which covers a broad range of pollutants, ensures that state and federal clean water quality standards are maintained by requiring a permit to discharge wastes into U.S. waters (EPA 2008b). NPDES permits specify the type and amount of pollutant, and include monitoring and reporting requirements, to ensure that discharges are not harmful to water quality and human health (EPA 2008a). Therefore, marine fish, mammals, and other aquatic organisms are not expected to be impacted by drilling muds, cuttings, produced waters, and other effluents associated with oil and gas exploration, development, and production.

Permits may contain stipulations on water use and quantity drawn in order to meet standards related to protection of recreation activities; navigation; water rights; or any other substantial public interest. Water use permits may also be subject to conditions, including suspension and termination of exploration activities, in order to protect fish and wildlife habitat, public health or the water rights of other persons. Before a permit to appropriate water is issued, ADNR considers local demand and may require applicants to conduct aquifer yield studies. Generally, water table declines associated with the upper unconfined aquifer can be best mitigated by industrial users tapping confined (lower) layers or searching for alternate water sources.

Mitigation measures included in this best interest finding which address water quality include: protection of wetland, riparian, and aquatic habitats, prohibitions of discharges into marine waters, turbidity reduction, water quality monitoring, stream buffers, and water conservation. A complete listing of mitigation measures is found in Chapter Nine.

C. Effects on Lower Trophic-Level Organisms

1. Potential Cumulative Effects

Organisms near the bottom of the food chain include marine plankton, shellfish, marine invertebrates, and terrestrial vegetation. Some oil and gas activities may affect the viability, distribution, reproduction, and abundance of these creatures, which may in turn affect species that feed on them. Habitat protection measures are designed to minimize adverse effects from potentially harmful oil and gas activities.

<u>Seismic Surveys</u>: Seismic surveys are expected to have little or no effect on plankton, because the energy sources (airguns) do not appear to have any adverse effect on this group of organisms. In general, even high explosives have had relatively little effect on marine invertebrates. Airguns also were shown to have no lethal effect on caged oysters placed close to the airguns. The use of ocean-

bottom cable seismic arrays has the potential to cause harm, although the effect, if any, would probably not be measurable. Seismic activities are, therefore, expected to have little or no effect on lower trophic level organisms (MMS 2008).

Drilling and Production Discharges: The types of materials discharged while drilling include drilling muds and cuttings. During production, the main discharge is produced waters. These discharges may contain small amounts of hydrocarbons and create plumes of material that disperse rapidly in the water column. In most continental shelf areas, most drilling muds and cuttings land on the sea bottom within 1,000 m the of the discharge point. The effect of drilling discharges on lower trophic-level organisms appears to be restricted to benthic organisms living nearest to the discharge source. There is no evidence of effects on plankton from drilling muds (MMS 1998). Other than those caused by permitted discharges and physical alterations or addition of structures, there have been few measurable effects on marine invertebrate communities from oil exploration and production operations in the region (NRC 2003).

Discharge of produced waters into open or ice covered waters less than 33 ft is prohibited; nearly all of the proposed lease sale area lies in waters shallower than 33 ft. In areas deeper than 33 ft, the commissioner of ADEC may approve discharges on a case-by case basis. MMS estimates that drilling discharges would affect less than 1 percent of benthic organisms and none of the plankton. Effects would mostly be sublethal, but some benthic organisms would be killed (MMS 2003b). Muds and cuttings from exploratory wells are typically discharged onto sea ice. This silty material, similar to riverine overflow sediments, may block sunlight and reduce photosynthesis of plankton in the water column. The area of impact would be limited to the immediate vicinity of the drill site, or where the ice melted when cuttings are carried out to sea with drifting ice after spring break-up.

Permitted drilling discharges are estimated to adversely affect less than 1 percent of the benthic organisms in the proposed lease sale area. These organisms likely would recover within a year. In the unlikely event that a large oil spill occurs, it is expected to be lethal for less than 1 percent of the planktonic organisms and, assuming a winter spill, less than 5 percent of the epontic organisms in the vicinity. Recovery of plankton would likely occur within 2 weeks (MMS 2003b).

Disturbance: Offshore construction typically involves the placement of bottom-founded production platforms and laying pipe. These activities normally would affect only benthic invertebrates and marine plants in the immediate vicinity. Construction is expected to have little or no effect on phytoplankton or zooplankton communities. However, dredging can affect benthic invertebrates and marine plants by physically altering the benthic environment, increasing sediments suspended in the water column, and killing organisms directly through mechanical actions.

Recovery time assumes that populations are stable or increasing at the time of impact. For those populations that may be declining, recovery to pre-development conditions may take longer. Population level (Beaufort wide) effects from construction of gravel islands and pipelines and from caisson use on lower trophic-level communities are very unlikely because of the relatively small area directly affected. Construction of gravel islands has had a short-term (1 to 2 years) affect on some benthic organisms near islands or dredging sites (MMS 1996). Platform and pipeline construction is estimated to adversely affect less than 1 percent of the immobile benthic organisms in the proposed lease sale area (MMS 2003b). Recovery likely would occur within a decade (MMS 2008). Kelp communities likely would colonize and slowly benefit from newly constructed gravel islands (MMS 2003b).

Gravel islands may be constructed in the nearshore zone off river deltas, in areas of high deposition. During high flow periods, the Colville and Sagavanirktok River delta systems transport and deposit large volumes of sediment in the nearshore environment. The sedimentation and turbidity caused by gravel island construction would be nearly undetectable against the naturally high sediment load in the Colville River delta system (BLM 2004). The greatest effects on water turbidity that construction may have would be during clear water phases, which occur during frozen conditions.

Increased turbidity can affect biological productivity by preventing sun light from penetrating the water column. During the winter, ice, temperature, and lack of sunlight are more influential in affecting biological productivity than water turbidity. During construction of gravel islands, benthic creatures may be buried and affected by the down current sediment plume. Factors affecting sedimentation are current speed, construction materials, and depth of water. It was concluded that, at distances beyond 100 m from an island, it would be difficult to detect differences in sedimentation volume between gravel island construction and natural sedimentation in the area. The increased turbidity from permitted construction activities would be local and short term (MMS 2003b).

Ice roads and pads cause depressions in microtopography due to compaction. The thaw depth in summer increases, as does wetness due to compression. Ice roads compress and shear tussocks, which may take up to 4 years or more to recover. Ice road and pads also affect tundra regeneration, with certain species recovering faster after summer melt than others. Vegetation should recover within three seasons following melt. Ice road thaw depths return to pre-impact levels after several years (Yokel et al. 2007).

<u>Natural Gas Development</u>: If a natural gas blowout occurred, some marine invertebrates in the immediate vicinity might be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. A plume of natural gas vapors and condensates would be dispersed very rapidly from the blowout site, but is not expected to be hazardous for greater than 1 kilometer downwind or for greater than one day. Activities associated with laying a gas pipeline would have localized effects on marine organisms. Mobile organisms such as adult crabs are expected to have virtually no adverse effects; however, longer-term but extremely localized effects over a small area are possible for immobile benthic organisms, such as clams. In some instances, the alteration of the benthos by laying pipe could enhance habitat for some lower trophic level organisms. Natural gas exploration and/or development in the Beaufort Sea are expected to have little to no effect on lower trophic-level organisms (MMS 1998).

<u>Oil Spills</u>: The effects of spilled oil on phytoplankton, zooplankton, and benthic communities range from lethal to sublethal. Adverse effects are expected to be greater in areas where water circulation is reduced, such as bays and estuaries. Phytoplankton would regenerate rapidly (9 to 12 hours) limiting any effect on phytoplankton communities and animals at higher trophic levels. Zooplankton communities experience short-lived effects from oil and appear to recover rapidly due to their wide distribution, large numbers, and rapid rate of regeneration (MMS 1996). If oil entered the substrate, some specie communities may require years to recover, and may be completely replaced by more hydrocarbon-tolerant specie communities.

In cases where studies have been conducted following an oil spill, a lack of substantial adverse effects on phytoplankton populations from spilled oil is common. Even if it is assumed that large numbers of phytoplankton are contacted by an oil spill in an open-ocean area, regeneration time (9-12 hours) and rapid replacement are expected to prevent any major effect on phytoplankton communities. Further, vertical distribution of most phytoplankton in the water column typically is below the area were they would be adversely affected by spilled oil. For these reasons, a large oil spill is not expected to have significant effects on phytoplankton. Recovery likely would occur within a month (within a year where water circulation is significantly reduced) (MMS 2003b).

There is no traditional intertidal zone in the Beaufort Sea. This is due to the annual pre-dominance of shorefast ice, which restricts marine plant life and most fauna along the shoreline. Nonetheless, marine plants do exist subtidally at a few locations in the Beaufort Sea, most notably at the Boulder Patch. The estimated effect of a large oil spill on subtidal marine plants in the Beaufort Sea area depends on the type and amount of oil reaching them. However, the only type of oil that can reach marine plants in the subtidal zone (most are 5 to 10 m deep) would be highly dispersed oil having no measurable toxicity due to heavy wave action and vertical mixing. The amount and toxicity of oil reaching subtidal marine plants is expected to be so low as to have no measurable effect on them (MMS 1998).

2. Mitigation Measures and Other Regulatory Protections

Although oil and gas activities subsequent to leasing could potentially have cumulative effects on lower trophic organisms, mitigation measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to avoid, minimize, and mitigate those potential effects.

For example, because of the potential effects discussed above, effluents discharged by the oil and gas industry into marine waters of the Beaufort Sea are regulated through EPA's NPDES program (see Chapter Seven). This program, which covers a broad range of pollutants, ensures that state and federal clean water quality standards are maintained by requiring a permit to discharge wastes into the nation's waters (EPA 2008b). NPDES permits specify the type and amount of pollutant, and include monitoring and reporting requirements, to ensure that discharges are not harmful to water quality and human health (EPA 2008a). Discharge of produced waters in marine waters less than ten meters deep is prohibited; most waters in the proposed lease sale are shallower. The commissioner of ADEC may approve discharges into waters greater than ten meters in depth after a case-by-case review of environmental factors and consistency with the conditions of a state-certified development and production phase NPDES permit. Furthermore, lessees must have an approved oil discharge prevention and contingency plan (C-Plan) before commencing operations. A complete listing of mitigation measures and other regulatory protections is found in Chapter Nine.

D. Effects on Land Habitat

1. Potential Cumulative Effects

Although this is primarily an offshore sale, a very small amount of sale lands lie onshore between the Colville and Canning Rivers. During oil and gas development and production, various activities could impact vegetation in the proposed lease sale area. These activities include construction and use of gravel pads, staging areas, roads, airstrips, and pipelines, excavation of material sites, and construction of ice roads and ice pads.

<u>Transportation</u>: Winter seismic surveys can affect tundra vegetation, depending on snow depth, vehicle type, traffic pattern, and vegetation type. Camp-move trails disturb vegetation more than seismic trails. Multiple vehicles in a single narrow trail cause more disturbance than dispersed tracks. Trails in shrub-dominated tundra recover slower than other vegetation types (Jorgenson and Martin 1997).

<u>Seismic Surveys</u>: Seismic surveys can compress microtopography, resulting in a wetter microenvironment and decreased vegetation cover of upright shrubs (willows), lichens, and mosses. Winter seismic trails have little adverse effect on, and may possibly enhance growth of, *C. aquatalis* and *E. angustifolium* due to the resulting wetter microenvironment (Noel and Pollard 1996, citing to Felix and Raynolds, 1989). Effects could be substantial if operations are conducted improperly. Vehicles can leave visible tracks in the tundra that should disappear with the recovery of the vegetation within a few years. Vehicles using tight turning radii have sheared off upper layers of vegetation, but left rhizomes intact, so those plants should recover. Dry, snowless ridges and vegetated sand dunes are at higher risk of damage. Damage to vegetation can be avoided by limiting travel to areas with at least 6 inches of snow cover, and avoiding minimum radius turns. In areas where damage is extensive and natural recovery not expected, restoration may be required of operators (DO&G 1996).

Overland moves and seismic surveys could alter the thermal balance, and increase the risk of thermokarsting, which is an irregular land formation due to the uneven melting of permafrost. The increase of thermokarsting, gullying, and sedimentation could impact other resources and land uses; for instance, surface travel could become more difficult. Soil erosion would increase and, in turn, disturb vegetation; therefore, the most effective mitigation would be to keep areas of disturbance as small as possible (BLM 2005).

Observations by the BLM and others (NRC 2003) indicate that short-term, transitory impacts to the tundra by seismic surveys can be estimated at about 1 percent of the seismic line mileage conducted during a winter season. Long-term impacts due to thermokarst are estimated at about 1 percent of the short-term impacts. Thus, modern-day seismic equipment has minimal impact to the tundra and a limited role in causing thermokarst. Limiting land seismic surveys to areas with adequate snow cover would greatly reduce the potential for thermokarst and long-term impacts to the tundra (BLM 2005). Based on earlier studies there should be no long-term impacts to vegetation from seismic lines (BLM 2005).

Drilling and Production Discharges: During exploration well drilling, muds and cuttings are stored on-site, in holding tanks, or in a temporary reserve pit, and then hauled to an approved solid waste disposal site or reinjected into the subsurface at an approved injection well. All production muds and cuttings on the North Slope are reinjected into a Class II injection well. All produced waters are reinjected either into the producing formation to enhance recovery or into an injection well. The Underground Injection Control program is administered by AOGCC. Drilling and production discharges are expected to have no impact on tundra habitat.

Construction and Gravel Infilling: Effects of constructing pads, roads, and pipelines include direct loss of acreage due to gravel infilling, and loss of dry tundra habitat due to entrainment and diversion of water. A secondary effect of construction activities includes dust deposition, which may reduce photosynthesis and plant growth.

While rehabilitation methods for gravel pad and roads vary depending on site-specific conditions, the overall goal of rehabilitation in the existing oil fields is to create a mosaic of moist meadows, sedge meadows, and grass marshes.

Development in the Prudhoe Bay and Kuparuk areas has directly affected about 9,500 acres because of gravel excavation and filling and indirectly affects many adjacent acres. The total affected acreage is a small part of the Arctic Coastal Plain, and cumulative effects probably are not significant to the overall productivity of tundra plants in this area (MMS 2008).

Gas Blowouts: If a natural gas blowout occurred, plants in the immediate vicinity could be destroyed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. Insects such as mosquitoes would also be affected or killed by a gas blowout. A plume of natural gas vapors and condensates would be dispersed very rapidly from the blowout site, but is not expected to be hazardous for more than 1 kilometer downwind or for more than one day. Impacts to vegetation from pollutants would likely not substantially alter the plant communities in the proposed lease sale area (BLM 2005).

Oil Spills: Spills can have toxic effects on soil productivity, depending on the season. Soils can also be impacted by compaction and thermokarst during cleanup activities. Oil spills of any size would affect soils by altering vegetation. The oil alone would decrease plant growth, but would leave the surface organic mat intact. Spill cleanup would be more likely to damage soils (BLM 2007).

In the March 2006, severe corrosion in a BP transit pipeline caused more than 6,357 bbl of oil to leak onto almost 2 acres of tundra. The spill resulted in a $6 million cleanup (see Chapter Six). ADEC officials believe the environmental damage to the tundra was minimal (ADN 2006a).

Fungi are important decomposers of organic material in tundra soil. Large numbers of fungi have been found in association with a natural oil seep at Cape Simpson. Under the right conditions involving oxygen, temperature, moisture in the soil, and the composition of the crude being spilled, bacteria assist in the breakdown of hydrocarbons in soils. Petroleum-contaminated soils are commonly treated with fertilization, raking, and tilling (bioremediation).

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities subsequent to leasing could potentially have cumulative effects on land habitat. Measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to avoid, minimize, and mitigate those potential effects. For example, impacts to important wetlands must be minimized, exploration facilities, including exploration roads and pads, must be temporary and must be constructed of ice, the preferred method for disposal of muds and cuttings from oil and gas activities is by underground injection. Impermeable lining and diking, or equivalent measures, will be required for reserve pits. New solid waste disposal sites will not be approved or located on state property during the exploration phase. A complete listing of mitigation measures is found in Chapter Nine.

E. Effects on Fish

1. Potential Cumulative Effects

Major anadromous streams within the proposed lease sale area, or that drain into the Beaufort Sea, include the Colville, Sagavanirktok, Shaviovik, Kavik, Canning, and Kadleroshilik Rivers. Numerous other rivers and streams that flow through the sale area also support anadromous fish populations. Several species of anadromous fish spawn and overwinter in these rivers and during summer migrate to nearshore coastal waters of the sale area to feed. Migration patterns vary by species and within species by life stage (see Chapter Four). Potential effects include degradation of stream banks and erosion; reduction of or damage to overwintering areas; habitat loss due to gravel removal, facility siting, and water removal; impediments to migration; and fish kills due to oil spills.

Habitat Loss: Erosion is a potential impact of all phases of exploration and development. Erosion results in siltation and sedimentation, which in turn may reduce or alter stream flow, affecting overwintering habitat availability and the ability of fish to migrate upstream. Protecting the integrity of stream bank vegetation and minimizing erosion are important elements in preserving fish habitat. Streambeds could be affected if stream banks are altered, such as in cases of damage from equipment crossings. Overwintering habitat may be limited; the Colville River provides the most consistently available overwintering habitat for anadromous fish in the proposed lease sale area.

Withdrawal of water from lakes and ponds could affect fish overwintering habitat by entraining juvenile fish, lowering water levels, and increasing disturbance. The construction of roads across rivers and streams may also affect the ability of fish to reach overwintering areas by blocking movement and causing direct loss of overwintering habitat. Blockage of movement could also occur from the improper installation of culverts in streams for permanent roads.

During development, unregulated gravel removal from fishbearing streams could adversely impact anadromous fish. Gravel removal could increase sediment loads, change the streambed course, cause instability upstream, destroy spawning habitat, and create obstacles to fish migration. Gravel removal from streambeds could also cause potential damage to overwintering fish populations. Alternatively, gravel mine sites can be restored as overwintering habitat and thus add to total available fish habitat.

Removal of water from lakes where fish overwinter may affect the viability of overwintering fish, and longer-term effects of lake drawdown may impede the ability of fish to return to the lake in subsequent years. Removal of snow from lakes may increase the freeze depth of the ice, kill overwintering and resident fish, and adversely affect the ability of fish to utilize the lake in future years.

<u>Seismic Activities</u>: The principle impact attributed to seismic surveys involves the acoustic-energy pulses emitted by airguns. These energy sources may damage or kill eggs, larvae, and fry of some fishes occurring in close proximity to an airgun, but the harm generally is limited to within 5 m (15 ft) of the airgun and is greatest within 1 m (3 ft). Airguns are unlikely to cause immediate deaths of adult and juvenile marine fishes. Overall, the available scientific and management literature suggests that mortality of juvenile and adult fish, the age-classes most relevant to future reproductive fitness and growth, likely would not result from seismic-survey activity. MMS anticipates any injury to adult and juvenile fish to be limited to a small number of animals (MMS 2007b). Fish distribution and feeding behavior can be affected by the sound emitted from airguns and airgun arrays. Normal fish behavior likely returns when the airguns are turned off. Effects from seismic activity on marine and freshwater fish, in both the exploration and development stages, would be low (MMS 2003b).

Shockwaves from explosions can also shock and jar fish eggs at sensitive stages of development. These types of impacts are mitigated by restricting the use of explosives in close proximity to fishbearing lakes and streams. Mitigation measures are considered by DO&G on a case-by-case basis as a condition for obtaining a geophysical exploration permit. Mitigation measures to protect fish eggs may include limiting the timing of seismic work. Other restrictions may include requiring that seismic activities be set back from freshwater fish spawning areas so that shockwaves are reduced to safe levels before reaching incubating eggs during sensitive stages of development. Seismic surveys are not expected to have any measurable effect on Arctic fish populations (BLM 2005).

Vessel traffic may disturb some fish resources and their habitat during operations. However, vessel noise is expected to be chiefly transient; fishes in the immediate vicinity of such vessels are believed likely to avoid such noise perhaps by as much as several hundred meters. Vessel noise is likely to have negligible impact to fish resources (MMS 2007a).

Additional disturbance agents involve the introduction of hydrophone arrays towed or suspended in the ocean or placed on the seafloor. Seismic surveys typically cover a relatively small area and only stay in a particular area for hours, thereby posing transient disturbances. Adverse effects to the migration, spawning, and hatchling survival of fish most likely would be temporary and localized, and only a moderate level of disturbance or displacement would occur (MMS 2007a).

<u>Causeways</u>: The state discourages the use of continuous-fill causeways. Though remote, the possibility of needing a causeway into the nearshore Beaufort Sea to support development in portions of the proposed lease sale area does exist. Placement of causeways, particularly continuous-fill causeways into the nearshore Beaufort Sea or in river deltas, can alter patterns of nearshore sediment transport, alter patterns of water discharge to the nearshore environment, and alter temperature and salinity regimes in areas near the causeway. The extent of alterations depends on the size or length of the causeway, its location relative to nearby islands and river mouths or deltas, and pre-causeway oceanographic characteristics. Minimizing alterations is accomplished by proper siting, minimal size, and by ensuring that breaches are sized and located to maximize goals. Changes to the physical environment may alter patterns of use of the deltaic area by anadromous and marine fishes. Changing marine current flow and circulation patterns result in physical changes to delta channeling and shorelines which could affect use by animals which feed on fish, such as shorebirds and waterfowl (ADF&G 1996).

Any gravel structure that obstructs the natural migratory corridor near river mouths has the potential to adversely affect anadromous fish. Altering temperature and salinity in nearshore waters may affect the distribution and abundance of organisms upon which fish feed. For these reasons, solid-fill causeways are discouraged, and many designs, although ideal for field development, are unsuitable for the nearshore environment. Additionally, significant alterations of the shoreline or changes to natural temperature and salinity patterns are prohibited. Overall, the construction of causeways is not expected to have a measurable effect on fish populations in and adjacent to the proposed lease sale area(BLM 2005).

Gas Blowouts: If a natural-gas blowout occurred, some fish in the immediate vicinity might be killed. Natural gas condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. A plume of natural gas vapors and condensates would be dispersed very rapidly from the blowout site but is not expected to be hazardous (MMS 1998).

Oil Spills: Oil spills could range from small chronic leaks from equipment or facilities to catastrophic pipeline failures or, however unlikely, a blowout. The effects of oil spills on fish would depend on many factors, including the time of year, size of the spill, and water body affected. Potential adverse effects include direct mortality from oiling of the gills, mortality of prey species, mortality from consumption of contaminated prey, and blockage of movement or displacement from important habitats. Mortality of egg and larvae could occur in spawning or nursery areas. Sublethal effects may also reduce fitness and impair an individual's ability to endure environmental stress. Effects of oil spills during the winter would be expected to be negligible, but could be more significant during the open-water season, depending on the site-specific conditions. Mitigation measures to protect fish and eggs from an oil spill include: siting facilities away from fishbearing streams and lakes, development of oil spill contingency plans, and providing adequate spill response training. Oil spills are not expected to have a measurable effect on freshwater or anadromous fish populations within and adjacent to the proposed lease sale area (BLM 2005). The effects of an oil spill would be moderate because, in most cases, salmon likely would recover within one generation. One year of salmon smolt would be affected, and salmon populations would expect to recover (MMS 2003b).

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities subsequent to leasing could potentially have cumulative effects on uses of fish populations. Measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to avoid, minimize, and mitigate those potential effects. AS 16.05 requires protection of documented anadromous streams from disturbances associated with development. Use of continuous-fill causeways is discouraged. Disposal of wastewater into freshwater bodies is prohibited unless authorized by an NPDES permit. A complete listing of mitigation measures is found in Chapter Nine.

F. Effects on Birds

1. Potential Cumulative Effects

The principal sources of potential adverse effects to birds in the Beaufort Sea and onshore areas of the lease sale include habitat loss; seismic surveys; disturbance from vessel presence and noise; aircraft presence and noise; and oil spills.

Habitat Loss: Habitat loss occurs as facilities are developed, covering tundra habitats used by birds for nesting, foraging, broodrearing, and molting. Hundreds of acres of North Slope bird habitats have been filled by oil and gas infrastructure (fill pads, pipelines, roads, gravel pits, etc.), as well as community development (residences, schools, airports, roads, landfills, etc.). While some species may have or will benefit from wetter or drier habitats near these facilities, evidence suggests that many birds avoid using habitats near these developments and the human activities they support. For example, regular vehicle traffic on roads could permanently displace nesting birds near the development (MMS 2008). Secondary effects, including changes in drainage patterns, thermokarst, deposition of dust, and disturbance associated with activity on roads, can displace additional individuals. Shorebird densities are lower near roads and, but higher on the leeward sides of roads suggesting that dust shadows could create conditions attractive to shorebirds.

Shorebird populations have probably been affected by the loss in food supply caused by contamination of wetlands by reserve pits. However, because reserve pits are no longer used for disposal of drilling waste and because existing reserve pits are being emptied, the outlook is improved (NRC 2003).

<u>Seismic Activities</u>: Most seismic surveys to collect geological data and exploratory drilling would occur during the winter months when birds are mostly absent from the proposed lease sale area. Birds displaced by seismic activities would likely return to preferred habitats after the airgun arrays passed through the area. Disturbance to birds near the shoreline could result from support activities such as use of helicopters to transport personnel and supplies. Disturbance related to support activities could result in permanent or temporary displacement from nesting, feeding, or brood-rearing habitats. Conducting support activities after the completion of the nesting and broodrearing periods would eliminate nest abandonment and loss of productivity (BLM 2005).

Seismic surveys by vessel and air traffic have a potential to affect marine and coastal birds, however the increased potential for impacts is not expected to be significant. There may be localized, temporary displacement and disruption of feeding for some offshore species, but any cumulative adverse impacts to marine birds would be negligible. Aircraft needed to support seismic-survey vessels and possibly to conduct aerial monitoring for marine mammals would be a relatively small addition to existing commercial air traffic servicing local communities. No adverse cumulative impacts to marine birds are anticipated from air traffic required to support seismic-survey activities or related aerial monitoring. (MMS 2007b).

<u>Disturbance</u>: How waterfowl and marine birds respond to vessel presence and noise disturbances can vary widely depending on the species, time of year, disturbance source, habituation, and other factors. Vessels might disturb waterfowl and marine birds that are foraging or resting at sea or, in the case of a few species, molting at sea. It appears that in some species of waterfowl, the distance at which disturbances will be tolerated varies depending on flock size, because larger flocks react at greater distances than smaller flocks. There is an energetic cost to moving away from a disturbance as well as a cost in terms of lost foraging opportunities or displacement to an area of lower feeding availability (MMS 2008).

Disturbance is most likely to have an impact during those periods of the annual cycle when birds have difficulty in meeting their daily energy requirements, especially when food intake needs to be high to enable birds to build up nutrient reserves in advance of periods of high demand. Frequent disturbance could result in energy expenditures that prolong the molt beyond the ice-free period or decrease the amount of stored energy reserves available for winter survival (MMS 2008).

Low-level helicopter or other aircraft traffic could adversely affect birds on the North Slope and coastal areas by displacing adults and/or broods from preferred habitats during prenesting, nesting, and broodrearing and migration; displacing females from nests, exposing eggs or small young to inclement weather or predators; and reducing foraging efficiency and feeding time. Aircraft flights could force large numbers of birds to interrupt feeding. (MMS 2008).

Some birds may be able to tolerate aircraft noise. The behavioral response of eiders to low-level aircraft flights is variable; some spectacled eiders nest and rear broods near the Deadhorse airport. Individual tolerances are expected to vary, however, and the intensity of disturbance, in most cases, would be less than that experienced by birds at the Deadhorse airport. Some birds may be displaced, with unknown physiological and reproductive consequences (MMS 2008).

Helicopter and fixed-wing aircraft operating at low altitudes have the potential to flush birds into the path of the aircraft, where a collision could occur. While such strikes are relatively rare, aircraft/bird collisions threaten the safety of aircraft/passengers. Migrating birds colliding with vessels have been well documented. These are usually caused by weather conditions such as storms associated with rain, snow, icing, and fog or low clouds (MMS 2008).

The level of impacts depends on the location and extent of facilities. However, once exploration and development or production ceases in an area, bird populations could recover from the effects of disturbance, reducing overall effects (BLM 2005).

Gas Blowouts: In the event of a natural gas explosion and fire, birds in the immediate vicinity could be killed. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site. Thus, it is not likely that toxic fumes would affect birds or their food sources except those very near to the source of the blowout (MMS 1996). Any accidental release of oil or gas could be intentionally ignited during cleanup. Burning could affect air quality in two ways. For a gas blowout, burning would reduce emissions of gaseous hydrocarbons by 99.98 percent and slightly increase emissions of other pollutants (MMS 2008).

Oil Spills: Bird deaths due to oil spills arise from exposure from wetting and loss of thermoregulatory ability, loss of buoyancy, or from matted plumage and inability to fly or forage. Alcids and sea ducks are highly vulnerable to oil spills, because they spend most of their time on the sea surface and aggregate in dense flocks. Fouled plumage is the primary cause of mortality and stress in oiled birds. Oil causes marked loss of insulation, waterproofing, and buoyancy in the plumage. Oiled feathers lose their ability to keep body heat in and cold water out, and resultant hypothermia can kill birds. Waterlogging and loss of buoyancy can rapidly lead to drowning (MMS 2008).

Inhalation of highly concentrated petroleum vapors can lead to inflammation and damage of the mucous membranes of the airways, lung congestion, emphysema, pneumonia, hemorrhage, and death. If a bird were unable to leave the immediate area of the source of the spill or were confined to a contaminated lead or bay, it could inhale enough vapors to cause some damage. Birds away from the immediate spill area or exposed to weathered or residual oils would not be expected to suffer any adverse effects from vapor inhalation (MMS 2008).

Oil contains many toxic compounds that can have fatal or debilitating effects on birds when ingested. The major route by which birds would be expected to ingest oils is by preening it off their feathers after exposure. These same toxic compounds could be absorbed through the skin. Additionally, food may be contaminated either directly or by hydrocarbons within the food chain. Food resources used by birds could be displaced from important habitats or be reduced following a petroleum spill. Benthic habitats that support marine invertebrates, however, would not be expected to experience substantial adverse effects following a spill (MMS 2008).

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities subsequent to leasing could potentially have cumulative effects on birds. Most of these potential effects would likely occur as secondary effects from effects on habitat. Measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to avoid, minimize, and mitigate those potential effects. If oil development occurs, some alteration of bird habitat can be expected. However, with state and federal government oversight, any activities within the proposed lease sale area should not prevent overall bird population levels from remaining at or near current levels. Specific mitigation measures require permanent, staffed facilities to be sited 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. Lessees must also comply with USFWS and NMFS requirements regarding the Endangered Species Act, Migratory Bird Treaty Act and Appendix B of the "Yellow-billed Loon Conservation Agreement." A complete listing of mitigation measures is found in Chapter Nine.

G. Effects on Caribou

1. Potential Cumulative Effects

Although this is primarily an offshore sale, a very small amount of sale lands lie onshore between the Colville and Canning Rivers. In addition, according to ADF&G, caribou will occasionally stand in water when insects are particularly bad and sometimes have been reported on the barrier islands. Most caribou studies and analysis consider impacts to caribou onshore, especially to the Central Arctic Caribou Herd, which uses the North Slope area most affected by oil industry exploration and development. These studies have been included in this finding to cover the small amount of acreage on which caribou could be found. Post-sale activities have the potential to affect caribou of the Western Arctic, Teshekpuk, Central Arctic, and the Porcupine herds. Caribou from each herd may pass through the small amount of uplands in the proposed lease sale area, especially when they seek relief from insect harassment each summer.

The principal herd using onshore lands in the proposed lease sale area is the Central Arctic herd, although other caribou may use the area as well. The caribou herds that use the North Slope have grown over the last 30 to 40 years, although there have been cyclical declines. In 1970, the Western Arctic herd numbered about 242,000 caribou, declined to about 75,000 animals in 1976 (MMS 2008). Since then the herd has grown to about 401,000 caribou (MMS 2008). The Teshekpuk Lake herd's population has ranged from 11,822 in 1984 to 45,166 in 2002 (BLM 2008b). The Central Arctic herd has also grown, from 5,000 in 1975 to about 31,857 in 2002 (MMS 2008). The Porcupine herd, in ANWR and away from the oil industry complex in the central North Slope, may be declining; it numbered 100,000 in 1972, increased to 178,000 in 1989 and has declined since then (MMS 2008).

Research regarding the effects of North Slope industrial development on caribou herds has been contentious. Although much research has been conducted on caribou in the region, researchers have disagreed over the interpretation and relative importance of some data and how serious data gaps are (NRC 2003; Cameron et al. 2005; Haskell et al. 2006; Joly et al. 2006). Since 1975, government and industry have conducted research on caribou biology and on various aspects of their interaction with North Slope oil and gas developments. Population characteristics (calf production and survival, and adult mortality), habitat use, movement and distribution, and behavioral responses of caribou to oil and gas developments have been widely studied. Some researchers think caribou have become habituated to the presence of development (Haskell et al. 2006). Some researchers think populations (reproduction and viability) are subject to natural cycles in the ability of the land to support large numbers of caribou (carrying capacity), while others think caribou numbers are influenced by many factors, such as disease, nutrition, predator abundance (including insects), and weather. "Demonstrating cause-and-effect relationships between resource extraction and wildlife populations is complicated by natural variation in caribou behavior, population trends, habitat selection, and climate. Detection of potential industrial impacts to the CAH [Central Arctic herd] has been further hampered by insufficient long-term distributional data collected prior to surface development." (Person et al. 2007:239) Nonetheless, some studies show that local distribution and behavior of caribou are influenced by infrastructure and human activities within producing oil fields.

Potential impacts can occur at all phases, but most are likely to occur during development and production. Adverse effects are discussed below. Potential effects to caribou populations from the sale include habitat loss and displacement from insect relief and calving areas due to construction, operations, and from oil spills.

Habitat Loss and Displacement: Direct habitat loss could result from construction of well pads, pipelines, roads, airfields, processing facilities, housing, and other infrastructure. Indirect habitat loss is possible if caribou avoid areas because of the presence of humans and traffic.

Shifting calving away from higher value forage habitat with higher value nutrition could affect maternal success and calf health (Cameron et al. 2005). Independent of oil activity, forage quality and quantity vary seasonally and annually and also affect herd success (Murphy and Lawhead 2000). Forage quality and quantity are superior in drier habitat south of the proposed lease sale area (Murphy and Lawhead 2000).

Caribou are subject to mosquito harassment from mid-to-late June through July, and to oestrid fly harassment from mid-July to late-August. To escape mosquitoes, caribou move from inland feeding areas to windswept, vegetation-free coastal areas, where they rely on various coastal habitats such as sandbars, spits, river deltas, and some barrier islands for relief from insect pests (MMS 1987). Caribou also seek relief from insects farther inland, in the foothills of the Arctic coastal plain. Flies are less tolerant of shade, so when oestrid flies dominate, caribou favor shade created by industrial buildings and pipes (Murphy and Lawhead 2000). Gravel pads are also favored habitat for relief from both mosquitoes and flies (Ballard et al. 2000).

Above-ground pipelines can restrict caribou movement and deter them from seeking preferred habitat unless provisions are made to allow for their free passage. Biologists representing both industry and ADF&G have agreed that facilities built earlier in the development of the Prudhoe Bay oil field created impediments to caribou movements. Flow and gathering pipelines were elevated only 1 to 4 feet above the ground, effectively barring caribou from crossing. However, extensive research on the response of caribou to development has now shown that for many situations it is possible to design facilities so that caribou movements are not significantly impeded. For example, in the Kuparuk development area, elevating pipelines and separating pipelines from roads with traffic have allowed caribou to move with ease through the oil field.

In the Kuparuk field, where all pipelines are elevated a minimum of 5 feet above ground, insect-harassed caribou were able to pass through the field on their way to and from insect-relief habitat, although they typically detoured around drill pads and were often delayed up to several hours at road crossings (BLM 2005). Current mitigation measures require that pipe be elevated 7 feet, higher than the previously required 5 feet.

If displacement from coastal insect-relief areas did occur during the construction of oil and gas facilities, it would be temporary and disturbance reaction would diminish after construction is complete, provided that road systems are not spaced too closely.

Documenting positive effects of oil field development is as challenging as documenting adverse effects. Dust settling alongside roads in the spring leads to earlier snowmelt and green-up of vegetation, facilitating travel and feeding. Caribou use roads and gravel pads and the shade of pipelines and buildings for relief from oestrid flies (Murphy and Lawhead 2000; BLM 2008a).

The Central Arctic and other herds have grown considerably during the period of oil field development, but researchers hotly disagree about the impact of industry activity on caribou populations. Still, research indicates that caribou can accommodate most oil field activities, although questions remain regarding the impact of high intensity or frequent disturbances (Murphy and Lawhead 2000). Based upon comparisons with other herds, there have been no apparent effects of oil field development on the growth of the Central Arctic herd. This does not suggest that there may not be effects in the future, or that other herds under different ecological conditions may not be affected (Cronin et al. 1994).

Seismic Surveys: Onshore seismic surveys would occur during winter, when most caribou overwinter in areas farther inland. Air or boat traffic associated with offshore surveys could disturb


S. Schmitz, DO&G

Caribou cows and calves crossing road, North Slope.

caribou using shorelands or islands. This would most likely be limited to periods of insect harassment.

Disturbance: Cow and calf groups are most sensitive to human disturbance just before calving and post-calving, but Haskell (Haskell et al. 2006) found that caribou with or without calves became habituated to development after the calving period. Cameron et al (Cameron et al. 2005) reported that caribou shifted calving inland, away from Milne Point, as infrastructure density increased. Ground-vehicle traffic, aircraft, and human presence near cows with newborn calves also affect individuals as they migrate. If caribou are displaced from calving in a certain area due to construction, they are likely to calve in an area where construction is not taking place. The use of specific calving sites within the broad calving area varies from year to year. If calving caribou are displaced from high nutrition forage near a drill site or facility, they are likely to seek any protective area regardless of the forage. The cumulative effect of displacement from higher value calving habitat could be lower calf survival or calves with smaller mass and size (Arthur and DelVecchio 2007). On the other hand, high populations would force the caribou into lower nutrition areas anyway.

Few caribou now calve in the Prudhoe Bay industrial complex; however, there is no evidence that calving levels were historically higher (Murphy and Lawhead 2000). Calving caribou prefer rugged, dry terrain and the Prudhoe Bay terrain is flat and wet, which may indicate caribou were unlikely to historically use this habitat (Ballard et al. 2000). Some displacement of the Central Arctic herd caribou from a portion of the calving range near Prudhoe Bay and Milne Point facilities has been reported (Cameron et al. 2005), but caribou continue to calve at Kuparuk and Milne Point, although in smaller numbers and densities (Murphy and Lawhead 2000). Variations could be attributed to annual snow melt patterns (Ballard et al. 2000). Other researchers posit that calving levels at Kuparuk and Milne Point cannot be definitively linked to disturbance-caused displacement because of a lack of historical data (Murphy and Lawhead 2000).

While aerial surveys of radio-collared females conducted between 1978 and 1987 indicate that parturient females can be displaced by road systems (Cameron et al. 1992), more recent analysis suggests that calving and adult caribou distribution is not strongly influenced by the presence of the Milne Point Road and that pipelines do not delay travel to the coast (Noel et al. 2004). In the 1992 study, after construction of the Milne Point road, caribou were significantly less numerous within 1 kilometer of roads and significantly more numerous 5 to 6 kilometers from roads. Noel's 2004 study of recent post-road calf densities reported that densities within 1 kilometer of the Milne Point Road were higher than intervals farther from the road. In addition, the densities of all caribou were not lower closer to the road than at greater distances, as reported by other researchers (Noel et al. 2004). Joly (Joly et al. 2006), however, contests the findings. Pipelines elevated at least 5 feet allow for effective crossing, except when they were in proximity to roads with moderate to heavy traffic (15 or more vehicles per hour). Noel et al studied pipe elevated 5 feet; mitigation measures now require that pipelines shall be elevated 7 feet. The Alaska Caribou Steering Committee concluded the most effective mitigation is achieved when pipelines and roads are separated by at least 500 feet (Cronin et al. 1994). Lessees are encouraged in planning and design activities to consider the recommendations for oil field design and operations contained in the final report of the Alaska Caribou Steering Committee.

During construction, small groups of caribou may be temporarily displaced; however, the reaction would diminish after construction is complete. Construction will not take place over the entire sale area at the same time and construction related to exploration will occur during winter, when caribou are absent from the proposed lease sale area. Furthermore, it is likely that industry will rely, to the extent feasible, on the existing oil infrastructure, thus minimizing new construction.

Motor vehicle and aircraft traffic can also disturb caribou. Caribou can be briefly disturbed by low-flying aircraft, with highly variable reactions, ranging from none to violent escape. Reactions depend upon distance from human activity; speed of approaching disturbance source; altitude of aircraft; frequency of disturbance; sex, age, and physical condition of the animals; size of caribou group; and season, terrain, and weather. Exploration-related disturbance of caribou, particularly by helicopter traffic, is expected to have minor impacts on caribou, particularly large groups, with animals being briefly displaced from feeding and resting areas when aircraft pass nearby. Vehicle traffic associated with transportation corridors has the potential to affect habitat use in intensely developed areas. Acute disturbance effects may in combination result in a cumulative effect on habitat availability for those individuals with fidelity to a calving area, but may have little or no effect on the Central Arctic herd population. It is expected these disturbances would be short term (BLM 2005). Despite the fact that cumulative effects at the population level are difficult to quantify, measures should be incorporated into operations planning and facility design to avoid both direct and indirect impacts to caribou.

<u>Gas Blowouts</u>: Impacts of a gas blowout on caribou would be similar to that of other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, caribou in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would disperse very rapidly. Therefore, toxic fumes would not affect animals, except those very near the source of the blowout.

<u>Oil Spills</u>: Caribou may also be impacted by oil spills. Caribou that become oiled could die from toxic-hydrocarbon inhalation and absorption through the skin. If caribou were to ingest oil-contaminated vegetation, the result would be significant weight loss and aspiration pneumonia, leading to death. In the event of an oil spill that contaminated tundra or coastal habitats, however,

caribou probably would not ingest the oiled vegetation. Caribou are selective grazers and are particular about the plants they consume (MMS 1996).The majority of impacts would result from disturbance associated with spill cleanup activities, such as the presence of cleanup workers and machinery or the use of hazing to divert caribou from oiled areas; these disturbances would, in turn, help minimize direct contact with oil.

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities subsequent to leasing could potentially have cumulative effects on caribou. Most of these potential effects would likely occur as secondary effects from effects on habitat. Measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to avoid, minimize, and mitigate those potential effects. In addition to mitigation measures addressing fish, wildlife, and habitat, other mitigation measures specifically address caribou. Specifically, pipelines shall be designed and constructed to avoid significant alteration of caribou movement and migration patterns. Lessees are encouraged to maintain aircraft at an altitude greater than 1,500 feet or a lateral distance of 1 mile, excluding takeoffs and landings, from caribou concentrations. Seasonal restrictions may be imposed on activities located in, or requiring travel through or overflight of, important caribou calving areas. Lessees are encouraged in planning and design activities to consider the recommendations for oil field design and operations contained in the final report to the Alaska Caribou Steering Committee (Cronin et al. 1994). A complete list of mitigation measures is found in Chapter Nine.

H. Effects on Muskoxen

1. Potential Cumulative Effects

Although this is primarily an offshore sale, a very small amount of sale lands lie onshore between the Colville and Canning Rivers. In addition, muskoxen have been sighted offshore on the sea ice.

Muskoxen were reintroduced in Kaktovik in 1969 and are spreading across the North Slope; they are found from the Kogru River in NPR-A east to Canada (MMS 2008, Vol. I, Chapter Three). Muskoxen have been sighted on sea ice 25 miles offshore (BLM 2008b). Little is known regarding the influence of roads, traffic, and pipelines on muskox movements.

Habitat Loss and Displacement: Direct habitat loss will result from construction of well pads, pipelines, roads, airfields, processing facilities, and other infrastructure; however, industry will likely rely on existing infrastructure to the extent practical.

Muskoxen have a high fidelity to particular habitat areas because of factors favorable to herd productivity and survival, such as food availability, snow conditions, or absence of predators. Displacement from preferred habitat could have a negative effect on muskoxen populations. The magnitude of the effect is difficult to predict, but would likely be related to the magnitude and duration of the displacement (USFWS 1987). Muskoxen populations on the North Slope have been declining in recent years (ADN 2006a), while herds elsewhere in the state are healthy. Most of the losses have been in ANWR. Biologists are not certain why, but starvation, drowning in floods, and predation by grizzly bears may play a role. Hunting has not played a big role, but state and federal managers closed hunting because herd numbers are so low (ADN 2006a).

Seismic Surveys: As year-round residents of the coastal plain, muskoxen could be impacted by winter seismic studies. Response varies from herd to herd (NRC 2003), Muskoxen activity drops each winter as the animals slow to conserve energy. Wintertime seismic surveys could disturb them at a time when they can least afford the energy expenditure.

Disturbance: Muskoxen may be subject to disturbance from oil and gas activities. Primary sources of disturbance include seismic activity, vehicle traffic, and aircraft. Muskoxen remain relatively sedentary in the winter, to conserve energy to compensate for reduced forage (Reynolds et al. 2002). The energetic costs associated with forced movements during winter may be as significant an impact as disturbance during calving. Mixed groups of muskoxen showed a greater sensitivity to fixed-wing aircraft in winter and during calving than in summer, fall, or during rut. Helicopters and low-flying aircraft have sometimes caused muskoxen to stampede and abandon their calves (NRC 2003).

Gas Blowouts: Impacts on muskoxen from a gas blowout would be similar to those to other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, muskoxen or moose in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would disperse very rapidly. Thus, it is not likely that toxic fumes would affect animals except those very near to the source of the blowout.

Oil Spills: In general, the effects of an oil spill on muskoxen would be similar to that of other terrestrial mammals. Muskoxen, because they have been spotted on the sea ice, could be adversely affected by a wintertime offshore spill, if one were to occur and if any animals were in the vicinity. An oil spill may contaminate individual animals in the immediate vicinity, contaminate habitat, and contaminate some local food sources. However, muskoxen are unlikely to eat contaminated vegetation and, while absorption or inhalation of oil is toxic, oiled animals would shed oiled fur before growing winter fur (BLM 2004). If a large oil spill oiled habitats used by muskoxen, cleanup workers and traffic from vehicles and aircraft would be expected to disturb and displace these species during cleanup operations, thus minimizing the animals' exposure to spilled oil. In addition, oil spill responders would employ hazing to divert animals from the cleanup area.

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities subsequent to leasing could potentially have cumulative effects on muskoxen. Most of these potential effects would likely occur as secondary effects from effects on habitat, Measures in this best interest finding, along with regulations imposed by other state, federal, and local agencies, are expected to avoid, minimize, and mitigate those potential effects. In addition to mitigation measures addressing fish, wildlife, and habitat, other mitigation measures specifically address muskoxen. Lessees are encouraged to maintain aircraft at an altitude greater than 1,500 feet or a lateral distance of 1 mile, excluding takeoffs and landings, from muskoxen concentrations. Seasonal restrictions may be imposed on activities located in, or requiring travel through or overflight of, important muskoxen calving or wintering areas. Pipelines shall be designed and constructed to avoid significant alteration of large ungulate movement and migration patterns. A complete list of mitigation measures is found in Chapter Nine.

I. Effects on Brown Bear

1. Potential Cumulative Effects

Although this is primarily an offshore sale, a very small amount of sale lands lie onshore between the Colville and Canning Rivers. Brown (grizzly) bears on the coastal plain are at the northern limit of their range. Densities are low, with the highest levels near the Prudhoe and Kuparuk complexes. The availability of food is limited and their reproductive potential is low; the region is considered marginal bear habitat (Shideler and Hechtel 2000).

Habitat Loss and Displacement: Direct habitat loss could result from construction of well pads, pipelines, roads, airfields, processing facilities, housing, and other infrastructure. Quantifying the number of animals involved is difficult. Brown bears travel along the major river corridors and feed in riparian areas in and near the proposed lease sale area. Siting facilities outside these areas will reduce potential impacts on brown bears (USFWS 1987).

Seismic Surveys: Seismic activity that occurs in winter may disturb denning bears. Studies have found that radio-collared bears in their dens were disturbed by seismic activities within 1.2 miles of their dens, demonstrated by an increased heart rate and greater movement within the den. However, no negative effect, such as den abandonment, was documented (BLM 2008a).

Disturbance: Brown bears may be subject to disturbance from oil and gas activity. Primary sources of disturbance include seismic activity, vehicle traffic, and aircraft. While human activity may initially cause bears to avoid an area, if food is present, human activity also serves as an attractive nuisance, attracting foraging bears, especially to refuse disposal areas. This may pose a threat to human safety and the potential need to shoot “problem” animals. In 2001, five grizzlies were shot in the Prudhoe Bay fields (NRC 2003). Another food source thriving in the oil fields is the Arctic squirrel (see Section J), a staple for bears located there (Shideler and Hechtel 2000). While cub survival is higher at Prudhoe/Kuparuk, these bears have a lower than normal survival rate as they become sub-adults (Ibid). Bears can also be displaced by human land use activities.

Gas Blowouts: Impacts on brown bear from a gas blowout would be similar to those to other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, brown bear in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would disperse very rapidly. Thus, it is not likely that toxic fumes would affect bears except those very near to the source of the blowout.

Oil Spills: The potential effects of oil spills on brown bears include contaminating of individual animals, coastal habitats, and some local food sources. Bears feed on fish concentrations at overwintering and spawning areas and on carrion along the coast. If an oil spill contaminates beaches, bears are likely to ingest contaminated food sources. If a large oil spill oiled habitats used by bears, cleanup workers and traffic from vehicles and aircraft are expected to disturb and displace these species during cleanup operations, thus minimizing the animals’ exposure to spilled oil. In addition, oil spill responders would employ hazing to divert animals from the cleanup area.

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities subsequent to leasing could potentially have cumulative effects on brown bears. Most of these potential effects would likely occur as secondary effects from effects on habitat. Measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to avoid, minimize, and mitigate those potential effects. In addition to mitigation measures addressing fish, wildlife, and habitat, other mitigation measures specifically address bears. For projects near areas frequented by bears, lessees are required to prepare and implement a human-bear interaction plan designed to minimize conflicts between humans and bears. The plan must include measures to minimize a facility’s attraction to bears, including garbage and food waste. Before commencement of any activities, lessees must consult with ADF&G to identify the locations of known brown bear den sites. Exploration and production activities started between September 20 and May 15 may not be conducted within one-half mile of known occupied brown bear dens. A complete list of mitigation measures is found in Chapter Nine.

J. Effects on Furbearers

1. Potential Cumulative Effects

Gray wolves, wolverines, and arctic foxes are the furbearer species that may use the proposed lease sale area’s limited upland and, during winter, offshore areas. Gray wolves have travelled across at least 70 km of sea ice (MMS 2008, Vol. I, Chapter Three). Wolverines are more common the Brooks Range than in the coastal plain (BLM 2008b).

Habitat Loss and Displacement: Winter arctic fox habitat is primarily along the coast and sea ice. Denning occurs up to 15 miles inland. Habitat destruction would primarily affect foxes through destruction of den sites. Placement of oil and gas infrastructure at or near den sites may either destroy den sites or cause foxes to den elsewhere (USFWS 1986). However, foxes have been known to use culverts and other construction materials for denning.

The effects of direct habitat loss on wolves would likely be negligible. The abundance of wolves is ultimately determined by the availability of prey. The ability of adults to provide food is the key determinant in wolf pup survival. Reduction in prey species, such as caribou, could reduce wolf populations (USFWS 1987).

Seismic Activities: Wolves, foxes, and wolverine may be disturbed by wintertime onshore seismic activity. These species are highly mobile and foxes and wolves readily adapt to human presence. Impacts are expected to be transitory.

Disturbance: These furbearers may be disturbed by oil and gas activity, particularly vehicle and aircraft traffic. Wolves and foxes readily habituate to human activity, leading to human-animal encounters. Primary sources of disturbance are aircraft traffic. Helicopters generally invoke a stronger response from wolves and foxes than fixed-wing aircraft. Ice roads connecting well sites and supply areas would provide a source of disturbance from vehicles. During construction of the Dalton Highway and TAPS, wolves readily accepted handouts from construction workers (USFWS 1987). When wolves approach humans, they are sometimes shot (McNay 2002)

Foxes are especially attracted to human activity because of potential scavenging sources. Arctic fox density is greater in the Prudhoe Bay complex than in undeveloped areas nearby (MMS 2008, Vol. I, Chapter Three). Fox populations vary in response to fluctuations in their natural prey sources, but a constant food supply could maintain the fox population at artificially high levels. This could cause near total nest failure of all waterfowl and shorebirds in the development area because foxes prey on eggs and young birds. Foxes and wolves are also noted for rabies outbreaks, which increase when population densities are high and which risk human health. Oil and gas activity may attract foraging foxes and wolves, especially to refuse disposal areas. Wolverines apparently are not attracted to garbage (USFWS 1986).

Gas Blowouts: Impacts on wolves, wolverines, and foxes from a gas blowout would be similar to those of other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, animals in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would disperse very rapidly; thus, it is not likely that toxic fumes would affect animals except those very near to the source of the blowout.

Oil Spills: The general effects of an oil spill on wolves, wolverines, and foxes include contamination of individual animals, habitats, and some local food sources. Furbearers, particularly foxes, may be attracted to oiled carrion. Foxes may be attracted to cleanup related activity in hopes of scavenging food or garbage. If a large oil spill oiled habitats used by bears, cleanup workers and traffic from vehicles and aircraft are expected to disturb and displace these species during cleanup operations, thus minimizing the animals' exposure to spilled oil, with the possible exception of foxes. In addition, oil spill responders would employ hazing to divert animals from the cleanup area.

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities subsequent to leasing could potentially have cumulative effects on furbearers, particularly foxes. Most of these potential effects would likely occur as secondary effects from effects on habitat. Measures in this best interest finding, along with regulations imposed by other state, federal, and local agencies, are expected to avoid, minimize, and mitigate those potential effects. Exploration facilities, including exploration roads and pads, must be temporary and must be constructed of ice unless the director determines that no practicable alternative exists. Proper disposal of garbage and putrescible waste is essential to minimize attracting wildlife. The lessee must use the most appropriate and efficient method to achieve this goal. A complete list of mitigation measures is found in Chapter Nine.

K. Effects on Polar Bear

1. Potential Cumulative Effects

In 2008, the USFWS listed the polar bear as a threatened species under the Endangered Species Act (ESA) (USFWS 2008). (See Chapter Four.)

Polar bears may be present in the upland and offshore areas year round. Potential impacts to polar bears include disruption of denning, attraction to areas of activity, and adverse interaction with humans. If an oil spill occurred, potential effects could include ingestion of oil and oil contamination.

Habitat Loss and Displacement: The primary impacts to polar bears from production-related activities include habitat losses due to construction of production facilities and human-bear encounters. Just over half of Alaska's dens are found in offshore pack ice, well north of the proposed lease sale area, and just under half occur on land (Durner 2006). Potential habitat losses on barrier islands and along the coast could displace polar bears from denning areas that appear to be increasing in importance. Denning is an integral part of the reproductive process and critical to reproductive success. Maternal denning is widely scattered, which may facilitate human avoidance of denning sites (Amstrup 2000). If disturbances lead bears to prematurely abandon dens before cubs are sufficiently mature, cub survival could be reduced. Bears denning near the Prudhoe Bay oil field did not show evidence of being disturbed by humans (Durner 2006). In fact, bears near roads showed fewer episodes of vigilant behavior than bears at undisturbed den sites. The researchers concluded that the near-road bears were habituated to traffic. Noise generated by exploration and development, particularly seismic activities, could lead pregnant bears to leave denning habitat or pre-maturely abandon dens. Again, the Prudhoe Bay study showed bears became habituated and did not abandon dens (Durner 2006). Research testing noise levels within artificially constructed dens revealed that most vehicle noise was undetectable when the source was 500 meters away. The temporary displacement of some polar bears from preferred habitats is anticipated as a result of routine exploration activities. Chronic disturbance or displacement can have moderate effects over time (MMS 2008, Vol. I, Chapter Two).

Alaskan polar bears spend most of their life on the sea ice; however, bears may be increasing their use of land during the fall open water season. Increased time onshore may be more related to access to seals than human-related food sources (Schliebe et al. 2008), but one consequence of more time onshore is increased human-bear interactions. Miller et al raise concerns about bears scavenging the remains of bowhead whales harvested by Inupiat whalers. The findings express concern over the large number of bears drawn by whale remains and other food to areas near humans and the potential for conflicts (Miller et al. 2006); some of these sites are in or near the proposed lease sale area. Polar bears can be attracted to artificial structures; buildings offer places for bears to forage for human discards. This increases the chances that bears will need to be driven away or killed to protect human safety (NRC 2003). Preparation of human-bear interaction plans and proper disposal of garbage will minimize conflicts with bears and humans.

Seismic Surveys: Polar bears are less sensitive to disturbance from seismic activities than many marine mammal species. However, seismic noise may disturb females in dens, both on sea ice and onshore. (See Habitat Loss and Displacement.)

Disturbance: The primary sources of noise disturbance would come from air and marine traffic. Seismic activities and low-frequency noise from drilling operations would also be sources of noise.

(See Habitat Loss and Displacement.) Females in dens, both on sea ice and onshore are at risk to disturbance from any vehicular traffic or noise. Exploration and development is likely to increase temporary displacement and disturbance. More vessel traffic could result in minor impacts to polar bears. Other sources of disturbance include building ice roads, temporary ice islands as drilling platforms, helicopter flights to move crews and lightweight equipment, rollogons, snow machines, vibroseis equipment, and other motorized vehicles. The level of impact related to these activities will depend upon the timing and extent of activities occurring simultaneously. If displacement is temporary and localized, disturbance impacts to polar bears are expected to be minor (MMS 2008, Vol. I, Chapter Three).

Oil Spills: Large-scale reduction or contamination of food sources (ringed and bearded seals) could reduce survival and reproductive success of polar bears. Small-scale reductions in seal populations are less likely to impact polar bears, because they tend to disperse over large areas in search of prey. However, polar bears are not likely to avoid oiled carcasses, and ingestion of oiled prey is likely to have lethal effects. The ingestion of petroleum hydrocarbons leads to anorexia and damage to kidneys, liver, and other tissues. The effects of the damage were not apparent for several weeks after ingestion (MMS 2008). Oiled fur loses it insulating qualities (USFWS 2008).

Amstrup et al. (Amstrup et al. 2006) conducted a modeling study to predict the probability that polar bears on the North Slope would be exposed to hypothetical oil spills from 2 locations in the Beaufort Sea, one that is currently operating offshore (Northstar) and one that was proposed for offshore (Liberty). The model incorporated actual weather data such as wind, ice, and currents, and used NOAA methods for modeling oil spills. Data from studies of radio-collared polar bears from 1985-2003 were also used. The model examined the worst case scenario: the largest anticipated catastrophic spill; the largest anticipated chronic spill; the worst possible times, the maximum open water period (September), and the period of maximum polar bear density (October); no attempt at cleanup or other human intervention; and maximum effect (all bears touched by oil killed). The model did not take into account uncertainty in polar bear population estimates or oil weathering. Median numbers of polar bears oiled by a worst-case scenario spill at Liberty were 1 bear in September and 3 bears in October; median numbers oiled at Northstar were 3 bears in September and 11 bears in October. Based on this model, there is a very low probability that a large number of polar bears would be affected by an oil spill; and, if an oil spill were to happen, there is a large probability that a low number of bears would be affected (Amstrup et al. 2006).

The Amstrup et al. (Amstrup et al. 2006) model did not take into account the risk of an oil spill. There have been no marine oil spills in the Beaufort Sea in more than 25 years of exploration and development and there has never been an oil spill from a platform blowout in Alaska. The Northstar pipeline is designed to operate without leaking even if all the potential sources of failure (ice gouging, strudel scour, settlement) occur at the same time and same location. This is an extraordinarily conservative design basis. MMS evaluated the design of the Northstar project and concluded the risk of an oil spill of 1,000 bbl or greater was on the order of 1 to 2 percent. From all approaches reviewed, zero was the most likely number of spills (MMS 2003a).

Finally, if a spill were to occur and to occur during broken ice, challenges with cleanup could increase the spill’s effects on polar bears. Still, the risk of a major spill in the proposed lease sale area is small.

The Marine Mammal Protection Act prohibits the taking of marine mammals, including polar bears and ringed seals, except in specifically permitted circumstances. The MMPA allows the secretary of commerce to permit industrial operations to take small numbers of marine mammals provided that doing so has a negligible effect on the species and will not reduce the availability of the species for subsistence use by Alaska Natives (NRC 2003). At the leasing phase, it is not possible to predict if, when, where, how or what kind of exploration, development or production might occur, but any activities that could occur subsequent to the lease sale will be subject to the mitigation measures in Chapter Seven. In addition, a host of other rigorous state, federal, and NSB permitting restrictions and regulatory mechanisms addressing polar bears, or applicable to them, are in place. Additional state regulatory mechanisms include large project planning (OPMP), ACMP, DMLW permits and approvals, ADF&G habitat and permitting, and SPCO mitigation measures and stipulations.

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities subsequent to leasing could potentially have cumulative effects on polar bears. Most of these potential effects would likely occur as secondary effects from effects on habitat. Measures in this best interest finding, along with regulations imposed by other state, federal, and local agencies, are expected to avoid, minimize, and mitigate those potential effects. In addition to complying with the Endangered Species Act and the Marine Mammal Protection Act, lessees shall consult with the USFWS to identify the location 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. Lessees are required to prepare human-bear interaction plans. Proper disposal of garbage and putrescible waste is essential to minimize attraction of wildlife. Lessees are required to have an approved oil discharge prevention and contingency plan. A complete list of mitigation measures is found in Chapter Nine.

L. Effects on Bowhead Whales

1. Potential Cumulative Effects

Bowhead whales are listed as threatened on the Endangered Species list. Bowhead whales migrate across the Beaufort Sea each spring and fall. The spring migration east typically rounds Point Barrow then shifts north of sale waters, into the central Beaufort; the fall migration west is closer to shore in the proposed lease sale area. Whales are more likely to use federal OCS waters than shallower nearshore state waters. Inupiat whalers estimate that bowheads take about two days to travel west from Kaktovik to Cross Island, reaching the Prudhoe Bay area by late September, and five days to travel from Cross Island to Point Barrow (MMS 2003b).

NMFS, in 2002, issued a determination deciding against designating critical habitat for bowheads. NMFS determined (1) the population decline was due to overexploitation by commercial whaling, and habitat issues were not a factor in the decline; (2) the population is abundant and increasing; (3) there is no indication that habitat degradation is having any negative impact on the increasing population; and (4) existing laws and practices adequately protect the species and its habitat (NMFS 2002).

NMFS has concluded that leasing and exploration are not likely to jeopardize the continued existence of the bowhead whale (NOAA 2006). The agency remains concerned about the potential additive effects of oil and gas exploration and development on bowhead whales. Sale-related activities likely to cause disturbance to bowhead whales may include seismic surveys, vessel and aircraft traffic, drilling noise, construction, discharge of drilling muds and cuttings, and an oil spill, should one occur.

Data gaps challenge studies of longer-term and cumulative effects of oil and gas activities on whales. Whales have long lifetimes, short-term experiments are logistically impossible, data on whales before human activities began is scarce, data accumulates slowly, and it’s difficult to distinguish human from natural effects (Richardson et al. 1995). Some scientists also have contentious interpretations of some studies.

Drilling and Production Discharges: The types of material discharged from drilling operations include drilling muds and cuttings. The discharges create plumes of the material that disperse rapidly in the water column. Most drilling muds and cuttings land on the sea bottom relatively close to the discharge point, depending on the water depth and current. Discharged drilling muds and cuttings during drilling operations are not expected to cause significant effects on bowhead whales either directly through contact or indirectly by affecting prey species. Any effects would be very localized around the drill rig due to rapid dilution and deposition of these materials. The preferred method for disposal of muds and cuttings from oil and gas activities is by underground injection. Discharge of produced waters into open or ice-covered marine waters of less than 33 feet in depth is prohibited. Drilling muds and cuttings may cover small areas of the seafloor that support epibenthic invertebrates used for food by bowhead whales. However, the effects of the discharges are expected to be negligible to bowhead whales because the proposed lease sale area is in relatively shallow nearshore waters outside the main migration routes. Also, bowhead whales feed primarily on pelagic zooplankton, and the areas of sea bottom that are impacted would be inconsequential in relation to the available habitat (MMS 2008).

Disturbance: Activities that may cause disturbance to bowhead whales are seismic surveys, vessel and aircraft activities, drilling noise, and construction. Noise is the common factor; whales have sensitive hearing and may use hearing to navigate under pack ice and locate polynyas (open water) to surface. High noise levels may cause temporary or permanent effects to bowhead whale hearing, or impact their use of sound to communicate or navigate (NOAA 2008). Exposure to noise could have temporary non-lethal effects (NOAA 2008).

Available information indicates that bowhead whales are responsive, in some cases highly responsive, to anthropogenic noise in their environment. Response to noise could include behavioral changes, including local avoidance to noise from aircraft and vessel traffic; seismic surveys; exploratory drilling; construction activities, including dredging; and development drilling and production operation that occur within several miles of the whales. Noise could divert whales from their migratory path and feeding habitat. If 2 or more types of disturbance occur at the same time, the effects could be greater than those observed from a single source. Inupiat whalers are concerned such disturbances could displace whales seaward into areas where ice conditions are more dangerous for hunters.

The primary documented response to noise is avoidance, sometimes at considerable distance. Collective observations of whaling captains indicate that pods of migrating bowhead whales can be displaced (diverted away from shore) as much as 30 miles from their normal migratory path, and that the whales begin their diversion at distances of up to 35 miles from an active seismic operation (NOAA 2008). This behavior helps the whales avoid the potential for any harm to their hearing from the noise. However, data indicate that fall migrating bowheads can show greater avoidance of active seismic vessels than do feeding bowheads. Response is variable, even to a particular noise source, and the reasons for this variability are not fully understood. In other species of mammals, including cetaceans, females with young are more responsive to noise and human disturbance than other segments of the population (NOAA 2008).

Whales demonstrate stronger responses to consistent noise than to pulsed noise, like that generated by seismic exploration, even if the pulsed noise is louder (Schick and Urban 2000). Whales also demonstrated greater response to sources with increasing sound levels, such as that of an approaching ship.

Whales may be disturbed by sound from drill rigs. When a drill rig is present, whales were distributed farther from the rig than they would be under a random scenario, indicating a significant temporary loss of habitat. The researchers suggest that bowheads vary their response to drill rigs during fall and summer feeding. However, the researchers had no data on noise levels and the study year was a year experiencing heavy ice, when whales would migrate farther offshore. They concluded that linkage between a drilling rig and whale avoidance patterns is incomplete, especially without data regarding long-term effects of short-term exposure to industrial noise (Schick and Urban 2000). Studies conducted as part of a monitoring program for Northstar indicate that, in one of the three years of monitoring efforts, the southern edge of the bowhead whale fall migration path may have been slightly (2-3 miles) farther offshore during periods when higher sound levels were recorded and detected no significant effect of sound during the other two years monitored (Angliss and Outlaw 2008). High noise levels that year were attributed to vessel traffic, not the rig itself. Noise on artificial gravel islands, like Northstar, must pass through gravel to reach water. The gravel lessens noise levels, substantially lowering noise levels within 4 km and often making them undetectable at 9.3 km (MMS 2006). Research conducted in the Canadian Beaufort Sea in the mid 80s indicated that bowheads reduced their use of the main industrial area. However, surveys were only funded during oil activity, with no data no compare levels before and after the oil exploration (Richardson et al. 1995).

Studies in the Alaskan Beaufort Sea by BBN Laboratories and LGL Limited (Miles et al. 1987) indicate that bowhead whales may respond to industrial noise at greater distances than previously thought, with drillships and related support vessels creating the largest potential zone of disturbance. However, another study shows that the whales did not deter from their migratory pattern even when only a long, narrow lead of 656 feet was available and they had to pass a projector emitting drillship noises. They only altered their pattern by passing the projector on the other side of the lead (Richardson et al. 1991). Several reports from drillships show that temporary displacement may occur at the direct approach of a boat or aircraft, but the bowheads continue their patterns of feeding and migratory behavior soon after the disturbance has passed, and even in the presence of drillship activity.

Seismic exploration presents the highest probability for avoidance of any of the activities associated with oil exploration. Seismic exploration generates strong underwater sound pulses from arrays of airguns and sound may be detected 50 to 100 km away. Strong pulses elicit short term responses–longer dives, lower percent to time at the surface and less frequent raised flukes–which tend to make whales less conspicuous when at the surface. Richardson et al (Richardson et al. 1995) suggest being “less conspicuous” might be a long term effect of intermittent exposure to humans and might protect whales from some human activities, like hunting. During the fall migration bowhead whales may avoid an area around a seismic vessel operating in nearshore waters by a radius of about 20 km (NOAA 2008). Avoidance did not persist beyond 12 hours after the end of seismic operations. Bowhead whales may begin to deflect around a seismic source at distances up to 35 km.

NMFS and MMS believe that seismic surveys during the open-water period, with airgun noise and increased vessel activity and aircraft traffic, have the potential to disturb bowhead whales. Available information does not indicate any long-term population-level adverse effects on bowhead whales. Therefore, NMFS and MMS conclude that seismic surveys are not expected to add significantly to the cumulative impacts on bowhead whales from past, present, and future activities (MMS 2008, Vol. I, Chapter Two; NOAA 2008). Whales may exhibit temporary avoidance behavior to seismic surveys, vessel and aircraft activities, drilling, and construction, but overall effects to bowheads from disturbance and noise likely would be temporary and nonlethal. (MMS 2003b, NOAA 2008).

Marine-vessel traffic, especially between mid-August and mid-to-late September, may disturb bowhead whales. Fleeing behavior from vessel traffic generally stops within minutes after a vessel has passed, but whales may remain scattered for a longer period (NOAA 2008). Smaller whales seem less wary of an approaching boat and may approach the boat (Carroll and Smithhisler 1980). Whaling captains from Alaskan North Slope communities have observed that as nearshore vessel traffic has increased in the Beaufort Sea during fall whaling, whales have been displaced farther offshore, thus making them less accessible to the whaling crews, and negatively impacting fall whaling (MMS 2003b).

A springtime study of whales migrating along leads and through pack ice found that a minority of bowhead whales (14 percent) dove or otherwise exhibited short term behavioral changes due to the approach of a Bell 212 helicopter (Patenaude et al. 2002). A Twin Otter airplane used in the study generated a less pronounced response, possibly because of its weaker and less complex sound. Bowheads showed no conspicuous startle reactions even when aircraft began circling at 460 m altitude and a radius of 1 km. There was no indication that bowheads reacted more frequently during lower altitude flights.

Bowhead movement patterns seem to have an effect on avoidance behavior. Fall-migrating bowheads in the U.S. Beaufort Sea display a tendency to avoid seismic sounds at a distance of 20-30 km (Richardson and Miller 1999). In the summer, "stationary" whales in the Canadian Beaufort Sea have a much smaller reaction zone of approximately 2 km (Miller and Davis 2002). The difference may be attributed to whale activity; whales in Canada more tolerant of noise were feeding, while the whales which avoided seismic noise were migrating. In 2007, whales were observed with 2 km of an active array on three occasions; these whales may have been feeding (NOAA 2008).

Behavioral studies have suggested that bowhead whales habituate to noise. For example, when hunting bowheads, the whale is struck with a harpoon with a line and float attached. The device normally includes an explosive device charged with black powder. The sound of one or more bomb detonations during as strike is audible for some distance. Whaling crews have observed that whales may act skittish and wary after a bomb detonates, or may be displaced farther offshore. However, disturbances to migration as a result of a strike are temporary. A biological opinion prepared by NOAA, found that overall, bowhead whales exposed to noise producing activities such as vessel and aircraft traffic, drilling operations, and seismic surveys most likely would experience temporary, nonlethal effects (NOAA 2008).

Evidence to support that permanent changes to feeding or migratory patterns have occurred is not conclusive (Fraker et al. 1982). These biologists believe that little information is available showing that bowheads abandon an area, travel far, or remain disturbed for extended periods after a ship passes. In terms of displacement from areas with heavy traffic, past observations and studies demonstrate that various cetacean species react differently to long-term disturbances, and consequently, bowhead whale responses to repeated disturbances cannot be predicted accurately. The most intense, and potentially most disturbing, human activities are subsistence whaling, commercial vessel traffic, and marine seismic activities (Miller et al. 1991).

Calculating the effect of noise on migration is hampered by natural factors affecting migration route selection; noise may not be only factor affecting migration routes. Ice cover may influence the timing or duration of the fall migration. Researchers attribute migration proximity to shore to the severity of ice; whales migrate closer to shore in light or moderate ice years and farther offshore in heavy ice years (MMS 2008, Vol. I, Chapter Three). Treacy detected no localized deflections caused by seismic exploration (Treacy 2002).

Hofman (2003) reviewed available studies of the effects of industrial noise on whales, finding that some effects on activity patterns of some whales were documented, but that research was insufficient for understanding which species are affected, how many animals are affected, distances at which various species are affected, and the biological significance of the effects. Although some studies found distribution and behavior changes for some whales, the changes were negligible and no harmful effects were documented (Hofman 2003). Research is also lacking on whether or not some species may become habituated to, and stop being affected by, certain kinds of sounds, or whether certain species may become more sensitive to sounds with increased exposure (Hofman 2003). Researching these effects on marine mammals and other marine animals is a difficult undertaking.

Hofman (2003) explained the many variables that influence the effects of noise on animals in the marine environment: The nature and significance of acoustic effects are dependent on a number of variables. They include

- the intensity, frequency, and duration of the sound;
- the location of the sound source relative to the potentially affected animals;
- water depth, bottom reflectivity and other features of the environment;
- the distance between the animal and the sound source;
- whether the sound source is stationary or moving;
- the species, age, sex, reproductive status, activity and hearing ability of the animals exposed to the sound;
- whether the animals use similar sounds for communicating, locating and capturing prey, etc.; and
- whether and how frequently the animals in question are exposed to the sound.

There are a few published, peer-reviewed studies of the effects of noise from oil and gas activities on marine animals. Several additional studies measured sound levels from drilling and operations in the Beaufort Sea, but these studies did not measure the effects of the sounds on marine life (Blackwell and Greene 2004, 2006). In one of the few controlled experiments on the response of whales to noise, a four-year study examined responses of whales to airguns used in seismic surveys in the Gulf of Mexico. This study found no horizontal avoidance to seismic airgun sounds by sperm whales (Jochens et al. 2008).

Behavioral disturbance to marine mammals is considered to be “take by harassment” under the MMPA. Based upon the predicted acoustics of the Northstar project, NMFS estimated up to 1,533 whales per year could be “taken” as they detect and react to the noise during the annual fall migrations. Recognizing there is considerable variability with such an estimate, NMFS would not expect this number of whales to be harassed year after year (NOAA 2008). Two existing offshore production facilities, at Oooguruk and Nikaitchuq, were constructed in nearshore state waters; neither is expected to result in takes of bowhead whales. All open-water seismic and other operations, like drilling programs, that have the potential to “incidentally take” marine mammals, including the bowhead whale, have monitoring programs. All seismic and other offshore energy projects undergo multi-agency review that includes NMFS. NMFS is notified of and receives copies of all geophysical exploration permit applications received by the division. The Alaska Region office routinely participates in seismic monitoring and mitigation plan reviews. During these reviews, specific recommendations for monitoring programs are made. Under the MMPA, Incidental Harassment Authorizations (IHAs) can be issued by NMFS that authorize unintentional disturbance but not serious injury or mortality. Disturbing or taking bowhead whales without an IHA would violate the MMPA and lessees must comply with the provisions of the Marine Mammal Protection Act of 1972 as amended. NMFS requires that seismic programs conducted under IHAs include provisions to monitor for marine mammals and to shut down airguns when mammals are detected within designated safety radii.

In addition, any tract or portion thereof in the lease sale area may be subject to seasonal drilling restrictions. The measure provides specific seasonal drilling restrictions for exploratory drilling operations from bottom-founded and floating drilling structures and natural and man-made gravel islands. The effect of this mitigation measure is to prevent whales from being disrupted during their migration and when they are most likely to be hunted by Inupiat whalers.

Offshore exploratory drilling operations in U.S. waters of the Beaufort Sea have been limited by a seasonal drilling restriction since the first Beaufort Sea OCS sale in 1979. The Joint Federal and State Beaufort Sea Lease Sale imposed a seven- month drilling seasonal drilling restriction on most leases to protect endangered bowhead whales. (Grogan 1990). The 1979 seasonal drilling restriction was modified in 1982 to generally restrict exploratory drilling during the fall bowhead migration. In 1985, two oil companies submitted requests for departures from the fall bowhead migration. These companies used drillships, which had not previously been used in the Alaskan Beaufort Sea. In response to this request the state, in consultation with the oil industry, federal government, and NSB, undertook a review of all information relevant to exploratory drilling activities and their effects on the bowhead whale. As a result of this review, the state established a seasonal drilling restriction policy in May 1986 which would apply to exploration activities on federal leases subject to the state's coastal consistency review, as well as offshore state oil and gas leases (Grogan 1990).

Geophysical exploration activities are governed by 11 AAC 96 and are not affected by leasing. Lessees or non-lessee companies may propose various operations, which include seismic surveys, in the proposed lease sale area. Restrictions on geophysical exploration permits, whether lease-related or not, will depend on the size, scope, duration, and intensity of the proposed project and on the reasonably foreseeable effects on important species, specifically marine mammals.

In 1986 industry and the Alaska Eskimo Whaling Commission formed an Oil/Whalers Agreement (now called a Conflict Avoidance Agreement, or CAA) to coordinate actions that may potentially affect whaling activities (EDAW/AECOM 2007). Through this agreement, industry provides logistical support to whaling crews, particularly from Nuiqsut. It provides facilities at Cross Island to use as a hunting camp during the fall hunt, as well as some transportation for the harvested meat. The CAA also provides a communications office in Deadhorse to coordinate industry exploration activities to minimize interference with whale migration and whaling expeditions.

NMFS and MMS believe that seismic surveys during the open-water period have the potential to disturb bowhead whales from airgun noise, increase marine vessel activity, and aircraft traffic. Available information does not indicate any long-term population-level adverse effects on bowhead whales. Therefore, NMFS and MMS conclude that seismic surveys are not expected to add significantly to the cumulative impacts on bowhead whales from past, present, and future activities (MMS 2007a, NOAA 2008). Whales may exhibit temporary avoidance behavior to seismic surveys, vessel and aircraft activities, drilling, and construction, but overall effects to bowheads from disturbance and noise likely would be temporary and nonlethal (MMS 2003b, NOAA 2008, Vol. I, Chapter Two).

<u>Causeways</u>: Although the post-construction environmental effects of continuous solid fill causeways are the subject of differing opinions, it is generally accepted that nearshore causeways have little or no effect on marine mammals. Bowhead whales have been sighted in nearshore areas of the Arctic coast, but they normally inhabit deeper water farther from shore and as experience with the Endicott and West Dock causeways near Prudhoe Bay has shown, the deeper water food sources eaten by whales, as well as ringed seals, are not affected by the construction and maintenance of a causeway (USACOE 1984). Furthermore, because noise propagates poorly in shallow waters where causeways are generally utilized, noise disturbance is not expected to affect the migration patterns or food sources of marine mammals in the proposed lease sale area. Use of continuous-fill causeways is discouraged and significant alterations to nearshore oceanographic circulation patterns are prohibited. The mitigation measure imposes design parameters that ensure natural salinity and temperature regimes that may affect fish distribution are not altered. Environmentally preferred alternatives for field development include use of buried pipelines, onshore directional drilling, or elevated structures. Causeways, if permitted, are not expected to affect whale migration or feeding because they are in-shore structures in shallow water.

Natural Gas Development: The most likely effect of natural gas development and production on whales would come from air traffic to and from production platforms and support facilities (probably at Deadhorse) and from platform and offshore-pipeline installation, with potential disturbances similar to those discussed above.

The effect of installing gas-production platforms and laying gas pipeline would be similar to the effect of installing oil production platforms and laying oil pipelines. Effects would be minimal or avoided because all construction occurs in winter when whales are not present. Construction is temporary lasting one to three seasons, thus any impacts during summer months would be near the gas production platforms along the pipeline routes. Although this effect could increase the habitat alterations, and possibly alter the availability of some food supplies, changes are expected be short-term (less than one year) and local (within about 1.6 km of the activity) (MMS 1998:IV-HL-11).

If a natural gas blowout occurred with a possible explosion and fire, whales in the immediate vicinity of the blowout could be killed, particularly if the explosion occurred below the water surface. Natural gas and condensates would disperse rapidly. Animals that are away from the immediate area or that are exposed to weathered oils would not be expected to suffer serious consequences from inhalation (MMS 2008). A blowout that results in an oil spill is extremely rare and has never occurred in Alaska. However, natural gas blowouts have occurred. Blowout preventers, which immediately close off the open well to prevent or minimize any discharges, are required for all drilling and work-over rigs and are routinely inspected by the AOGCC.

Available data do not indicate that noise and disturbance from oil and gas exploration and development activities since the mid-1970s has had lasting population level adverse effects on bowhead whales. Bowheads are robust, increasing in abundance, and have been approaching the lower limit of their historic population size at the same time that oil and gas exploration activities have been occurring in the Beaufort Sea (NOAA 2006).

Overall Effects of Development: Although whales may change their behavior in response to anthropogenic sounds, the most common effects are expected to be temporary and unlikely to prevent whales' survival and recovery (NOAA 2008). The majority of bowhead whales that may encounter seismic and other noise related to oil exploration and development are migrating to summering or wintering habitats. While feeding does occur in the U.S. Beaufort Sea, it seems to occur primarily during fall migrations and does not appear to be critical to survival.

Because offshore oil and gas activities in State waters are generally well shoreward of the bowheads main migration route, and some of the activities occur inside the barrier islands, the overall effects on bowheads from activities on State leases is likely to be minimal (NOAA 2008). These impacts could be magnified, however, if construction activity associated with additional development projects were to occur simultaneously, rather than consecutively.

Because the bowhead whale population is approaching its pre-exploitation population size and has been documented to be increasing at a roughly constant rate for over 20 years, the impacts of oil and gas industry on individual survival and reproduction in the past have likely been minor (Angliss and Outlaw 2008).

Oil spills: There is little data about the effects of oil on bowheads and other cetaceans (NOAA 2008). Primary concerns about the potential effects of oil spills on bowheads in the Beaufort Sea include: 1) accumulation of oil in eroded areas of the bowhead's skin and around the eye, leading to noxious effects from surface contact with hydrocarbons; 2) accidental ingestion or inhalation of oil while feeding, possibly resulting in lethal or sublethal effects, including gastrointestinal tract obstructions; 3) fouled baleen, resulting in reduced filtering efficiencies; and 4) destruction or contamination of critical food sources from acute or chronic oil pollution. Bowheads could also be affected by passing through residual oil, even if they were not present during the spill (NOAA 2008). A spill in broken ice, if one occurred, would be more difficult to clean up than one on land or on solid ice. If spilled oil migrated into leads or ice-free areas used by migrating whales, a significant proportion of the population could be affected (NOAA 2008). The North Slope Borough is concerned about a possible oil spill in spring or fall broken ice, when whales might be present in sale waters (NSB 2005).

Bowhead whales have not been observed in the presence of an oil spill, so it is uncertain if they can detect oil or would avoid surface oil. Bowhead skin, like most cetaceans, is mostly soft and smooth. However, it also contains up to several hundred roughened lesions on the surface of the skin. If a bowhead came in contact with spilled oil it is unlikely that the oil would stick to the smooth areas of its skin, but might adhere to rough areas on the skin surface. If bowheads left the oiled area it is likely that most of the oil would wash off within a short time. Bratton et al. (Bratton et al. 1993) concluded that bowhead encounters with fresh or weathered oil present little topological hazard to the skin of a bowhead (MMS 1996). However, oil adherence to the roughened parts of the skin has the potential to introduce tissue-destructive pathogens (NRC 2003).

Bowheads would most likely contact oil as they surfaced to breathe. Although unlikely, inhalation of oil vapor might cause intoxication, irritation of the mucus membrane and respiratory tract, and the absorption of volatile aromatic hydrocarbons into the bloodstream. These would likely be rapidly excreted. Vapor concentrations that could be harmful to whales would likely dissipate within a few hours. However, whales exposed to toxic vapors within a few hours of the oil spill could suffer pulmonary distress and possible death. Generally, only a few whales would likely be affected at any given time. Newborn calves would be the most likely to be affected (MMS 2008). Oil may also enter and irritate the eye tissues through the bowhead’s large conjunctival sac (NRC 2003).

If feeding bowheads contacted spilled oil, the baleen hairs might be fouled. Repeated baleen fouling over an extended period of time might result in reduced food intake which might affect the health and survival of bowheads. There is a potential pathway for the accumulation of petroleum hydrocarbons in animals that feed on contaminated zooplankton, including a primary food species of the bowhead, *Calanus hyperboreus* (Bratton et al. 1993). Bowheads might ingest some tar balls or large blobs of oil along with oil-contaminated prey while feeding. While the fate of an ingested tar ball is difficult to ascertain, toxic chemicals in tar could obstruct digestive passages resulting in acute illness or death (Bratton et al. 1993:724, citing to Tarpley, 1985). Production of zooplankton, the major food source of bowheads, would not be permanently affected by an oil spill. The amount lost even in a large spill would be negligible in comparison with the plankton resources available in the bowhead’s summer feeding grounds in the Canadian Beaufort (NOAA 2008). While feeding does occur in the central Beaufort, its importance as an energy source diminishes compared to feeding in the Canadian Beaufort (Richardson and Thomson 2002). Pipelines must be designed to prevent accidental rupture or discharge. Drilling is prohibited during periods of broken ice in summer when cleanup would be most difficult.

Cleanup activities, with associated presence of boats, aircraft, and workers, as well as strategies such as in-situ burning, may also impact bowhead whales (NOAA 2008).

Past studies found that effects from oil would be of local and limited distribution (Geraci and Aubin 1982, Richardson and Bradstreet 1987). More specifically, that: (1) the effects of oil on important feeding grounds would be local and of limited duration; (2) there is growing evidence that bowheads feed over a large area in the Beaufort Sea; (3) the fouling of baleen by oil would have a limited, short-term influence on the filter/feeding process; (4) lethal effects from ingestion of oil are unlikely unless aspiration of vomitus occurs, which could also cause sublethal lung damage; and (5) evidence to date shows that while oil may cause some short-term effects on cetacean skin, such effects are not lethal.

It is unlikely that an oil spill entering the substrate would have any population-level effect on either the bowhead whale food source or the whale itself. First, primary bowhead whale feeding areas are outside of the proposed lease sale area (see Chapter Four). Second, if oil entered the substrate, some specie communities would require years to recover. These species include epibenthic organisms and the number of organisms affected would be limited to the area oiled. However, copepods and euphausiids are the principal foods of bowhead whales, not epibenthic species. Copepods are nearly microscopic free-living zooplankton and their entire life cycle can be completed within 2 weeks. Euphausiids are a small group of pelagic (in water column) crustaceans, commonly called krill. Epibenthic invertebrates such as mysids and gammarid amphipods occasionally are dominant foods, but are usually consumed incidentally while whales are feeding on copepods and euphausiids. Third, the Western Arctic bowhead whale stock is healthy and growing approximately 3.2 percent/year and is therefore less vulnerable to mortality associated with an oil spill. In conclusion, an oil spill could not create a significant impact on the Beaufort Sea bowhead population.

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities subsequent to leasing could potentially have cumulative effects on bowhead whales. Measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to avoid, minimize, and mitigate those potential effects. In addition to complying with the Marine Mammal Protection Act, lessees must comply with seasonal drilling restrictions in identified subsistence whaling zones and coordinate with local whaling groups, communities, and other interested parties. Exploration, development, and production activities located on tracts 1 through 26 shall be conducted in a manner that prevents unreasonable conflicts between oil and gas activities and subsistence whale hunting. Lessees are required to have an approved oil discharge prevention and contingency plan. Pipelines must be designed to prevent accidental rupture or discharge from geophysical hazards, like ice scouring. Permanent facility siting on Cross Island, within 3 miles of Cross Island, and in state waters between the west end of Arey Island and the east end of Barter Island is prohibited unless development will not preclude reasonable access to whales. A complete listing of mitigation measures is found in Chapter Nine.

Any adverse effects on bowhead whales will be minimized by these measures. In addition to bowhead whales, species such as beluga, humpback, fin, killer, and gray whales may occasionally be present in the vicinity. Beluga whales can be found to the north outside of the proposed lease sale area but are rarely seen in state waters. The majority of the Beaufort Sea beluga whale stock occurs between 30 and 80 nautical miles from shore. With the exception of beluga whales, occurrences of these other whales are rare because these waters are at the extreme margin of their range (USFWS 1987). These other whales will also be protected by the measures developed to minimize disturbance to bowhead whales.

M. Effects on Other Marine Mammals

1. Potential Cumulative Effects

Despite protective measures, development of leases in the proposed lease sale area could add to cumulative impacts on the region's most common pinnipeds, ringed, spotted, and bearded seals, and walrus. Ringed seals are the seal species most commonly seen in the sale area, using stable land-fast ice each winter and spring; in summer, these seals commonly move north to follow receding pack ice. Spotted seals are common in coastal waters during ice-free seasons. Bearded seals are found in the Beaufort Sea from July to October at the pack ice edge. Spring and summertime oil and gas exploration and development activities in the sale area and elsewhere in the Beaufort Sea could disturb seals and, depending on other human activity in the area, could ultimately contribute to some limited displacement. The majority of the North Pacific walrus population occurs west of Barrow, although a few walrus may move east throughout the Alaskan portion of the Beaufort Sea to Canadian waters during the open water season.

Habitat Loss: Some pinnipeds could be temporarily displaced by construction activities associated with causeway construction or creating a gravel drilling/production on land. Onshore development in the limited uplands included in the sale could also disturb a small number of pinnipeds. However, the amount of displacement is likely to be very small in comparison with the natural variability in seasonal habitat use and is not expected to affect seal populations. Effects are likely to be 1 year or 1 season or less, with any disturbance of pinnipeds declining after construction activities are complete (MMS 1996). A study on the abundance and distribution of seals near the Northstar development indicated that seal densities during spring were unaffected (Moulton et al. 2005). Habitat, temporal, and weather factors did affect densities. The researchers concluded that the effect of Northstar on basking ringed seals is slight. In another seal study, Moulton et al (Moulton et al. 2002) found that industrial activities on landfast ice–ice road construction, drilling from an artificial island, and on-ice seismic surveys using vibroseis–did not affect seal densities. Williams et al found no evidence that ringed seal use of the landfast ice less than 2 km from Northstar or the ice roads was different than their use of ice 2 to 3.5 km distant. Vehicle traffic on the ice road did not influence ringed seals' use of ice (Williams et al. 2006).

Disturbance, Including Seismic Exploration: The primary sources of noise and disturbance of pinnipeds would come from marine traffic, drill rigs, air traffic, and geophysical surveys. A secondary source would be low frequency noises from drilling operations. Boat traffic could disturb some pinniped concentrations; however, such traffic is not likely to have more than a short-term (a few hours to a few days) effect. Helicopter traffic is assumed to be a source of disturbance to pinnipeds hauled out on beaches or sea ice. Such brief occasional disturbances are not likely to have any serious consequences. Noise and disturbance from pipeline, island, or causeway construction may also adversely affect pinnipeds in the area. Ringed seals near Northstar in 2000 and 2001 established lairs and breathing holes in the landfast ice within a few meters of Northstar, before and during the onset of winter oil activity. These seals' use of the habitat continued undisturbed despite low-frequency noise and vibration, construction, and use of an ice road, indicating their ability to adapt to highly variable habitat availability (Williams et al. 2006).

Noise and disturbance from seismic operations could cause a brief disturbance response from seals. Numbers, sighting distances, and behavior of seals were studied during a nearshore seismic program off northern Alaska in 1996 (Harris et al. 2001). During daylight, seals were seen at nearly identical rates during periods with no airguns firing, 1 airgun, and a "full-array" of 8-11 120-in^3 airguns. Seals tended to be farther away during full-array seismic testing. Seals did avoid a 150 meter zone away from the boat during full-array seismic, but seals apparently did not move much beyond 250 m. "Swimming away" was more common during full-array than no-airgun periods. Affected animals are likely to return to normal behavior patterns within a short period of time (MMS 1996).

MMS (MMS 2008, Vol. I, Chapter Two) determined that oil and gas activities should result in a negligible level of direct, indirect, or cumulative impacts to seals. Seismic exploration and the presence of drill rigs could displace seals (MMS 2008, Vol. I, Chapter Two).

Oil Spills: Direct contact with spilled oil by pinnipeds may result in mortalities. Newborn seal pups that come in contact with oil may lose their thermo-insulation capabilities and die from hypothermia. Adults may only suffer from temporary eye and skin irritations. The specific effects would depend on many factors, including the seal's age and health. Seals are known to be capable of metabolizing as well as excreting and absorbing oil. In general, deaths from contact with oil among adult seals are most likely to occur during periods of high natural stress, such as during the molting season, times of inadequate food supply or if affected by disease (MMS 1987). Seals' eyes may be damaged by exposure to oil; captive ringed sales placed in crude and seals in the Antarctic after a spill developed corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes (NOAA 2006). In the event of a large oil spill contacting and extensively oiling coastal habitats with concentrations of pinnipeds, boat, vehicle, and aircraft traffic operating in the area is expected to cause disturbance and displacement of pinnipeds during cleanup operations. If operations occurred in the spring they would contribute to increased stress and reduced pup survival of seals (MMS 1996).

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities subsequent to leasing could potentially have cumulative effects on seals. Measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to avoid, minimize, and mitigate those potential effects. Lessees must comply with the Marine Mammal Protection Act. Lessees are required to have an approved oil discharge prevention and contingency plan. Causeways are discouraged. If causeways are approved, they must be designed, sited, and constructed to prevent significant changes to nearshore oceanographic circulations patterns and water quality characteristics. A complete listing of mitigation measures is found in Chapter Nine.

These measures will also protect other marine mammals, including other seals and walrus, from the effects of oil and gas exploration and development.

N. Effects on Subsistence Uses

1. Potential Cumulative Effects

For centuries, survival in the Arctic has centered on the pursuit of subsistence foods and materials as well as the knowledge needed to find, harvest, process, store, and distribute the harvest. The development of Inupiat culture depended on handing down traditional knowledge and beliefs about subsistence resources. This knowledge included observations of game behavior, how to use those observations to successfully locate and harvest game, and how hunters and their families should behave to ensure successful harvests in the future. For the Inupiat, subsistence and culture continue to be inextricably intertwined. The process of obtaining, refining, and passing on subsistence skill is inextricably linked to the Inupiat culture, which is based on interdependent family groups, and a tradition of sharing harvested resources (MMS 2007b).

As jobs in Barrow and other North Slope communities became increasingly professionalized, more individuals had to forego part of the subsistence hunting and fishing cycle due to time constraints or limit their subsistence harvests to the most desired species. Those with financial resources frequently counterbalance limited “free time” by using motorized equipment such as ATVs, snow machines, and outboard motors for boats, to reduce travel time. Consequently, cash derived from wage employment did not replace subsistence but underwrote it (EDAW/AECOM 2007).

In the past, borough jobs were especially valued because the NSB government implemented generous “subsistence leave” policies, which eased the burden of making choices about the time to invest in wage work and hunting. In addition, workers irregularly absent from work for subsistence or other reasons were usually rehired. However, interviews with Barrow residents indicate that NSB jobs are now much harder to come by and working policies are more stringent. The uncertainty of income-earning opportunities is forcing the wage-working hunters in Barrow to reevaluate the conditions for earning money and harvesting subsistence resources (EDAW/AECOM 2007).

Traditional subsistence uses include: bowhead and beluga whaling; walrus, polar bear, and seal hunting; brown bear, caribou, muskox, and moose harvesting; hunting and trapping of furbearers, such as wolf, fox, weasel, wolverine, and squirrel; hunting migratory waterfowl and collecting their eggs; fishing for whitefish, char, salmon, smelt, grayling, trout, and burbot; collecting berries, edible plants, and wood; and producing crafts, clothing, and tools made from these wild resources. Equally important, subsistence also includes social activities of consuming, sharing, trading and giving, cooperating, teaching, and celebration among members of the community.

Direct effects on subsistence uses may include: decreased access and land use limitations; less privacy; immediate effects of oil spills; and potential increase in wage earning opportunities to supplant subsistence activities. Indirect effects include: the potential reduction in local fish and wildlife populations due to development; increased travel distance and hunting time required to harvest resources; potential reductions in harvest success rates; increased competition for nearby subsistence resources; improvements in community transportation, trade, and utilities infrastructure; and increased revenues to local government through petroleum revenue taxes.

Alteration of the physical environment may affect migration, nesting, breeding, calving, denning, and staging of animals that are sensitive to oil and gas development activities. For example, noise propagation from jet aircraft is known to affect the behavior of molting waterbirds. Pipelines can disrupt annual caribou migrations, if not elevated properly or buried. Vehicle traffic may adversely affect foraging caribou by displacing them from preferred forage areas. Such effects can be reduced or avoided by observing mitigation measures that restrict oil and gas activities.

Other physical alterations of the environment from post-sale activity could affect subsistence. For example, if a road adjacent to a pipeline was heavily traveled, as might occur during a project's construction phase, caribou may avoid the area of higher vehicle activity. The result could be that a subsistence hunter may have to travel farther from the village in order to capture the affected caribou. Another example might be the industrial use of water, which could affect the drainage pattern of a river tributary, thereby affecting a particular anadromous fish run that are part of a subsistence fishery.

Any activity that has the potential to harm fish or wildlife has the potential to affect subsistence. Mitigation measures have been designed to avoid, reduce, or minimize biological alterations to the proposed lease sale area. Reducing impacts to subsistence resources from oil and gas development is a primary goal in lease sale planning. The objective of protecting subsistence uses lies in protecting cultural and biological resources.

The effects of an oil spill on marine mammals and fish is the most feared adverse impact from oil and gas development offshore. Residents are concerned that the technology does not exist to clean up a major spill, which, regardless of the time of year, would not be possible to fully clean up and which would have incalculable effects on subsistence resources. Residents, having witnessed decades of sea-ice activity, continue to question the structural integrity of drill rigs in the face of tremendous ice forces. An older resident observed sea ice suddenly rise up a 20-foot bluff, threatening homes in Barrow (MMS 1996).

Fish, such as arctic cisco or broad whitefish, which utilize portions of the proposed lease sale area for migration and feeding, could also be affected by excessive disturbances from some oil and gas activities, such as causeways or oil spills. These fish could be directly damaged, or otherwise made less accessible to subsistence fishers. The inability to harvest seals or other marine mammals due to avoidance behavior or loss of supporting habitat could affect subsistence uses other than for food consumption, such as use of seal skins for covering umiaks, or skins and furs for clothing and handicrafts. Traditional whaling harvests are not expected to be affected by post-sale activities.

Community well-being depends on the continued use of subsistence resources because of their cultural and economical significance. The subsistence way of life, with its associated values of sharing food and influence on the extended family and traditional knowledge, is considered an integral part of being Inupiat (Kruse et al. 1983). In addition to this cultural component, subsistence is the direct source of economic well being for NSB residents. Subsistence resources enter into household income as a food source that does not have to be purchased. A loss of subsistence resources would be a loss of income for the entire community (MMS 1996).

While noise, traffic disturbance, and oil spills would produce chronic short-term impacts on subsistence species, none of these impacts would lead to the elimination of any subsistence resource (MMS 2007a). Most impacts to subsistence species associated with oil and gas exploration, development, and production would be localized and would not substantially affect subsistence species numbers, as long as the activities occurred outside of key habitat areas or migratory zones when animals are present (BLM 2005).

As new discoveries are made, the number of development-related facilities will increase, and portions of the developed areas could be closed to public access, reducing the area available for subsistence activities. If subsistence hunters are displaced from traditional hunting areas, they might have to travel greater distances and spend more time harvesting resources. At the same time, increased public access to hunting, fishing, and trapping areas, due to construction of new roads, could increase competition between user groups for subsistence resources. If competition for scarce resources, like moose, on the North Slope were to increase, game managers would restrict non-subsistence hunting and fishing. Management practices to restrict non-local resident hunting are in place for Game Management Unit 26. See Chapter Five for a description of sport hunting and fishing in the proposed lease sale area.

2. Mitigation Measures and Other Regulatory Protections

Although oil and gas activities subsequent to leasing could potentially affect subsistence uses, primarily as secondary effects from effects on habitat, fish, or wildlife, measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to avoid, minimize, and mitigate those potential effects. In addition to mitigation measures addressing fish, wildlife, and habitat, other mitigation measures specifically address harvest interference avoidance, public access, road construction, and oil spill prevention. A plan of operations must include a training program to inform each person working on the project of environmental, social, and cultural concerns. Local communities have a unique understanding of their environment. Involving residents in the planning process for oil and gas activities can be beneficial to the industry and to the community. A complete listing of mitigation measures is found in Chapter Nine.

O. Effects on Historic and Cultural Resources

1. Potential Cumulative Effects

Historic and cultural resources could be affected by oil and gas exploration, development, and production activities. For example, historic and cultural resources may be encountered during field-based activities, and these resources could be affected by accidents such as an oil spill.

Potential impacts could occur in the exploration, development, or production phases, but are more likely to occur if development occurs. Impacts include disruption of culture and disturbance of historic and archeological sites. Impacts could be associated with installation and operation of oil and gas facilities, including drill pads, roads, airstrips, pipelines, processing facilities, and any other ground-disturbing activities. Damage to archaeological sites may include direct breakage of cultural objects; damage to vegetation and thermal regime, leading to erosion and deterioration of organic sites; shifting or mixing of components in sites resulting in loss of association between objects; and damage or destruction of archeological or historic sites by crews collecting artifacts (USFWS 1986).

Many sites along the coast are currently eroding into the sea. Storm surges during the summer and fall open water season have caused rapid coastline erosion. Sediments are reworked to varying depths by current transport and ice gouging, which makes unlikely the survival of any prehistoric resources eroded offshore (MMS 1996).

Cumulative effects on archaeological sites from oil and gas exploration, development, and production are expected to be low. In the event that an increased amount of ground-disturbing activity takes place, state and federal laws and regulations should mitigate effects to archaeological resources. The expected effects on archaeological resources from an oil spill are uncertain.

Well Blowout or Explosion: Disturbance to historical and archaeological sites might occur as a result of activity associated with incidents such as an oil or gas well blowout or explosion. Archaeological resources in the immediate vicinity of the blowout might be destroyed, and cleanup activities could result in disturbance by workers near the accident site.

Oil Spills: Oil spills can have an indirect effect on archaeological sites by contaminating organic material, which would eliminate the possibility of using carbon-dating methods (MMS 1998; USFWS 1986). Subsequent to the *Exxon Valdez* spill, the detrimental effects of cleanup activity on these resources were minor because the work plan for cleanup was constantly reviewed, and cleanup techniques were changed as needed to protect archaeological and cultural resources (Bittner 1993). Various mitigation measures used to protect archaeological sites during oil-spill cleanups include avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, artifact collection, and cultural resource awareness programs.

2. Mitigation Measures and Other Regulatory Protections

Historic and cultural resources could be affected by oil and gas exploration, development, and production activities. For example, historic and cultural resources may be encountered during field-based activities, and these resources could be affected by accidents such as an oil spill.

Although oil and gas activities subsequent to leasing could potentially have cumulative effects on historic and cultural resources, measures in this best interest finding, along with regulations imposed by other state, federal and local agencies, are expected to avoid, minimize, and mitigate those potential effects.

Because historic and cultural resources are irreplaceable, caution is necessary in order to not disturb or impact them. AS 41.35.200 addresses unlawful acts concerning cultural and historical resources. In addition, all field-based response workers are required to adhere to historic properties protection policies that reinforce that it is unlawful to collect or disturb, remove, or destroy any historic property or suspected historic property and to immediately report any historic property that they see or encounter (AHRS 2008).

Under North Slope Borough municipal code, proposed development shall not impact any historic, prehistoric, or archaeological resource before the assessment of that resource by a professional archaeologist (NSBMC 19.50.030(F)). Borough municipal code 19.70.050(F) says, “Development shall not significantly interfere with traditional activities at cultural or historic sites identified in the Coastal Management Program” (NSB 2008b). These provisions give the NSB authority to protect cultural and historic resources and current subsistence uses of these sites.

Mitigation measures address education and protection of historic and archeological sites. A complete listing of mitigation measures is found in Chapter Nine.

P. Fiscal Effects

1. Statewide

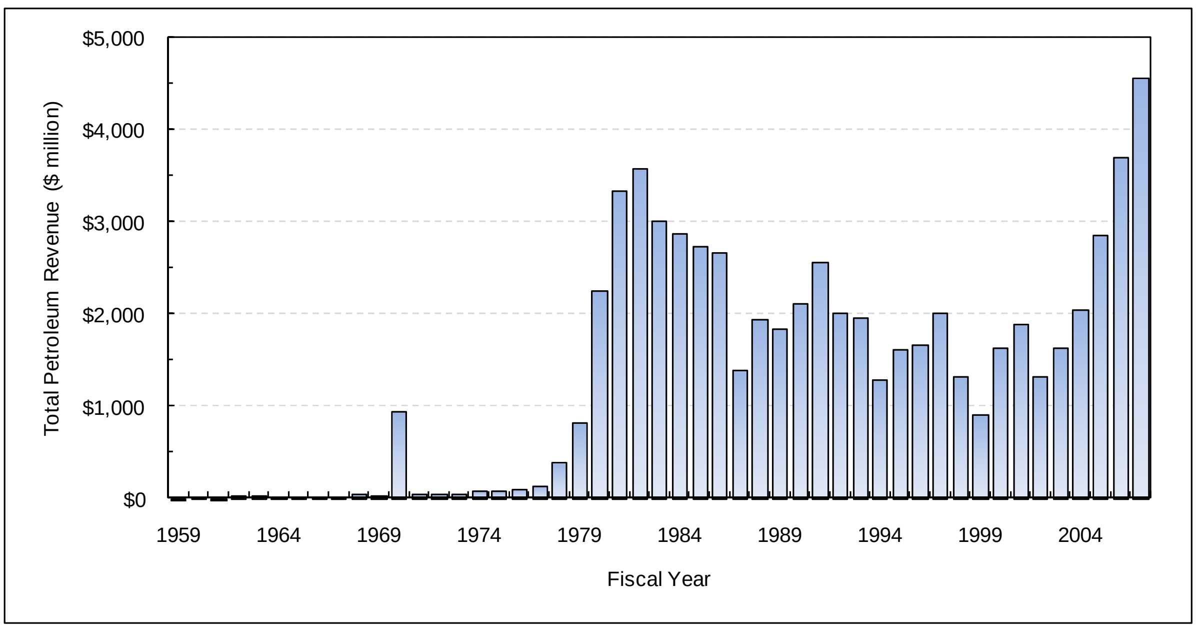
Alaska’s economy depends heavily on revenues related to oil and gas production and government spending resulting from those revenues. Oil and gas lease sales generate income to state government through royalties (including bonuses, rents, and interest), production taxes, petroleum corporate income taxes, and petroleum property taxes. Unrestricted oil revenue totaled $10.012 billion in fiscal year (FY) 2008 (Figure 8.1). Revenue in FY 2009 is expected to drop to $6 billion due to declining oil prices and production (ADOR 2008c).

Bonus payments are the amounts paid by winning bidders for the individual tracts leased. Since 1959, 6,832 tracts have been leased, generating more than $2 billion in bonus income and interest to the state (ADNR 2008a).

Each lease requires an annual ***rental payment***. The first year rent is $1 per acre or fraction of an acre, and the rent increases in 50-cent increments to $3 per acre or fraction of an acre in the fifth and all subsequent years of the lease. The lessee must pay the rent in advance and receives a credit on the royalty due under the lease for that year equal to the rental amount. Rental income from state leases for FY 2007 (July 2006 through June 2007) was approximately $7.4 million. Rentals from federal leases were approximately $2 million (ADNR 2008b).

Royalties represent the state's share of the production as the mineral interest owner. Royalties, including bonuses, rents, and interest provided more than $2.4 billion in revenue to the state in FY 2008 (ADOR 2008c). Royalty rates can vary depending on tracts. For the most recent Beaufort Sea Areawide Oil and Gas Lease Sale held October 22, 2008, the royalty rate was either 12.5 percent or 16.666 percent.

Production taxes are the biggest source of state revenue. In 2007, the state replaced the Petroleum Profits Tax (PPT) with the Alaska's Clear and Equitable Share (ACES). The revision increased overall rates and narrowed allowances for cost deductions and investment credits. With the new law, oil revenue estimates are significantly higher than would have been expected under the prior law. For FY 2008 production taxes were $6.879 billion; for FY 2009 they are forecast to be $3.579 billion (ADOR 2008c).



Source: ADOR 2007b.

Notes: Includes petroleum corporate income tax; production tax; petroleum property tax; oil and gas royalties (net); bonuses, rents and interest (net); and petroleum special settlements. Does not include Permanent Fund contributions and Constitutional Budget Reserve Fund.

Figure 8.1. Historical petroleum revenue to the State of Alaska, 1959-2007.

Corporate income taxes must be paid by all corporations in the state for all taxable income derived from sources within the state. Special provisions apply to apportioning total income worldwide for corporations involved in producing or transporting oil and gas. Most, if not all, producers and transporters of oil and gas in Alaska are corporations. For FY 2008, oil and gas corporation taxes were $605.8 million and are forecast to be $635 million for FY 2009 (ADOR 2007b, 2008c).

Petroleum property taxes are annual taxes levied each year on the full and true value of property taxable under AS 43.56. This includes exploration property, production property, and pipeline transportation property. Property taxes amounted to $81.5 million in FY 2008 and are anticipated to be $72.5 million for FY 2009(ADOR 2008c).

In addition, tax settlements to the Constitutional Budget Reserve Fund amounted to approximately $438.3 million and National Petroleum Reserve-Alaska (NPR-A) royalties, rents, and bonuses amounted to $5.2 million.

Alaska’s oil revenue in 2008 totaled $11.255 billion (ADOR 2008c).

Unrestricted oil revenue comprised approximately 93 percent of the state’s general fund unrestricted revenue in FY 2009 (ADOR 2008a). Such revenues finance the state’s education funding, operating budget, and capital budget. State spending supports nearly one out of every three jobs, and $3 of every $10 of personal income result from state spending. Nearly one of every 2 local government jobs (including school district jobs) in Alaska relies on state funding (Goldsmith 1991). Table 8.1 shows state funding and enrollment figures for the NSB School District.

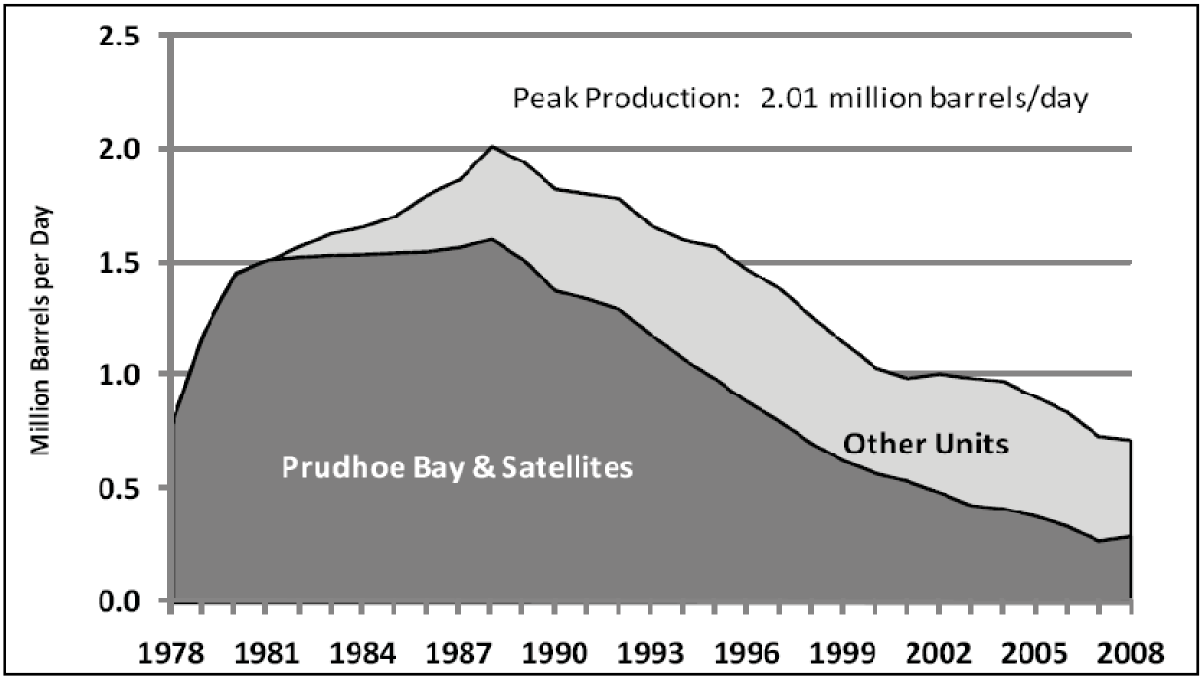
Table 8.1. State aid and enrollment for the North Slope Borough School District, fiscal year 2000-2008.

Fiscal Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
Aid in millions	$8.96	$9.75	$8.94	$8.47	$8.70	$9.28	$11.60	$12.24	$10.20
Enrollment	1,936	2,187	2,165	2,115	2,065	1,938	1,941	1,859	1,864

Source: ADEED 2009a, b.

Alaska North Slope production peaked at 2.006 million barrels per day in FY 1988 and has declined steadily since then (Figure 8.2). The Alaska Department of Revenue (ADOR) anticipates production will decline by 3.8 percent in FY 2009 to about 0.689 million barrels per day. For FY 2010, ADOR projects a 3.5 percent decrease in North Slope production to 0.665 million barrels per day (ADOR 2008c). ADOR expects oil prices to average $57.78 a barrel in FY 2010 down from $90.46 in FY 2008 (ADOR 2009).

The energy industry is Alaska’s largest industry, spending $2.1 billion annually in the state. The industry directly spends $422 million on payroll in Alaska and $1.7 billion on goods and services in-state. Overall, this spending generates 33,600 jobs, $1.4 billion in payroll, and adds $1.8 billion in value to the Alaska economy, for total output of $3.1 billion. Oil and gas account for 12 percent of private sector jobs and 20 percent of private sector payroll. The oil and gas industry has the highest average wage in Alaska. The average producer company pays a monthly wage of $7,754, which is 2.8 times higher than the statewide average of $2,798 (Information Insights and McDowell Group 2001).



Source: ADOR 2008c.

Figure 8.2. Alaska North Slope oil production, 1978-2008.

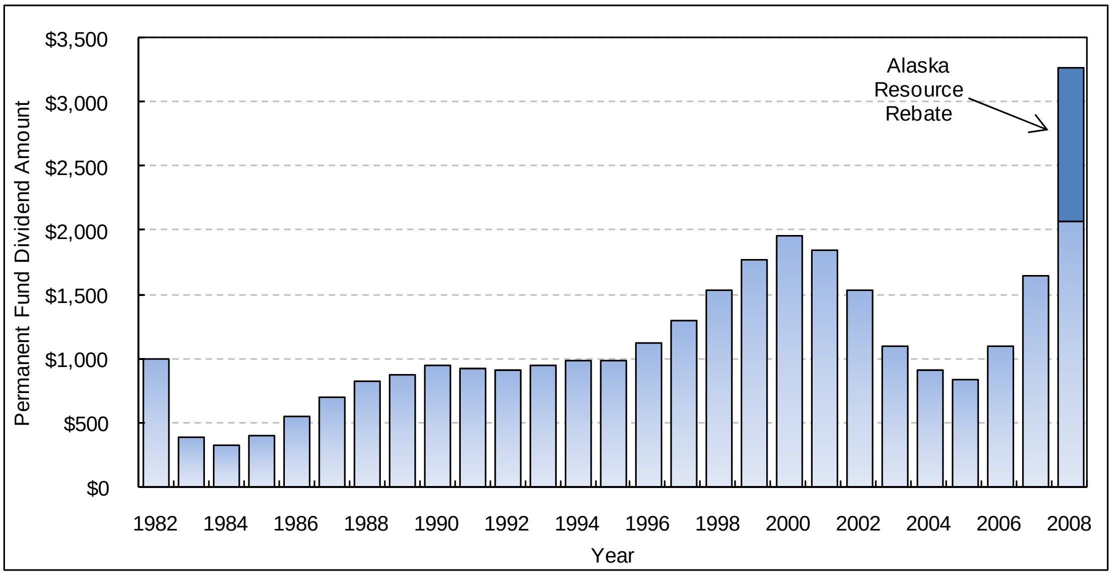
When state and local governments spend oil and gas revenues, Alaska's petroleum industry exercises significant indirect impacts on local communities. Money is spent throughout the state on capital projects, to support basic government operations (including payroll for state government employees), for revenue sharing and municipal assistance, to fund education, and to pay the annual Permanent Fund dividend (Information Insights and McDowell Group 2001).

Furthermore, the total economic effects of any spending, including state government spending and salaries paid to private oil and gas industry employees, are always greater than the direct effect. When money is re-spent in the economy, its original value multiplies. For example, this "income multiplier" is calculated at 1.35 for state spending. This means that for every dollar of income Alaskans receive directly from state spending, an additional 35 cents of income is generated when that dollar is re-spent in the local economy (Goldsmith 1991).

In 2006, nonresidents accounted for 30.8 percent of the statewide oil industry's workforce (major oil companies and oilfield services), an increase of 1.2 percentage points over 2005 (ADOL 2008). Earnings paid to nonresidents working in the oil industry increased from $242.9 million in 2005 to $327.6 million in 2006. The nonresident share of earnings in the oil industry was 28.7 percent, a figure much higher than the statewide private sector average of 12.9 percent. By comparison, Alaska's seafood processing industry employed the highest percentage of nonresident workers of any industry sector in 2006; 76.4 percent of workers were nonresidents (ADOL 2008).

The mitigation measures encourage lessees to employ local Alaska residents and contractors, to the extent they are available and qualified. Lessees must submit, as part of the plan of operations, a proposal detailing the means by which the lessee will comply with the measure. The proposal must include a description of the operator's plans for partnering with local communities to recruit, hire, and train local and Alaska residents and contractors.

Oil and gas royalties and revenues also contribute to the Alaska Permanent Fund, which pays significant dividends each year to eligible state residents. The Alaska Permanent Fund, established by ballot proposition in 1976, is also funded with oil and gas revenues. Twenty-five percent of all revenue generated by oil and gas activities is placed in the fund, which is forecast to exceed $40 billion in FY 2008 (APFC 2008). All eligible Alaskans who apply receive an annual Permanent Fund Dividend (PFD) from the earnings of the fund. In 2008, the PFD was $2,069 per person; 610,768 dividends were paid, totaling $1.2 billion (ADOR 2008b; Figure 8.3). In addition, in 2008 every Alaska resident also received an additional $1,200 resource rebate. The PFD is an equitable benefit transfer because it reaches every eligible Alaskan regardless of income or socio-economic status. The PFD, with its large annual infusion of cash, contributes to the growth of the state economy, like any other basic industry.



Source: ADOR 2007a; ADOR 2008b.

Figure 8.3. Amount of the Alaska Permanent Fund Dividend, 1982-2008; includes Alaska Resource Rebate in 2008.

2. Municipalities and Communities

The North Slope Borough (NSB) is host to the production center for the state's oil industry and no other borough is more influenced by the oil and gas industry. Although the borough relies on oil revenues, most local residents pursue a traditional and community-based economic life. The finances of the NSB government depend predominately on tax revenues from oil properties. Approximately 98 percent of all local property tax collections come from oil producers. For fiscal year 2008/2009, property tax receipts are anticipated to be $248 million (NSB 2008a).

Oil and gas property is exempt from local municipal taxation, but the state levies a 20-mill tax against this property. Each municipality with oil and gas property within its boundaries is reimbursed an amount equal to the taxes which would have been levied on the oil and gas property, up to the 20-mill limit. The 2005 property tax rate for the NSB was 19.03 mills. Since the 1980s, the NSB property tax base has consisted mainly of high-value property owned or leased by the oil industry in the Prudhoe Bay area (BLM 2007)

A critical issue facing the NSB is a growing shortfall in revenues consequent to reductions in the assessed value of oil facilities as they depreciate. The real property assessed valuation for the NSB has declined from $11.5 billion in 1992 to $194 million in 2005. The full value determination of real property was $10.36 billion in 2005. Future assessed values could be higher than current projections if industrial infrastructure is built in the NSB. In the near term, a decline in tax revenues and bonding capacity is anticipated (BLM 2007).

One of the NSB's main goals is to create employment for Native residents and it has successfully hired many Natives for NSB construction projects and operations. The NSB has been less successful facilitating employment of Native people in the oil industry at Prudhoe Bay. The NSB is concerned that the oil industry has not done enough to train unskilled laborers or to allow them to participate in subsistence hunting. The NSB also is concerned that the oil industry recruits using methods common to western industry (MMS 2008).

The NSB employs many permanent residents directly and finances construction projects under its Capital Improvement Program. The NSB pay scales have been equal to, or better than, those in the oil and gas industry, while working conditions and the flexibility offered by the NSB are considered by Alaska Native employees to be superior to those in the oil and gas industry. In addition, NSB employment policies permit employees to take time off, particularly for subsistence hunting (BLM 2007).

While the NSB ranks highly on income statistics (Table 8.2), it also has one of the highest costs of living in the state. The Cooperative Extension Service of the University of Alaska Fairbanks surveys food prices in 24 locations in the state. In June 2004, it listed Nuiqsut and Barrow as the second and fourth most expensive places for weekly food costs for a family with 2 school-age children. Food items were more than 2.3 times higher in Nuiqsut and 2.1 times higher in Barrow than in Anchorage (ADOL 2005).

Table 8.2. Comparison of NSB per capita personal income to other locations.

Location	Income ($)
United States	34,685
Alaska	36,636
Anchorage Municipality	40,670
Fairbanks North Star Borough	33,568
North Slope Borough	42,209
Northwest Arctic Borough	26,339

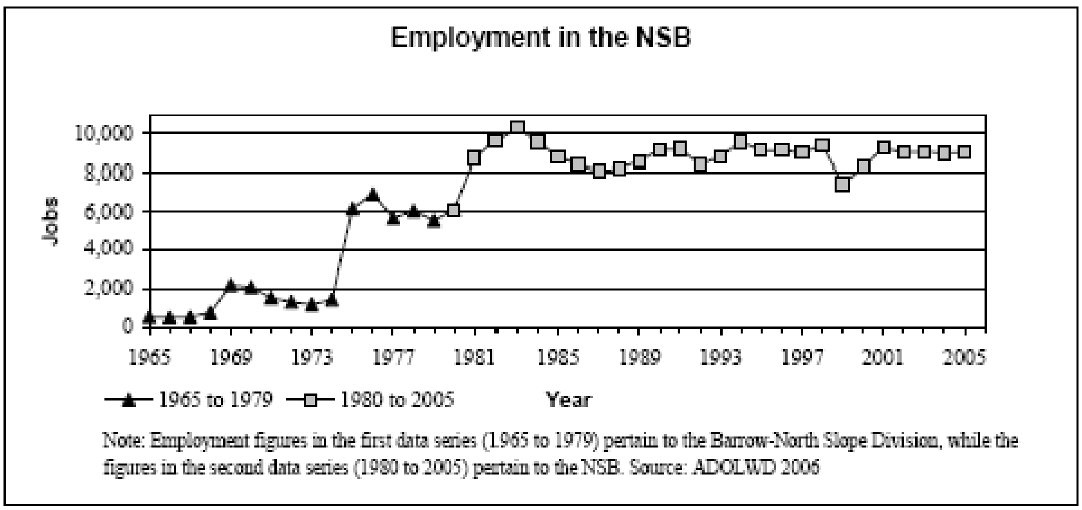
According to a spring 2004 construction cost survey conducted for the Alaska Housing Finance Corporation, Barrow bears the highest material costs among 11 Alaska locations surveyed. A basic construction market basket that does not include doors or windows was quoted to cost $37,873, exceeding the Anchorage price by 114 percent. Most of the additional price is attributed to transportation costs. Airfares are also among the highest in the state because of the distance and the costs involved with service to remote locations (ADOL 2005).

The NSB established its own permanent fund that contains assets that are to be held in perpetuity. As of June 30, 2008, the value of the fund was approximately $462 million. Income from the fund is to be added to the corpus of the fund, except that an annual transfer is made to the general fund in an amount up to 8 percent of the average total fair value of the fund at the end of the 3 preceding fiscal years (NSB 2009).

Q. Effects of Oil and Gas on Municipalities and Communities

1. Employment North Slope Borough 2009

Local government is the largest employer of borough residents and the median household income is $63,173 (MMS 2007c). Barrow is a hub and economic center of the North Slope Borough. Borough, state, and Federal agencies provide 57 percent of total employment. The Arctic Slope Regional Corporation and subsidiaries employ 5.2 percent. Seven residents hold commercial fishing permits. Fourteen oil and gas industry jobs on the North Slope are held by Barrow residents. Census 2000 reports Barrow's per capita income at $22,902 and household income at $67,097 (BLM 2008a citing to Shepro and Maas 2003). Table 8.4 shows employment in Barrow.



BLM 2008a

Figure 8.4. Employment in the NSB, 1965-2005.

Table 8.3. NSB employment profile: average monthly employment and earnings, first quarter, 2007

Industry	Workers	Average Monthly Earnings
Construction	163	$7,628
Transportation/Trade/Utilities	444	$6,075
Retail Trade	204	$2,842
Federal Government	18	$4,953
State Government	62	$5,006
Local Government	1,713	$3,413
Financial Activities	208	$9,141

ADOL 2007

Table 8.4. Barrow employment in 1998 and 2003.

	1998		2003	
Employment Status	Number	Percent	Number	Percent
Permanent Full-time	1,565	71.4	1,461	61.5
Temporary/Seasonal	287	13.1	301	12.7
Part-time	91	4.2	155	6.6
Unemployed	251	11.5	460	19.4
Totals/Percentages	2,194	100.0	2,377	100[a]

Source: URS Corp. 2005a citing to Shepro, Maas et al. 2003.

[a] Total percentage rounded off.

In Nuiqsut, education and other government services provide the majority of full-time employment (Table 8.5). The Kuukpik Native Corporation and the North Slope Borough including its school district are the largest employers. Government employment, including part-time or temporary, totaled 44 of 98 workers in the village in 2003. Arctic Slope Regional Corporation and subsidiaries employed 3 persons providing services to oil field operations. Three oil and gas industry jobs on North Slope were held by local residents. In 2003, per capita income was $13,633 and household income was $59,907 (BLM 2008a, citing to Shepro and Maas 2003).

Table 8.5. Nuiqsut employers in 2003.

Employer	Total
State Government	1
City Government	5
NSB Government	29
NSB School District	27
NSB CIP	2
Oil Industry	3
Private Construction	3
ASRC or Subsidiary	3
Village Corp./Subsidiary	37
Other	11
Total	121

Source: URS Corp. 2005c citing to Shepro, Maas et al. 2003.

The primary employers in Kaktovik are the North Slope Borough, NSB, North Slope Borough School District, and the Kaktovik Inupiat Corporation (Table 8.6). Craft sales are also part of Kaktovik’s economy. Approximately 19 percent of households participated in craft sales in 2003, but the majority of artisans made less than $500 per year. Table 8.7 shows the labor status of village residents.

Table 8.6. Household member employer by ethnicity and gender, Kaktovik.

	Inupiat		Non-Inupiat	
Employer	Male	Female	Male	Female
Federal Government	0	0	1	0
State Government	0	0	0	0
City Government	1	1	1	0
NSB Government	16	10	1	0
NSB School District	3	5	6	7
NSB CIP	0	0	0	0
Oil Industry	1	0	0	0
Private Construction firm	5	0	0	0
ASRC or Subsidiary	3	2	0	0
Village Corp./Subsidiary	10	7	0	1
Finance/Insurance	0	0	0	0
Transportation	0	0	0	0
Communications	0	0	0	0
Trade	0	0	0	0
Service	0	0	0	0
Ilisagvik	0	0	0	0
Other	0	1	1	1
Total	39	26	10	9

Source: URS Corp. 2005b, citing to Shepro and Maas 2003.

Table 8.7. All individuals reporting labor status, 2003.

Employment Status	Number	Percent
Permanent full-time	63	36.8
Temporary/Seasonal	10	5.8
Part-Time	9	5.3
Unemployed	16	9.4
Retired	12	7.0
Still in school	61	35.7

Source: URS Corp. 2005b citing to Shepro and Maas 2003.

Very few Alaska Native residents of the North Slope have been employed in oil-production facilities and associated work in and near Prudhoe Bay since production started in the late 1970s (Table 8.8). A study contracted by MMS showed that 34 North Slope Natives interviewed comprised half of all North Slope Natives who worked at Prudhoe Bay in 1992, and that the North Slope Natives employed at Prudhoe Bay comprised less than 1 percent of the 6,000 North Slope oil-industry workers (BLM 2008c).

The NSB is concerned that the oil industry has not done enough to accommodate training of workers, or to accommodate their cultural and economic needs to participate in subsistence-hunting activities. In response, BP Exploration initiated the Itqanaiyagvik Program, a training partnership with Arctic

Slope Regional Corporation (ASRC), Ilisagvik College, and the NSB School District to provide education and training for oil industry professional and craft jobs (BLM 2008c).

ConocoPhillips has worked closely with Kuukpik Corporation, ASRC, and other companies to hire and train Alaska Natives. ConocoPhillips, in cooperation with Kuukpik Corporation, sponsors mentoring and training at the Alpine field for North Slope residents. As a result of current development of the Alpine field, Nuiqsut has received a number of economic benefits and employment opportunities, including construction, catering, seismic, surveying, trucking, and security (BLM 2008c).

Table 8.8. Estimated number of resident jobs by sector, NSB communities, 2003.

Sector	Anaktuvuk Pass	Atqasuk	Barrow	Kaktovik	Nuiqsut	Point Hope	Point Lay	Wainwright
Federal Government	1	0	45	1	0	10	2	2
State Government	2	0	22	0	1	0	1	0
City Government	12	1	21	3	5	14	2	8
NSB Government	51	20	464	27	29	44	24	48
NSB School District	30	20	194	21	27	62	29	44
NSB CIP	0	0	4	0	2	0	1	3
Oil industry	3	0	14	1	3	2	0	0
Private Construction	4	0	23	5	3	1	4	4
ASRC	3	0	69	5	3	1	4	3
Village Corporation	19	27	87	18	37	60	9	38
Finance	0	0	5	0	0	0	1	0
Transportation	0	0	48	0	1	3	1	1
Communications	0	0	8	0	0	0	0	0
Trade	0	1	27	0	0	2	0	1
Service	4	0	103	0	0	0	1	0
Ilisagvik College	0	0	58	0	0	2	1	1
Other	2	3	132	3	10	25	5	18

Source BLM 2008c.

Nanook Incorporated, a subsidiary of Kuukpik Corporation, based in Nuiqsut, has a training program that could be used to train Natives for position in the oil industry, such as technicians and other long-term jobs (MMS 2008)

As exploration takes place, and if development occurs in the proposed lease sale area, it would add jobs to the local economy. These jobs would not be limited to the petroleum industry, but would be spread throughout the trade, service, and construction industries. The number of jobs produced would depend on whether commercial quantities of oil and gas are discovered and developed. Discovery and development of commercial quantities of petroleum or natural gas in the sale area would bring direct economic benefits to the local and regional economy.

The standard of living of North Slope communities depends largely on a steady flow of money related to oil and gas activities. This way of life will be impossible to maintain unless significant revenues continue to come into those communities from outside; the prospects of other sources of revenue appear to be modest. Painful adjustments can and probably will be postponed for as long as oil and gas are being extracted, but eventual adjustment is unavoidable. The nature and extent of these adjustments will be determined by the adaptations North Slope residents have made to the cash economy made possible by oil and gas and other activities (NRC 2003).

2. Public Health

Health status on the North Slope is determined by a wide array of factors, including genetic susceptibility, behavioral change, environmental factors, diet, and socio-cultural impacts. The state is currently developing a policy regarding Health Impact Assessments (HIA) for large resource extraction projects. HIA is a tool that seeks to identify potential lasting or significant changes, both positive and negative, of different actions on the health and social well-being of a defined population as a result of a program, project, or policy.

The Alaska Inter-Tribal Council received a grant from the Robert Wood Johnson Foundation to integrate an HIA into the federal environmental impact study process. In 2007, the NSB was awarded a $1.67 million NPR-A impact grant to perform an HIA. The goal of the HIA is to aid the NSB in analyzing and understanding potential impacts of proposed development on the health of communities and to design appropriate mitigation measures.

The borough's HIA contractor, Northern Health Impact Group (NHIRG), has been conducting meetings in North Slope communities to present information to various stakeholder and community groups on the HIA program and the baseline community health analysis project. In collaboration with the state-tribal-federal HIA working group, NHIRG drafted guidelines for scoping and public health intervention strategies (DCCED 2009).

Each year, under AS 38.05.035(e)(6)(F), ADNR issues a call for comments requesting substantial new information that has become available since the most recent finding for that sale area was written. Based on information received, ADNR will determine whether it is necessary to supplement the finding. By this mechanism, ADNR will have the opportunity to consider health impacts once the Alaska Inter-Tribal Council and NSB complete their HIAs and the state finalizes its HIA policy.

HIA's have not been routinely performed in the United States. However, BLM in its 2007 NPR-A Draft Supplemental and MMS in their 2008 Beaufort Sea and Chukchi Sea Draft Environmental Impact Statement considered health effects of North Slope oil and gas development. Their analysis is summarized below.

The overall health of Alaska Natives, including the North Slope Inupiat, has improved significantly since 1950 due to the combination of improved socio-economic status, housing, sanitation, and health care and infection control efforts. Health status on the North Slope has continued to improve as measured by overall mortality and life expectancy. Since 1979, overall mortality has declined roughly 20 percent (BLM 2007, citing to Goldsmith 2004; Bjerregaard, Young et al 2004; Day et al 2006). Despite these improvements, significant disparities remain between Alaska Natives and the general U. S. population as cancer, social pathology, and chronic diseases are rapidly increasing (MMS 2008).

The incidence and the mortality rates for cancer have increased roughly 50 percent since 1969. Cancer is now the leading cause of death on the North Slope. Three cancers, breast, colon, and lung, account for much of the overall increase. By a small margin, North Slope Alaska Natives have the highest incidence of cancer in Alaska, at 579/100,000. The increase in lung cancer and possibly breast and colon cancer may be due to smoking, although there are no definitive studies to prove this (BLM 2007). However, smoking rates on the North Slope are extremely high (BLM 2007, citing to

Wells, 2004). Radon gas exposure also is a risk factor in some areas of Alaska and, nationwide, it is thought to be the second leading cause of lung cancer behind smoking tobacco (MMS 2008, citing to EPA, 1993).

Colorectal cancer has known genetic risk factors, in addition to family history. Cigarette smoking is a known risk factor, and recent studies have suggested that increased insulin levels associated with sedentary lifestyle and consumption of high sugar diets also are risk factors. Breast cancer has several known risk factors, including genetics, use of estrogen-progesterone hormone replacement therapy, obesity, and consumption of 4 or more alcoholic drinks daily. Prostate cancer risk factors include age and possibly a diet high in animal fat. Stomach cancer is far more frequent in Alaskan Natives. The major known risk factor for this cancer is infection with the bacteria Helicobacter pylori, which causes a chronic infection in the lining of the stomach (MMS 2008).

Psychological and social problems including alcohol and drug abuse, depression, assault, sexual abuse, and suicide are highly prevalent on the North Slope, as they are in many rural Alaska Native villages and Inuit villages in Canada and Greenland. The prevalence of suicide on the North Slope in recent years has been estimated at roughly 45/100,000, more than 4 times the rate in the general U.S. population. In one recent survey, 3 percent of NSB Alaskan Native residents reported having seriously considered suicide within the last year, compared with 7 percent in the Northwest Arctic Borough (NWAB). The same survey found that 6 percent of NSB Alaskan Native residents were likely to be depressed based on responses to a series of mental health screening questions, compared with 14 percent of NWAB residents (MMS 2008 citing to Poppel et al., 2007).

Unintentional injury rates are high in the North Slope because of factors such as high rates of alcohol and substance abuse and risk-taking behavior in youth. Research suggests that social pathology problems are related to the rapid cultural changes that have occurred. Alcohol prohibition has been demonstrated to reduce rates of suicide, homicide, and other social pathology (BLM 2007).

Diabetes, obesity, and related metabolic disorders were previously rare or non-existent in the Inupiat but are now increasing. The prevalence of diabetes in the North Slope is estimated at only 2.4 percent compared with the U.S. rate of roughly 7 percent. However, between 1990 and 2001, the rate of diabetes climbed roughly 110 percent, nearly 3 times the rate of increase in the general U.S. population (Alaska Native Medical Center Diabetes Program). Available data suggest that younger Inupiat people are consuming relatively higher proportions of market foods (MMS 2008 citing to Nobmann et al., 2005). This raises a number of concerns, because foods available and affordable in village stores are costly and often of poor nutritional value (MMS 2008 citing to Bersamin et al., 2006). Subsistence diets and the associated active lifestyle are known to be the main protective factors against diabetes. The increase in diabetes may reflect the increased use of store-bought food, a more sedentary lifestyle, and, potentially, genetic susceptibility (BLM 2007, citing to Murphy, Schraer et al., 1995; Naylor, Schraer et al., 2003; Ebbesson, Kennish et al., 1999).

Cardiovascular disease rates are significantly lower in Alaska Natives than in non-Natives in the U.S. On the North Slope, recent mortality figures show death rates roughly 10 percent less than the U.S. population (BLM 2007, citing to Day, et al., 2006). However, many of the risk factors are increasing, and smoking rates are already extremely high (BLM 2007 citing to Wells, 2004).

North Slope residents have the highest mortality rate in the state from chronic lung diseases, at nearly three times the mortality rate for the U.S. (130/100,000 compared with 45/100,000) (Day et al 2006). The disparate rates of increase and mortality from pulmonary disease are accompanied by high smoking rates, which many public health experts believe to be the primary explanation. Smoking rates in the NSB are high. According to a regional analysis of federal Behavioral Risk Factor Surveillance System (BRFSS) data from 2005-2007, 44 percent of North Slope residents reported being smokers, compared to a statewide rate of 23 percent (ADHHS, unpublished data). In one North Slope survey, 61 percent of those sampled reported smoking daily (MMS 2008 citing to Poppel et al., 2007).

Indoor air quality also has been suspected as a cause of increasing rates of chronic lung disease in the Arctic. Modern, highly insulated housing in remote Inupiat villages has caused a decrease in ventilation. One recent study in Canadian Inuit villages noted that ventilation in these houses was poor, and CO2 levels were higher than recommended. It is not known whether these study results can be generalized to NSB housing (MMS 2008).

It is impossible to estimate the contribution of environmental factors because there are no available data on local fine particulate concentrations, hazardous air pollutants, and indoor air quality. Data generally does not exist to allow the direct attribution of a particular illness to a specific development project. However, an ambient Air Quality Monitoring Station has operated at Nuiqsut since 1999, as permit condition for the Alpine field. Data collected indicate that air quality is in compliance with National Ambient Air Quality Standards (NAAQS) and Alaska Ambient Air Quality Standards (BLM 2007). However, adverse health effects may occur at levels below NAAQS thresholds and particularly to vulnerable groups: the elderly and very young, people with chronic illnesses, and the socioeconomically disadvantaged (MMS 2008).

While reductions in infectious disease has significantly improved the health status of the North Slope Inupiat people since the 1950s, BLM concludes that the rates of cancer, chronic diseases such as diabetes, hypertension, and asthma, and social pathology have increased. At present, no evidence exists to conclusively link rates of any of these problems to oil and gas development (BLM 2007).

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Chapter Nine: Mitigation Measures and Other Regulatory Requirements

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Chapter Nine: Mitigation Measures and Other Regulatory Requirements (Lessee Advisories)

AS 38.05.035(e) and the departmental delegation of authority provide the director, Division of Oil and Gas (DO&G) ("director"), with the authority to impose conditions or limitations, in addition to those imposed by statute, to ensure that a resource disposal is in the state's best interests. Consequently, to mitigate the potential adverse social and environmental effects of specific lease-related activities, DO&G has developed mitigation measures and will condition plans of operation, exploration, or development and other permits based on these mitigation measures.

Lessees must obtain approval of a detailed plan of operations from the director before conducting exploration, development, or production activities. A plan of operations must identify the sites for planned activities and the specific measures, design criteria, construction methods, and operational standards to be employed to comply with the restrictions listed below. It must also address any potential geophysical hazards that may exist at the site.

These measures were developed after considering terms imposed in earlier competitive lease sales and comments and information submitted by the public, local governments, environmental organizations, and other federal, state, and local agencies. Additional measures will likely be imposed when lessees submit a proposed plan of operations.

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 rivers plans; and ADF&G game refuge plans, critical habitat area plans, and sanctuary area plans within which a lease area is located. Lease activities must be consistent with the enforceable policies of the Alaska Coastal Management Program (ACMP), including statewide standards and the enforceable policies of an affected coastal district with a plan in effect.

The director may grant exceptions to these mitigation measures. Exceptions will only be granted upon a showing by the lessee that compliance with the mitigation measure is not practicable or that the lessee will undertake an equal or better alternative to satisfy the intent of the mitigation measure. Requests and justifications for exceptions must be included in the plan of operations. The decision whether to grant an exception will be made during the public review of the plan of operations.

Except as indicated, the mitigation measures do not apply to geophysical exploration on state lands; geophysical exploration activities are governed by 11 AAC 96. Lessees or non-lessee companies may propose various operations, which include seismic surveys, in the sale area. Lessees may not have control over those activities not contracted by them. However, post-lease seismic surveys conducted or contracted by the lessee, are considered lease-related activities. Restrictions on geophysical exploration permits, whether lease-related or not, will depend on the size, scope, duration, and intensity of the proposed project and on the reasonably foreseeable effects on important species, specifically marine mammals.

Studies indicate that some geophysical activities may have an impact on the behavior of bowhead whales. Measures may be imposed on geophysical exploration permits in the vicinity of bowhead whale migratory routes during spring or fall migrations. See the subsistence mitigation measures. The extent of effects on marine mammals varies depending on the type of survey and gear used.

Copies of the non-proprietary portions of all Geophysical Exploration Permit Applications will be made available to the North Slope Borough, Alaska Eskimo Whaling Commission, and potentially affected subsistence communities for comment.

Agency abbreviations are:

Abbreviation	Agency Name
ADF&G	Alaska Department of Fish and Game
ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
AEWC	Alaska Eskimo Whaling Commission
DMLW	Division of Mining, Land, and Water (ADNR)
DO&G	Division of Oil and Gas (ADNR)
DPOR	Division of Parks and Recreation
NMFS	National Marine Fisheries Service
NSB	North Slope Borough
USFWS	U.S. Fish and Wildlife Service

A. Mitigation Measures

1. Facilities and Operations

a. A plan of operations must be submitted and approved before conducting exploration, development, or production activities, and must describe the lessee's efforts to minimize impacts on residential, commercial, and recreational areas, Native allotments and subsistence use areas. At the time of application, lessee must submit a copy of the proposed plan of operations to all surface owners whose property will be entered.

b. Facilities must be designed and operated to minimize sight and sound impacts in areas of high residential, commercial, recreational, and subsistence use and important wildlife habitat. Methods may include providing natural buffers and screening to conceal facilities, sound insulation of facilities, or by using alternative means approved by the director, in consultation with ADF&G and the NSB.

c. To the extent practicable, the siting of facilities, other than docks, roads, utility, and pipeline crossings will be prohibited within 500 feet of all fish-bearing streams and water bodies and 1,500 feet from all current surface drinking water sources. Additionally, to the extent practicable, the siting of facilities will be prohibited within one-half mile of the banks of the main channel of the Colville, Canning, Sagavanirktok, Shaviovik, Kadleroshilik, and Kuparuk rivers. Facilities may be sited within these buffers if the lessee demonstrates to the satisfaction of the director, in consultation with ADF&G, that site locations outside these buffers are not practicable or that a location inside the buffer is environmentally preferred. Road, utility, and pipeline crossings must be consolidated and aligned perpendicular or near perpendicular to watercourses.

d. Impacts to identified wetlands must be minimized to the satisfaction of the director, in consultation with ADF&G and ADEC. The director will consider whether facilities are sited in the least sensitive areas. Further, all activities within wetlands require permission from the U.S. Army Corps of Engineers (see Lessee Advisories).

e. Exploration facilities, with the exception of artificial gravel islands, must be temporary and must be constructed of ice unless the director determines that no practicable alternative exists. Use of abandoned gravel structures may be permitted on a case-by-case basis by the director, after consultation with DMLW, and ADF&G. Approval for use of abandoned structures will depend on the extent and method of restoration needed to return these structures to a usable condition.

f. Pipelines must utilize existing transportation corridors where conditions permit. Pipelines and gravel pads must be designed to facilitate the containment and cleanup of spilled fluids. Where practicable, onshore pipelines must be located on the upslope side of roadways and construction pads unless DMLW determines that an alternative site is environmentally acceptable. Wherever possible, onshore pipelines must be buried where soil and geophysical conditions permit. All pipelines, including flow and gathering lines, must be designed, constructed and, maintained to assure integrity against climatic conditions, geophysical hazards, corrosion and other hazards as determined on a case-by-case basis.

g. Onshore pipelines shall be designed and constructed to avoid significant alteration of caribou and other large ungulate movement and migration patterns. At a minimum, above-ground pipelines shall be elevated 7 feet, as measured from the ground to the bottom of the pipe, except where the pipeline intersects a road, pad, or a ramp installed to facilitate wildlife passage. Lessees shall consider increased snow depth in the sale area in relation to pipe elevation to ensure adequate clearance for wildlife. ADNR may, after consultation with ADF&G, require additional measures to mitigate impacts to wildlife movement and migration.

h. All pipelines, including flow and gathering lines, must be designed and constructed to provide adequate protection from water currents, storm and ice scouring, subfreezing conditions, and other hazards as determined on a case-by-case basis.

i. Offshore oil and gas transportation pipelines will be encouraged if the director determines that the laying of such pipelines is technically feasible and environmentally preferable to transport by oil tanker or other means.

j. Following the installation of a pipeline of sufficient capacity, no crude oil will be transported by surface vessel from offshore production sites, except in an emergency. The director will evaluate the emergency and determine an appropriate response to the condition.

k. Causeways

   i. The State of Alaska discourages the use of continuous-fill causeways. Environmentally preferred alternatives for field development include use of buried pipelines, onshore directional drilling, or elevated structures. Approved causeways must be designed, sited, and constructed to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics (e.g., salinity, temperature, suspended sediments) that exceed water quality criteria, and must maintain free passage of marine and anadromous fish.

   ii. Causeways and docks shall not be located in river mouths or deltas. Artificial gravel islands and bottom founded structures shall not be located in river mouths or active stream channels on river deltas, except as provided for in measure iii below.

   iii. Each proposed structure will be reviewed on a case-by-case basis. Causeways, docks, artificial gravel islands, and bottom-founded structures may be permitted if the director, in consultation with ADF&G, ADEC, and the NSB determines that a causeway or other structures are necessary for field development and that no practicable alternatives exist. A monitoring program may be required to address the objectives of water quality and free passage of fish, and mitigation shall be required where significant deviation from objectives occurs. (See also Lessee Advisories regarding U.S. Army Corps of Engineers requirements.)

l. 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.

m. Gravel mining sites required for exploration and development activities will be restricted to the minimum necessary to develop the field efficiently and with minimal environmental damage. Where practicable, gravel sites must be designed and constructed to function as water reservoirs for future use. Gravel mine sites required for exploration activities must not be located within an active floodplain of a watercourse unless DMLW, after consultation with ADF&G, determines that there is no practicable alternative, or that a floodplain site would enhance fish and wildlife habitat after mining operations are completed and the site is closed.

   Mine site development and rehabilitation within floodplains must follow the procedures outlined in McLean, R. F. 1993, North Slope Gravel Pit Performance Guidelines, ADF&G Habitat and Restoration Division Technical Report 93-9, available from ADF&G.

2. Habitat, Fish, and Wildlife

a. Detonation of explosives will be prohibited in open water areas of fish-bearing streams and lakes. Explosives must not be detonated beneath, or in proximity to fish-bearing streams and lakes if the detonation of the explosive produces a pressure rise in the water body of greater than 2.7 pounds per square inch, or unless the water body, including its substrate, is solidly frozen. 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. Blasting criteria have been developed by ADF&G and are available upon request from ADF&G. The location of known fish-bearing waters within the project area can also be obtained from ADF&G.

   The lessee will consult with the NSB before proposing the use of explosives for seismic surveys. The director may approve the use of explosives for seismic surveys after consultation with the NSB.

b. Removal of water from fish-bearing rivers, streams, and natural lakes shall be subject to prior written approval by DMLW and ADF&G. Water intake pipes used to remove water from fish-bearing water bodies must be surrounded by a screened enclosure to prevent fish entrainment and impingement. Screen mesh size shall 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 foot per second, unless an alternative velocity has been approved by ADF&G

c. Removal of snow from fish-bearing rivers, streams, and natural lakes shall be subject to prior written approval by ADF&G. Compaction of snow cover overlying fish-bearing water bodies is prohibited except for approved crossings. If ice thickness is not sufficient to facilitate a crossing, ice or snow bridges may be required.

d. Bears:

i. 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:

A. minimize attraction of bears to facility sites, including garbage and food waste;

B. organize layout of buildings and work areas to minimize interactions between humans and bears such as including the use of electric fencing;

C. warn personnel of bears near or on facilities and the proper actions to take;

D. if authorized, deter bears from the drill site;

E. provide contingencies in the event bears do not leave the site;

F. provide for proper storage and disposal of materials that may be toxic to bears; and

G. document and communicate the sighting of bears onsite or in the immediate area to all shift employees.

ii. Before commencement of any activities, lessees shall consult with ADF&G to identify the locations of any known brown bear den sites that are occupied in the season of proposed activities. Exploration and development activities started between September 20 and May 15may not be conducted within one-half mile of known 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 DO&G with concurrence from ADF&G. Non-mobile facilities will not be required to relocate.

iii. Before commencement of any activities, lessees shall consult with the USFWS 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.

e. 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.

f. Due to high concentrations of staging and molting brant and other waterbirds within the coastal habitats along the Teshekpuk Lake Special Area (TLSA) and other areas, operations that create high levels of disturbance, including but not limited to dredging, gravel washing, and boat and barge traffic along the coast, will be prohibited from June 20 to September 15 within one-half mile of coastal salt marshes, specifically Tracts 187, 209, 320, 483-485, 493, 494, 496, 497, 500-514, 517-519, 524, and 530. In addition, Tracts 228 and 231 are subject to the same restrictions between May 15 and July 30 to protect large concentrations of breeding snow geese. The construction and siting of facilities within one mile of these areas may be allowed on a case-by-case basis if the director and ADF&G determine that no other feasible and prudent location exists.

g. To protect hauled-out spotted seals, boat and barge traffic will be prohibited between July 15 and October 1 within one-half mile of the Piasuk River delta and Oarlock Island.

3. Subsistence, Commercial, and Sport Harvest Activities

a. i. Before submitting a plan of operations for either onshore or offshore activities that have the potential to disrupt subsistence activities, the lessee shall consult with the potentially affected subsistence communities, the AEWC, and the NSB (collectively "parties") to discuss the siting, timing, and methods of proposed operations and safeguards or mitigating measures that could be implemented by the operator to prevent unreasonable conflicts. The parties shall also discuss the reasonably foreseeable effect on subsistence activities of any other operations in the area that they know will occur during the lessee's proposed operations. Through this consultation, the lessee shall make reasonable efforts to assure that exploration, development, and production activities are compatible with subsistence hunting and fishing activities and will not result in unreasonable interference with subsistence harvests. In order to avoid conflicts with subsistence, commercial, and sport harvest activities, restrictions may include alternative site selection, requiring directional drilling, seasonal drilling restrictions, and other technologies deemed appropriate by DO&G.

ii. A discussion of resolutions reached or not reached during the consultation process and any plans for continued consultation shall be included in the plan of operations. The lessee shall identify who participated in the consultation and send copies of the plan to participating communities and the NSB when it is submitted to the division.

iii. If the parties cannot agree, then any of them may request that the commissioner of ADNR or his/her designee to intercede. The commissioner may assemble the parties or take other measures to resolve conflicts among the parties.

iv. The lessee shall notify the director of all concerns expressed by subsistence hunters during operations and of steps taken to address such concerns.

b. Traditional and customary access to subsistence areas shall be maintained unless reasonable alternative access is provided to subsistence users. "Reasonable access" is access using means generally available to subsistence users. Lessees will consult the NSB, nearby communities, and native organizations for assistance in identifying and contacting local subsistence users.

c. Whale Harvest Protection:

i. Permanent facility siting on Cross Island will be prohibited unless the lessee demonstrates to the satisfaction of the NSB, in consultation with the AEWC, that the development will not preclude reasonable access to whales as defined in former North Slope Borough Coastal Management Plan (NSBCMP) Policy 2.4.3(d) and in North Slope Borough Municipal Code (NSBMC) 19.79.050(d)(1) and as may be determined in a conflict avoidance agreement, if required by the NSB. With the approval of the NSB, the director may authorize permanent facilities.

ii. Permanent facility siting in state waters within 3 miles of Cross Island will be prohibited unless the lessee demonstrates to the satisfaction of the director, in consultation with the NSB and the AEWC, that the development will not preclude reasonable access to whales as defined in the former NSBCMP Policy 2.4.3(d) and in NSBMC 19.79.050(d)(1) and as may be determined in a conflict avoidance agreement if required by the NSB.

iii Permanent facility siting in state waters between the west end of Arey Island and the east end of Barter Island (Tracts 40 through 45) will be prohibited unless the lessee demonstrates to the satisfaction of the director, in consultation with the NSB and the AEWC, that the development will not preclude reasonable access to whales as defined in the former NSBCMP Policy 2.4.3(d) and in NSBMC 19.79.050(d)(1) and as may be determined in a conflict avoidance agreement if required by the NSB.

d. Any tract or portion thereof in the Beaufort Sea areawide sale area may be subject to seasonal drilling restrictions in conjunction with the submission of a plan of operations permit application by the lessee.

i. Exploratory Drilling From Bottom-founded Drilling Structures and Natural and Gravel Islands: Subject to measure iii below, exploratory drilling operations and other downhole operations from bottom-founded drilling structures and natural and gravel islands are allowed year-round in the Central Subsistence Whaling Zone (SWZ).[1] In the Eastern SWZ, drilling is prohibited upon commencement of the fall bowhead whale migration until whaling quotas have been met.

ii. Exploratory Drilling Operations from Floating Drilling Structures: Subject to measure iii below, exploratory drilling below a predetermined threshold depth and other downhole operations from floating drilling structures is prohibited throughout the Beaufort Sea upon commencement of the fall bowhead whale migration until the whale migration mid-point.[2]

In addition to the above restriction, exploratory drilling above and below a predetermined threshold depth in the Eastern SWA from floating drilling structures is prohibited upon commencement of the fall bowhead whale migration until the whaling quotas have been met.

In the Central and Western SWZ, exploratory drilling above and below a predetermined threshold depth may be prohibited on a case-by-case basis until the whaling quotas have been met.[3] The following criteria will be used to evaluate these operations: 1) proximity of drilling operations to active or whaling areas, 2) drilling operation type and feasible drilling alternatives, 3) number of drilling operations in the same area, 4) number of whaling crews in the area, and 5) the operator's plans to coordinate activities with the whaling crews in accordance with the subsistence harvest protection mitigation measure.

All non-essential activities associated with drilling are prohibited in the Central SWZ during the whale migration until whaling quotas have been met. Essential support activity associated with drilling structures occurring within active whaling areas shall be coordinated with local whaling crews in accordance with the subsistence harvest protection mitigation measure.

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1 Subsistence Whaling Zones:
Eastern SWZ is that area within 20 nautical miles of the shoreline between 141° and 144° W longitude.
Central SWZ is that area within 20 nautical miles of the shoreline between 144° and 151° W longitude.
Western SWZ is that area within 20 nautical miles of the shoreline between 154° and 157° W longitude.

2 Migration Dates:
Eastern SWZ - September 1 - October 10 with the midpoint of the migration on September 20.
Central SWZ and Western SWZ - September 10 - October 20 with the midpoint of the migration on September 28.
Outside SWZ - Seaward of the Eastern SWZ - September 1 - October 10 with the midpoint of the migration on September 20; Seaward and west of the Central SWZ - September 10 - October 20 with the midpoint of migration on September 28. The midpoint of the migration is when 50 percent of the whales have been deemed to have passed the drill site.

3 If upon review of the proposed operation using the above described criteria, the state determines that conflict with subsistence whaling activities may occur, additional drilling restrictions, similar to those imposed for the Eastern SWZ, may be imposed in the Central and Western SWZ's. In the Eastern SWZ, drilling is prohibited upon commencement of the fall bowhead migration until whaling quotas have been met.

"Essential activities" include those necessary to maintain well control, maintain physical integrity of the drilling structure, and scheduled crew changes. Support craft include aircraft, boats, and barges. "Non-essential activity," by exclusion, are those activities that do not fit the definition of essential activities. Both types of activities must be described by the operators in their exploration plans submitted for state review. To the extent feasible, mobilization or demobilization of the drilling structures should not occur during the whale migration. If operators propose to mobilize or demobilize during the whale migration, they must describe the activity in their exploration plan and must demonstrate why the activity must occur during the migration period.

iii. Exploratory Drilling in Broken Ice: Lessees conducting drilling operations during periods of broken ice must:

A. participate in an oil spill research program;

B. be trained and qualified in accordance with Minerals Management Service standards pertaining to well-control equipment and techniques; and

C. have an oil spill contingency plan approved by the state that includes requirements for in situ igniters, fire resistant boom, relief well plans, and a decision process for igniting an uncontrolled release of oil.

e. Exploration, development and production activities located on lease tracts 1 through 26 shall be conducted in a manner that prevents unreasonable conflicts between oil and gas activities and subsistence whale hunting.

i. Before submitting a plan of operations for activities on lease tracts 1 through 26, the lessee shall consult with the NSB, the AEWC, and the community of Kaktovik to discuss how the siting, timing, and methods of proposed operations can be planned and carried out to avoid potential conflicts with subsistence whale hunting. Through this consultation, which may include the negotiation of a conflict avoidance agreement, the lessee shall make every reasonable effort to ensure that their activities will not result in unreasonable interference with subsistence whale hunting.

ii. A plan of operations for activities on lease tracts 1 through 26 shall include a discussion of the consultation process and any resulting conflict avoidance agreements. In the event that no agreement is reached, the lessee, the NSB, the AEWC, or the community of Kaktovik may request that ADNR call a meeting of representatives of the NSB, the AEWC, the community of Kaktovik, and the lessee to discuss the potential conflict caused by the proposed activities, and attempt to resolve the issues. If the parties are still unable to reach an agreement, then ADNR will make a final determination of the measures proposed to be taken to prevent unreasonable interference with subsistence whale hunting.

4. Fuel, Hazardous Substances, and Waste

a. Secondary containment (see definition) shall be provided for the storage of fuel or hazardous substances.

b. Containers with an aggregate storage capacity of greater than 55 gallons that contain fuel or hazardous substances shall not be stored within 100 feet of a water body, or within 1,500 feet of a current surface drinking water source.

c. During equipment storage or maintenance, the site shall be protected from leaking or dripping fuel and hazardous substances by the placement of drip pans or other surface liners designed to catch and hold fluids under the equipment, or by creating an area for storage or maintenance using an impermeable liner or other suitable containment mechanism.

d. During fuel or hazardous substance transfer, secondary containment or a surface liner must be placed under all container or vehicle fuel tank inlet and outlet points, hose connections, and hose ends. Appropriate spill response equipment, sufficient to respond to a spill of up to 5 gallons, must be on hand during any transfer or handling of fuel or hazardous substances. Trained personnel shall attend transfer operations at all times.

e. Vehicle refueling shall not occur within the annual floodplain, except as addressed and approved in the plan of operations. This measure does not apply to water-borne vessels.

f. All independent fuel and hazardous substance containers shall be marked with the contents and the lessee’s or contractor’s name using paint or a permanent label.

g. A fresh water aquifer monitoring well, and quarterly water quality monitoring, may be required down gradient of a permanent above-ground liquid hydrocarbon storage facility.

h. Waste from operations must be reduced, reused, or recycled to the maximum extent practicable. Garbage and domestic combustibles must be incinerated or disposed of at an approved site in accordance with 18 AAC 60. (See also Section B2, below.)

i. New solid waste disposal sites will not be approved or located on state property during the exploration phase. Exceptions may be provided for drilling waste if the facility will comply with the applicable provisions of 18 AAC 60.

j. Wherever practicable, the preferred method for disposal of muds and cuttings from oil and gas activities is by underground injection. Other methods of disposal shall be allowed only upon approval by the director, in consultation with ADEC and ADF&G.

k. Proper disposal of garbage and putrescible waste is essential to minimize attraction of wildlife. The lessee must use the most appropriate and efficient method to achieve this goal. The primary method of garbage and putrescible waste disposal is prompt, on-site incineration in compliance with state air quality control regulations (18 AAC 50). The secondary method of disposal is on-site frozen storage in animal-proof containers with backhaul to an approved waste disposal facility. The tertiary method of disposal is on-site non-frozen storage in animal proof containers with backhaul to an approved waste disposal facility. Daily backhauling of non-frozen waste must be achieved unless safety considerations prevent it.

5. Access

a. Except for approved off-road travel, exploration activities must be supported only by ice roads, winter trails, existing road systems or air service. Wintertime off-road travel across tundra and wetlands may be approved in areas where snow and frost depths are sufficient to protect the ground surface. Summertime off-road travel across tundra and wetlands may be authorized subject to time periods and vehicle types approved by DMLW. Exceptions may be granted by DMLW, and the director, if an emergency condition exists; or, if it is determined, after consulting with ADF&G that travel can be accomplished without damaging vegetation or the ground surface.

b. Public access to, or use of, the lease area may not be restricted except within the immediate vicinity of drill sites, buildings, and other related facilities. Areas of restricted access must be identified in the plan of operations. Lease facilities and operations shall not be located so as to block access to or along navigable or public waters as defined in AS 38.05.965.

6. Prehistoric, Historic, and Archaeological Sites

a. Before the construction or placement of any gravel, or other structure, road, or facility resulting from exploration, development, or production activities, the lessee must conduct an inventory of prehistoric, historic, and archaeological sites within the area affected by an activity. The inventory must include consideration of literature provided by the NSB, nearby communities, Native organizations, and local residents; documentation of oral history regarding prehistoric and historic uses of such sites; evidence of consultation with the Alaska Heritage Resources Survey and the National Register of Historic Places; and site surveys. The inventory must also include a detailed analysis of the effects that might result from the activity.

b. The inventory of prehistoric, historic, and archaeological sites must be submitted to the director and to DPOR Office of History and Archaeology who will coordinate with the NSB for review and comment. If a prehistoric, historic, or archaeological site or area could be adversely affected by a lease activity, the director, after consultation with DPOR Office of History and Archaeology and the NSB, will direct the lessee as to the course of action to take to avoid or minimize adverse effects.

c. If a site, structure, or object of prehistoric, historic, or archaeological significance is discovered during lease operations, the lessee must report the discovery to the director as soon as possible. The lessee must make reasonable efforts to preserve and protect the discovered site, structure, or object from damage until the director, after consultation with DPOR Office of History and Archaeology and the NSB, has directed the lessee as to the course of action to take for its preservation.

7. Local Hire, Communication, and Training

a. Lessees are encouraged to employ local and Alaska residents and contractors, to the extent they are available and qualified, for work performed in the lease area. Lessees shall submit, as part of the plan of operations, a proposal detailing the means by which the lessee will comply with the measure. The proposal must include a description of the operator's plans for partnering with local communities to recruit, hire and train local and Alaska residents and contractors. The lessee is encouraged, in formulating this proposal, to coordinate with employment and training services offered by the State of Alaska and local communities to train and recruit employees from local communities.

b. A plan of operations application must describe the lessee's past and prospective efforts to communicate with local communities and interested local community groups.

c. A plan of operations application must include a training program for all personnel including contractors and subcontractors. The program must be designed to inform each person working on the project of environmental, social, and cultural concerns that relate to that person's job. The program must use methods to ensure that personnel understand and use techniques necessary to preserve geological, archaeological, and biological resources. In addition, the program must be designed to help personnel increase their sensitivity and understanding of community values, customs, and lifestyles in areas where they will be operating.

8. Definitions

Facilities means any structure, equipment, or improvement to the surface, whether temporary or permanent, including, but not limited to, roads, pads, pits, pipelines, power lines, generators, utilities, airstrips, wells, compressors, drill rigs, camps and buildings;

Hazardous substance means (A) an element or compound that, when it enters into or on the surface or subsurface land or water of the state, presents an imminent and substantial danger to the public health or welfare, or to fish, animals, vegetation, or any part of the natural habitat in which fish, animals, or wildlife may be found; or (B) a substance defined as a hazardous substance under 42 USC 9601 - 9675 (Comprehensive Environmental Response, Compensation, and Liability Act of 1980); "hazardous substance" does not include uncontaminated crude oil or uncontaminated refined oil (AS 46.09.900).

Identified wetlands are those areas that have been identified as wetlands by the U. S. Army Corps of Engineers under Section 404 of the Clean Water Act.[4];

Minimize means to reduce adverse impacts to the smallest amount, extent, duration, size, or degree reasonable in light of the environmental, social, or economic costs of further reduction;

Plan of operations means a lease plan of operations under 11 AAC 83.158 and a unit plan of operations under 11 AAC 83.346;

Practicable means feasible in light of overall project purposes after considering cost, existing technology, and logistics of compliance with the standard;

Secondary containment means an impermeable diked area or portable impermeable containment structure capable of containing 110 percent of the volume of the largest independent container. Double walled tanks do not qualify as Secondary Containment unless an exception is granted for a particular tank.

Temporary means no more than 12 months.

B. Other Regulatory Requirements (Lessee Advisories)

Lessees must comply with all applicable local, state, and federal codes, statutes, and regulations, as amended. 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 regulatory, permitting, or management authority.

1. Alaska Department of Natural Resources, Division of Coastal and Ocean Management

a. Pursuant to AS 46.40, projects are required to comply with all policies and enforceable standards of the Alaska Coastal Management Program, including the District Coastal Management Plans.

2. Alaska Department of Environmental Conservation

a. Pursuant to AS 46.04.030, lessees are required to have an approved oil discharge prevention and contingency plan (C-Plan) before commencing operations. The plan must include a response action plan to describe how a spill response would occur, a prevention plan to describe the spill prevention measures taken at the facility, and supplemental information to provide background and verification information.

b. Pursuant to state regulations administered by ADEC and the Clean Air Act administered by EPA, lessees are required to obtain air quality permits before construction and operation. The permits will include air quality monitoring, modeling, and emission control obligations.

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4 ***Wetlands*** means those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (40 CFR Parts 122.2, 230.3, and 232.2).

c. Unless authorized by an ADEC permit, surface discharge of reserve pit fluids and produced waters is prohibited.

d. Unless authorized by National Pollutant Discharge Elimination System or state permits, disposal of wastewater into freshwater bodies is prohibited.

3. Alaska Department of Fish and Game

a. Under the provisions of Title 16 of the Alaska Statutes, the measures listed below may be imposed by ADF&G below the ordinary high water mark to protect designated anadromous water bodies and to ensure the free and efficient passage of fish in all fish-bearing water bodies. Specific information on the location of anadromous water bodies in and near the area may be obtained from ADF&G.

   i. Alteration of riverbanks may be prohibited.

   ii. The operation of equipment, excluding boats, in open water areas of rivers and streams may be prohibited.

   iii. Bridges or non-bottom founded structures may be required for crossing fish spawning and important rearing habitats.

   iv. Culverts or other stream crossing structures must be designed, installed, and maintained to provide free and efficient passage of fish.

b. Removal of water from fish-bearing water bodies is subject to the regulations for the Appropriation and Use of Water (11 AAC 93.035-.147) and Fish and Games statutes AS 16.05.841 and AS 16.05.871.

c. The director, in consultation with ADF&G, may impose seasonal restrictions on activities located in, or requiring travel through or overflight of, important caribou or other large ungulate calving and wintering areas during the plan of operations approval stage.

d. The director, in consultation with ADF&G, may impose seasonal restrictions on activities located in and adjacent to important waterfowl and shorebird habitat during the plan of operations approval stage.

e. To minimize impacts on Dolly Varden (arctic char) overwintering areas, permanent, staffed facilities must be sited to the extent practicable outside identified Dolly Varden overwintering areas.

f. Lessees are encouraged in planning and design activities to consider the recommendations of oil field design and operations in the final report to the Alaska Caribou Steering Committee: Cronin, M. et al., 1994. “Mitigation of the Effects of Oil Field Development and Transportation Corridors on Caribou.” LGL Alaska Research Associates, Inc., July.

g. Lessees must comply with the provision of Appendix B of the “Yellow-billed Loon Conservation Agreement,” dated July 31, 2006, between ADF&G, ADNR, USFWS, Bureau of Land Management, and the National Park Service.

4. Alaska Department of Labor and Workforce Development

a. The Lessee shall facilitate Alaska resident hire monitoring by reporting project wages on a quarterly basis for each individual employed by the Lessee in the lease area, through electronic unemployment insurance reporting, and by requiring the same of the lessee’s contractors and subcontractors.

5. U.S. Army Corps of Engineers

a. A U.S. Army Corps of Engineers permit is required when work is anticipated on, in, or affects navigable waters or involves wetland-related dredge or fill activities. A Section 10 permit is required for construction, excavation, or deposition of material in, over, or under navigable waters, or for any work which would affect the course, location, condition, or capacity of navigable waters, or for any work which would affect the course, location, condition, of capacity of navigable waters (33 USC 403). Oil and gas activities requiring this type of permit include, but are not limited to, exploration drilling from a jackup drill rig, installation of a production platform, or construction of a causeway. A Section 404 permit (33 USC 404) authorizes the discharge of dredged and fill material into waters and wetlands of the United States. The process and concerns are similar for both permits and, at times, both may be required.

6. U.S. Fish and Wildlife Service and National Marine Fisheries Service

a. Lessees are advised that the Endangered Species Act of 1973 (ESA), as amended (16 USC 1531-1544) protects endangered and threatened species and candidate species for listing that may occur in the lease sale area. Lessees shall comply with the Recommended Protection Measures developed by the USFWS to ensure adequate protection for all endangered, threatened and candidate species. The following endangered or threatened species occur in or adjacent to the proposed lease sale area:

Common Name	ESA Status
Bowhead whale	Endangered
Spectacled eider	Threatened
Steller's eider (Alaska breeding population)	Threatened
Polar bear	Threatened

b. Lessees are advised of the need to comply with the Migratory Bird Treaty Act (MBTA; 16 USC 703) which is administered by the USFWS. Under the MBTA, it is illegal to "take" migratory birds, their eggs, feathers or nests. “Take” is defined (50 CFR 10.12) to include “pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting.” The MBTA does not distinguish between “intentional” and “unintentional” take. Migratory birds include songbirds, waterfowl, shorebirds, and raptors. In Alaska, all native birds except grouse and ptarmigan (which are protected by the State of Alaska) are protected under the MBTA.

In order to ensure compliance with the MBTA, it is recommended that lessees survey the project area before construction, vegetation clearing, excavation, discharging fill or other activities which create disturbance, and confirm there are no active migratory bird nests. It is recommended lessees contact the USFWS for assistance and guidance on survey needs, and other compliance issues under the MBTA. While the USFWS can recommend methods (such as surveys and timing windows) to avoid unintentional take, responsibility for compliance with the MBTA rests with lessees.

c. Lessees are advised that they must comply with the provisions of the Marine Mammal Protection Act of 1972, as amended (16 USC 1361-1407). USFWS shares authority for marine mammals with the NMFS.

d. Peregrine falcon nesting sites are known to occur in the sale area. Lessees are advised that disturbing a peregrine falcon nest violates federal law. Lessees are required to comply with the federal resource recovery plan for the arctic peregrine falcon.

7. North Slope Borough

a. Lessees are advised that the NSB Assembly has adopted a comprehensive plan and land management regulations under Title 29 of the Alaska Statutes (AS 29.40.020-040). The NSB regulations require borough approval for all proposed uses, development, and master plans. The former NSBCMP policies are included as part of the NSB zoning regulations (Title 19) and all NSB permit approvals will require the proposal to be substantially consistent with these policies.

b. Lessees are advised that restricting access to and use of fish camps and other subsistence use areas defined in the NSB Traditional Land Use Inventory, may violate the former NSBCMP and NSBMC subsistence harvest protection and land use regulations. Lessees are advised to consult with the NSB Planning Department and local communities during planning of operations.

c. Lessees are encouraged to bring one or more residents of communities in the area of operations into their planning process. Local communities have a unique understanding of their environment and community activities. Involving local community residents in the earliest stages of the planning process for oil and gas activities can be beneficial to the industry and to the community. Community representation on management teams developing plans of operation, oil spill contingency plans, and other permit applications can help communities understand permitting obligations and help industry to understand community values and expectations for oil and gas operations being conducted in and around their area.

d. In order to protect species that are sensitive to noise or movement, horizontal and vertical buffers will be required, consistent with aircraft, vehicle, and vessel operations regulated by NSB Code ß19.70.050(I)(1), which codifies former NSBCMP policy 2.4.4.(a). Lessees are encouraged to apply the following provisions governing aircraft operations in and near the sale area:

   i. From June 1 to August 31, aircraft overflights must avoid identified brant, white fronted goose, tundra swan, king eider, common eider, and yellow-billed loon nesting and brood rearing habitat, and from August 15 to September 15, the fall staging areas for geese, tundra swans, and shorebirds, by an altitude of 1,500 feet, or a lateral distance of 1 mile.

   ii. To the extent practicable, all aircraft should maintain an altitude greater than 1,500 feet or a lateral distance of 1 mile, excluding takeoffs and landings, from caribou and muskoxen concentrations. A concentration means numbers of animals in excess of the general density of those animals found in the area.

   iii. Human safety will take precedence over flight restrictions.

e. Lessees are advised that certain areas are especially valuable for their concentrations of marine birds, marine mammals, fishes, or other biological resources; cultural resources; and for their importance to subsistence harvest activities. The following areas must be considered when developing plans of operation. Identified areas and time periods of special biological and cultural sensitivity include:

   i. the Boulder Patch in Stefansson Sound, year round;

   ii. the Canning River Delta, January-December;

   iii. the Colville River Delta, January-December;

iv. the Cross, Pole, Egg, and Thetis Islands, June-December;

v. the Flaxman Island waterfowl use and polar bear denning areas, including the Leffingwell Cabin national historic site located on Flaxman Island;

vi. the Jones Island Group (Pingok, Spy, and Leavitt Islands) and Pole Island are known polar bear denning sites, November-April; and

vii. the Sagavanirktok River delta, January-December.

viii. Howe Island supports a snow goose nesting colony, May-August.

f. No lease facilities or operations may be located so as to block access to, or along, navigable and public waters as defined by AS 38.05.965(13) and (18).

g. Subsistence whaling activities occur generally during the following periods:

i August to October: Kaktovik whalers use the area circumscribed from Anderson Point in Camden Bay to a point 30 km north of Barter Island to Humphrey Point east of Barter Island. Nuiqsut whalers use an area extending from a line northward of the Nechelik Channel of the Colville River to Flaxman Island, seaward of the Barrier Islands.

ii September to October: Barrow hunters use the area circumscribed by a western boundary extending approximately 15 km off Cooper Island, with an eastern boundary on the east side of Dease Inlet. Occasional use may extend eastward as far as Cape Halkett.

h. ADF&G reports that Howe Island may be one of only two significant known snow goose nesting colonies in the United States. (The other colony is in the Ikpikpuk River Delta; several small colonies occur in the area of Harrison Bay.) Lessees are advised that surface entry onto Howe Island will likely be prohibited.

i. Lessees are advised that the NSB may, under its authorities, require the lessee to enter into a Conflict Avoidance Agreement with the AEWC before applying for a NSB rezoning or development permit for the siting of permanent facilities in state waters. If the director permits permanent facility siting in state waters within 3 miles of Cross Island, subject to the subsistence harvest protection and whale harvest protection mitigation measures, the NSB has advised the state they will require a Conflict Avoidance Agreement.

Chapter Ten: Bidding Method and Lease Terms

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Chapter Ten: Bidding Method and Lease Terms

Under AS 38.05.180(f) and 11 AAC 83.100(a), the leasing of oil and gas resources must be by competitive bidding. AS 38.05.180(f)(3) provides a number of leasing methods for competitive bidding that the commissioner may adopt for an oil and gas lease sale:

(1) a cash bonus bid with a fixed royalty share reserved to the state of not less than 12.5 percent in amount or value of the production removed or sold from the lease;

(2) a cash bonus bid with a fixed royalty share reserved to the state of not less than 12.5 percent in amount or value of the production removed or sold from the lease and a fixed share of the net profit derived from the lease of not less than 30 percent reserved to the state;

(3) a fixed cash bonus with a royalty share reserved to the state as the bid variable but no less than 12.5 percent in amount or value of the production removed or sold from the lease;

(4) a fixed cash bonus with the share of the net profit derived from the lease reserved to the state as the bid variable;

(5) a fixed cash bonus with a fixed royalty share reserved to the state of not less than 12.5 percent in amount or value of the production removed or sold from the lease with the share of the net profit derived from the lease reserved to the state as the bid variable;

(6) a cash bonus bid with a fixed royalty share reserved to the state based on a sliding scale according to the volume of production or other factor but in no event less than 12.5 percent in amount or value of the production removed or sold from the lease;

(7) a fixed cash bonus with a royalty share reserved to the state based on a sliding scale according to the volume of production or other factor as the bid variable but not less than 12.5 percent in amount or value of the production removed or sold from the lease.

For each lease sale under the proposed 10-year Beaufort Sea Areawide Best Interest Finding, the commissioner will adopt the bidding method or methods under AS 38.05.180(f) as the commissioner determines is in the best interests of the state. The bidding method or methods may not be the same for each lease sale over the 10-year term of this best interest finding, but the method for each sale will be adopted from the methods set out in AS 38.05.180(f)(3). The bidding method or methods adopted for a particular lease sale will be published in the pre-sale notice describing the interests to be offered, the location and time of the sale, and the terms and conditions of the sale (AS 38.05.035(e)(6)(F)).

Appendix A: Summary of Comments and Responses

Reserved for Final Finding

Appendix B: Laws and Regulations Pertaining to Oil and Gas Exploration, Development, Production, and Transportation

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Appendix B: Laws and Regulations Pertaining to Oil and Gas Exploration, Development, Production, and Transportation

A. Alaska Statutes (AS) and Administrative Code (AAC) Sections

1. Alaska Department of Natural Resources (ADNR)

AS 38.05.027	Management of legislatively designated state game refuges and critical habitat areas is joint responsibility of ADF&G (AS 16.20.050-060) and ADNR. Lessees are required to obtain permits from both ADNR and ADF&G.
AS 38.05.127	Provides for reservation of easements to ensure free access to navigable or public water.
AS 38.35.010 to AS 38.35.260	Right-of-way leasing for pipeline transportation of crude oil and natural gas is under control of commissioner of ADNR. Commissioner shall not delegate authority to execute leases.
11 AAC 51.045	Easements to and along navigable or public water.
11 AAC 83.158(a)	Plan of operations for all or part of leased area or area subject to oil and gas exploration license must be approved by ADNR commissioner before any operations may be undertaken on or in leased or licensed area.
11 AAC 96.010	Operations requiring permits, including use of explosives and explosive devices, except firearms.
11 AAC 96.025	Generally allowed land use activities are subject to general stipulations that will minimize surface damage or disturbance of drainage systems, vegetation, or fish and wildlife resources.

2. ADNR Division of Oil and Gas (DO&G)

AS 38.05.035(a)(8)(C)	Requires geological and geophysical data to be kept confidential upon request of supplier.
AS 38.05.130	Allows DO&G director to approve oil and gas exploration and development activities in cases where surface estate is not held by state or is otherwise subject to third-party interests, provided director determines that adequate compensation has been made to surface estate holder for any damages that may be caused by lease activities.
AS 38.05.132	Establishes exploration licensing program.
AS 38.05.180	Establishes oil and gas leasing and gas only leasing programs to provide for orderly exploration for and development of petroleum resources belonging to the State of Alaska.

11 AAC 96.010 to 11 AAC 96.145	Provides controls over activities on state lands in order to minimize adverse activities; applies to geophysical exploration permit.

3. ADNR Division of Forestry

AS 41.17.082	Alaska Forest Resources Practices Act. Requires that all forest clearing operations and silvicultural systems be designed to reduce likelihood of increased insect infestation and disease infections that threaten forest resources.
11 AAC 95.195	Describes approved methods of disposal or treatment of downed spruce trees to minimize spread of bark beetles and reduce risk of wildfire.
11 AAC 95.220	Requires lessee to file detailed plan of operations with state forester.

4. ADNR Division of Mining, Land and Water

AS 38.05.075	Governs public auctions for leasing lands (including tidelands and submerged lands) — procedures, bidding qualifications, and competitive or noncompetitive bidding methods.
AS 38.05.850	Authorizes the director to issue permits, rights-of-way, or easements on state land for recovery of minerals from adjacent land under valid lease.
11 AAC 80.005 to 11 AAC 80.085	Establishes pipeline right-of-way leasing regulations.
11 AAC 93.040 to 11 AAC 93.130	Requires a water rights permit for appropriation of state waters.
11 AAC 93.210 to 11 AAC 93.220	Provides for temporary water use permits and application procedures.
11 AAC 96.010 to 11 AAC 96.110	Land use permit activities not permitted by multiple land use permit or lease operations approval.

5. ADNR Division of Coastal and Ocean Management

6 AAC 80.070(b)(3)	Requires that energy facilities in coastal areas be consolidated to extent feasible and prudent.
6 AAC 80.070(b)(10) to 6 AAC 80.070(b)(12)	Requires that energy facilities in coastal areas be sited to extent feasible and prudent where development will necessitate minimal site clearing, dredging, and construction in productive habitats; to minimize risk of oil spills in, or other contamination of, productive or vulnerable habitats; and to allow for free passage and movement of fish and wildlife.

6 AAC 80.130(c)(3)	Requires that wetlands and tide flats be managed to assure adequate water flow and to avoid adverse effects on natural drainage patterns, destruction of important habitat, and discharge of toxic substances.
11 AAC 110	Alaska Coastal Management Program implementation.

6. Alaska Department of Fish and Game (ADF&G)

AS 16.05.841	Requires that an obstruction across a fishbearing stream provide for fish passage.
AS 16.05.871	Provides for protection of anadromous fish and game in connection with construction or work in beds of specified water bodies and calls for approval of plans by ADF&G for construction of hydraulic project or any use, diversion, obstruction, change, or pollution of these water bodies.
AS 16.20	Manages legislatively designated game refuges, sanctuaries, and critical habitat areas.
AS 16.20.060 and AS 16.20.530	Commissioner, ADF&G, may require submission and written approval of plans and specifications for anticipated use and construction work and plans for proper protection of fish and game (including birds) within legislatively designated game refuges, critical habitat areas, and sanctuaries.
AS 16.20.180 to AS 16.20.210	Requires measures for continued conservation, protection, restoration, and propagation of endangered fish and wildlife.
5 AAC 95.010	Atlas and catalog of waters important for spawning, rearing, or migration of anadromous fish. Permit application procedures.

7. Alaska Oil and Gas Conservation Commission (AOGCC)

AS 31.05.005	Establishes and empowers AOGCC.
AS 31.05.030(d)(9)	Requires oil and gas operator to file and obtain approval of plan of development and operation.
AS 46.03.100	Standards and limitations for accumulation, storage, transportation, and disposal of solid or liquid waste or heated process or cooling water.
AS 46.03.900(35)	Defines waste.
20 AAC 25	Requires permit to drill, to help maintain regulatory control over drilling and completion activities in state. Regulates well spacing and underground injection.
20 AAC 25.140	Requires authorization to allow an abandoned oil and gas well to be converted to a freshwater well.

8. Alaska Department of Environmental Conservation (ADEC)

AS 26.23.900(1)	Defines Alaska State Emergency Response Commission.
AS 46.03	Sets state policy; to conserve, improve, and protect the state's natural resources and environment, and control water, land, and air pollution.
AS 46.03.100	Requires solid waste disposal permits.
AS 46.03.759	Establishes maximum liability for discharge of crude oil at $500 million.
AS 46.03.900(35)	Defines waste.
AS 46.04	Oil and Hazardous Substance Pollution Control Act. Prohibits discharge of oil or any other hazardous substances unless specifically authorized by permit; requires those responsible for spills to undertake cleanup operations; and holds violators liable for unlimited cleanup costs and damages as well as civil and criminal penalties.
AS 46.04.030	Requires lessees to provide oil discharge prevention and contingency plans (C-plans). Also provides regulation of aboveground storage facilities that have capacities of greater than 5,000 bbl of crude oil or greater than 10,000 bbl of noncrude oil.
AS 46.04.050	Exemptions for oil terminal facilities that have capacities of less than 5,000 bbl of crude oil or less than 10,000 bbl of noncrude oil.
18 AAC 50	Provides for air quality control, including permit requirements, permit review criteria, and regulation compliance criteria.
18 AAC 50.316	Preconstruction review for construction or reconstruction of major source of hazardous air pollutants.
18 AAC 60.265	Requires proof of financial responsibility before a permit for operation of hazardous waste disposal facility may be issued.
18 AAC 60.200	Requires a solid waste disposal permit.
18 AAC 60.430(a)(2)	General requirement for containment structures used for disposal of drilling wastes.
18 AAC 70	Sets water quality standards.
18 AAC 72	Protects public health, public and private water systems, and the environment from diseases transmitted by domestic wastewater by establishing minimum treatment, construction, operation, and maintenance standards for domestic wastewater treatment works and disposal systems.

18 AAC 75.005 to 18 AAC 75.025	Requirements for oil storage facilities for oil pollution prevention.
18 AAC 75.065 to 18 AAC 75.075	Requirements for oil storage tanks.
18 AAC 75.080	Facility piping requirements for oil terminal, crude oil transmission pipeline, and exploration and production facilities. Requires a corrosion control program.
18 AAC 75.235	Sets financial responsibility levels for oil discharges
18 AAC 75.300	Requires ADEC be notified of spill of oil and other hazardous substances.
18 AAC 75.400 to 18 AAC 75.496	Requires oil discharge contingency plans and specifies their contents.

B. Federal Laws and Regulations

Notes: CFR is the Code of Federal Regulations; USC is the United States Code.

1. Clean Water Act

33 USC §§ 1251 to 1387	Establishes water pollution controls to restore and maintain the integrity of U.S. waters
33 USC § 1344	Requires a COE Section 404 permit to excavate, fill, alter, or otherwise modify course or condition of navigable or U.S. coastal waters and to discharge dredge-and-fill material

2. Environmental Protection Agency (EPA)

Oil and other hazardous substance regulations.

40 CFR § 109	Establishes criteria for oil removal (spill) contingency plans
40 CFR § 110	Requires reporting of spills
40 CFR § 112	Oil pollution prevention, designed to form a comprehensive federal/state spill prevention program that minimizes the potential for discharges
40 CFR § 112.7	General requirements for spill prevention, control, and countermeasures plan
40 CFR § 113	Sets liability limits for small onshore storage facilities (oil)

40 CFR § 116	Designates hazardous substances
40 CFR § 117	Determination of reportable quantities for hazardous substances

Water quality regulations.

40 CFR § 121	State certification of activities requiring federal license or permit which may result in any discharge into navigable waters
40 CFR § 122	NPDES permit regulations
40 CFR § 125	Sets criteria and standards for NPDES permits
40 CFR § 129	Sets toxic pollutant effluent standards and lists toxic pollutants
40 CFR § 136	Establishes test procedures for the analysis of pollutants
40 CFR § 401	Prescribes effluent limitations guidelines and standards
40 CFR § 435	Sets discharge criteria for onshore and offshore facilities

Underground injection regulations.

40 CFR § 144	Requirements for underground injection control program
40 CFR § 146	Sets technical criteria and standards for the underground injection control program
40 CFR § 147	Sets forth state-administered underground injection control program

Ocean dumping regulations.

40 CFR §§ 220 to 228	Regulations, permits, and criteria related to dumping of material in the ocean

Materials discharge and disposal regulations.

40 CFR § 230	Regulates the discharge of dredged or fill material into navigable waters
40 CFR § 231	Sets the procedures for approving or prohibiting disposal of dredged or fill material at a site

Oil and other hazardous substance pollution regulations.

40 CFR § 300	National Oil and Hazardous Substances Pollution Contingency Plan, to provide for efficient, coordinated, and effective response to discharges of oil and hazardous substances

3. Coast Guard, Department of Homeland Security

Regulations relevant to a determination of a hazard to navigation and oil spills in navigable waters.

33 CFR § 64.31	Determination of hazard to navigation
33 CFR §§ 153 to 158	Prescribes regulations concerning notification to the Coast Guard of the discharge of oil or hazardous; the procedures for the removal of a discharge of oil; the costs that may be imposed or reimbursed for the removal of a discharge; and for the transfer of oil to, from, or within vessels

4. Army Corps of Engineers

Navigable waters regulations.

33 CFR § 209.200	Regulations governing navigable waters
33 CFR §§ 320 to 327 and 330	Prescribes policies and procedures applicable to review of applications for certain activities in U.S. waters, including discharge of dredged or fill material, including nationwide permits
33 CFR §§ 328 and 329	Defines waters and navigable waters of the U.S.

5. Fish and Wildlife Coordination Act

16 USC § 662(a)	Requires consultation between agencies on activities conducted in waters.

6. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

42 USC §§ 9601 to 9675	Defines and designates hazardous substances, sets quantities for reportable releases, and sets cleanup standards

7. Safe Drinking Water Act

42 USC § 300 (f) to (h)	Regulates public water systems to ensure their safety

8. Solid Waste Disposal Act, as amended by Resource Conservation and Recovery Act

42 USC §§ 6901 to 6991	Regulates solid waste disposal planning and management and sets reduction or elimination of hazardous waste as national policy

9. Clean Air Act

42 USC §§ 740l to 7671	Encourages and promotes reasonable governmental actions for air pollution prevention; sets standards, and permit requirements

10. Toxic Substances Control Act

15 USC §§ 2601 to 2655	Controls toxic substances, including asbestos

11. National Environmental Policy Act (NEPA)

42 USC §§ 4321 to 4347	Sets environmental policy; requires a detailed statement of environmental impacts in reports on proposed federal actions significantly affecting the quality of the environment.

Council on Environmental Quality-administers NEPA-related regulations

40 CFR §§ 1500 to 1508	Provides regulations applicable to and binding on federal agencies for implementing NEPA, including when and whether to prepare and environmental impact statement

12. Endangered Species Act

16 USC §§ 1531 to 1543	Interagency cooperation, prohibited acts, penalties, and enforcement

13. USF&WS

Threatened and endangered species regulations

50 CFR § 17	Threatened and endangered wildlife and plant species
50 CFR § 402	Directs federal agencies to further the purposes of the Endangered Species Act

14. Marine Protection, Research, and Sanctuaries Act

33 USC §§ 1401 to 1445	Regulation and research of ocean dumping

15. Marine Mammal Protection Act

16 USC §§ 1361 to 1423	Requires measures to conserve and protect marine mammals

16. Pipeline Inspection, Protection, Enforcement, and Safety Act (PIPES Act) of 2006

49 CFR § 192	Prescribes minimum safety requirements for pipeline facilities and the transportation of gas
49 CFR § 195	Prescribes safety standards and reporting requirements for pipeline facilities used in the transportation of hazardous liquids or carbon dioxide

17. Migratory Bird Treaty Act

16 USC §§ 703 to 712 and 715	Protects migratory birds, per the act and international treaties

18. Archaeological and Historic Preservation Act

16 USC § 469	Preserves historical and archaeological data that might be lost or destroyed due to a federally licensed activity

19. National Historic Preservation Act

16 USC § 470	Protects prehistoric and historic resources

20. Leases and Permits on Restricted Properties

25 CFR § 162	Leasing and permitting on Native and restricted lands

C. Local Laws and Regulations

1. North Slope Borough

Title 19	North Slope Borough land management regulations, planning, and permitting powers.

Appendix C: Directional and Extended-Reach Drilling

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Appendix C: Directional and Extended-Reach Drilling

A. Directional and Extended-Reach Drilling

Directional drilling is a drilling technique whereby a well is deliberately deviated from the vertical in order to reach a particular part of the reservoir. Directional drilling technology enables the driller to steer the drill stem and bit to a desired bottom hole location. Directional wells initially are drilled straight down to a predetermined depth and then gradually curved at one or more different points to penetrate one or more given target reservoirs. This specialized drilling usually is accomplished with the use of a fluid-driven downhole motor, which turns the drill bit (Gerding 1986). Directional drilling also allows multiple production and injection wells to be drilled from a single surface location such as a gravel pad or offshore production platform, thus minimizing cost and the surface impact of oil and gas drilling, production, and transportation facilities (Figures C.1 and C.2). It can be used to reach a target located beneath an environmentally sensitive area and may offer the most economical way to develop offshore oil fields from onshore facilities.

The limitations of directional drilling are primarily dependent upon maximum hole angle, rate of angle change, and torque or friction considerations. In directional drilling, it is now common for the horizontal displacement of the bottom hole location to be twice the total vertical depth (TVD) of the well. That is, a well with a vertical depth of 7,000 ft could have a bottom hole horizontal displacement of 14,000 ft from the drill site. However, in a shallower well, such as one in which a potential target is two miles away from the drill site but only one mile deep, directional drilling would be much more difficult, risky, and costly (Schmidt 1994).

Direction drilling may be limited by the type of geology or rock through which drillers must drill in order to reach the desired target. Coal and shale deposits tend to expand or collapse the well bore and cause the drill string to get stuck. This is more likely to happen in wells that take longer to drill where the downhole formations are exposed to the drilling mud and drill string longer before well casing is cemented into the hole. Small subsurface faults are difficult to locate prior to drilling, and if the drill bit crosses a fault, the type of rock being drilled may suddenly change and a new geologic reference must be established. During this intermediate period in the drilling operation, the driller will not be sure if the desired geologic target is being drilled or could be intersected again (Schmidt 1994). Stuck pipe can also occur in directional wells when the borehole becomes oval shaped from the drill pipe constantly laying on the downside part of the well bore. The pipe gets lodged in the groove cut on the bottom of the hole. The most common cause of hole collapse is the chemical difference between in-formation saltwater and the water in drilling mud. This is especially common when drilling through shale. Ions in the water in the mud have a tendency to transfer to the shale, the shale expands, and small sheets slough off into the hole, causing the pipe to get stuck (Gerding 1986

Subsurface collisions with neighboring wells can be problematic when drilling multiple boreholes from one surface location. A collision with a producing well could result in a dangerous situation. Anti-collision planning begins with accurate surveys of the subject well and a complete set of plans for existing and proposed oil and gas wells (Schlumberger Anadrill 1993).

Perhaps the greatest limitation on directional drilling is cost. For certain reservoirs, directional drilling technically may be possible but is not always economically feasible. Factors that may prohibit the use of directional drilling, such as the position of oil or gas deposits in the geologic structure relative to the drilling rig, the size and depth of the deposit, and the geology of the area, are all important elements that determine whether directional drilling is cost effective (Winfree 1994).

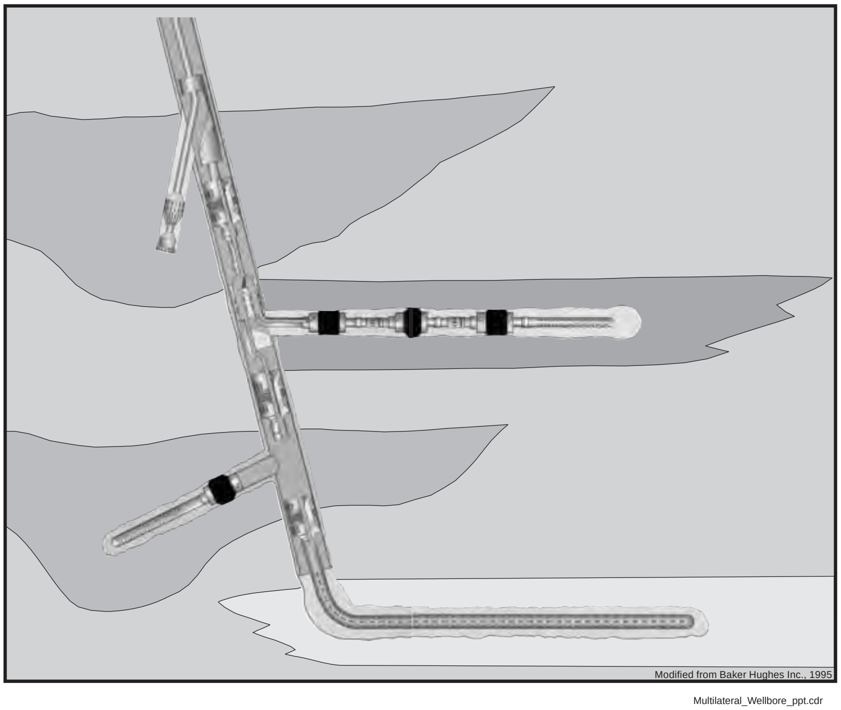

Figure C.1. Multilateral wellbore.

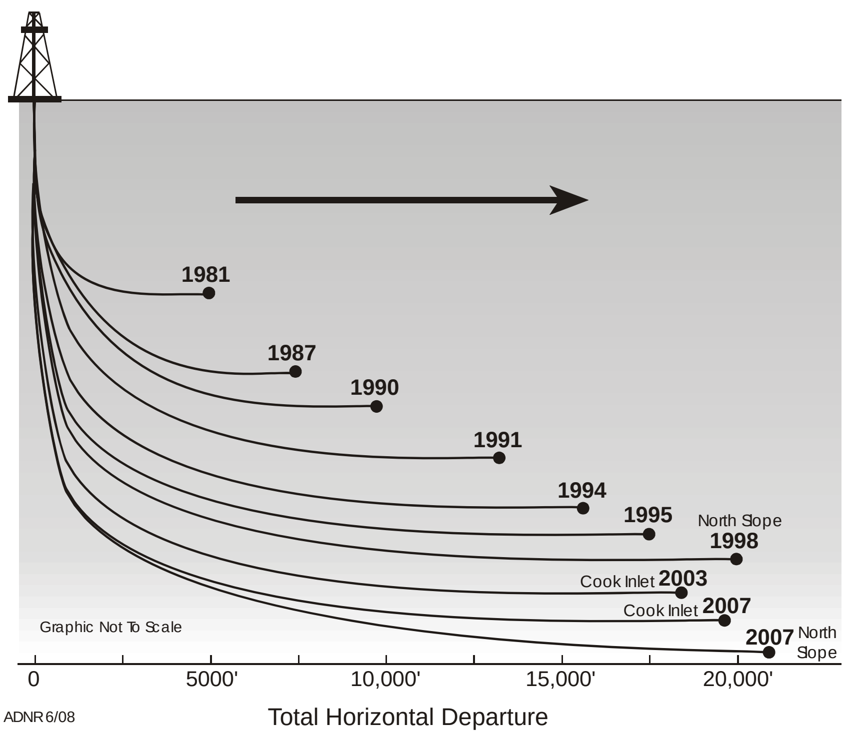

Figure C.2. Well reach versus time (in Alaska).

The environment and the cost of multiple pads or locations are also considerations in determining the cost-effectiveness of directional drilling.

Horizontal drilling, a more specialized type of directional drilling, allows a single well bore at the surface to penetrate oil- or gas-bearing reservoir strata at angles that parallel or nearly parallel the dip of the strata. The well bore is then open and in communication with the reservoir over much longer distances. In development wells, this can greatly increase production rates of oil and gas or volumes of injected fluids (Winfree 1994). Horizontal drilling may involve underbalanced drilling, coiled tubing, bit steering, continuous logging, multilateral horizontals, and horizontal completions. Lateral step-outs are directional wells that branch off a main borehole to access more of the subsurface. Conditions for successful horizontal wells include adequate pre-spud planning, reservoir descriptions, drillable strata that will not collapse, and careful cost control (PTTC 1996).

Extended-Reach Drilling (ERD) has evolved from simple directional drilling to horizontal, lateral, and multilateral step-outs (Figures C1 and C2). ERD employs both directional and horizontal drilling techniques and has the ability to achieve horizontal well departures and total vertical depth-to-deviation ratios beyond the conventional experience in a particular field (Gerding 1986). ERD can be defined in terms of reach/TVD (total vertical depth) ratios (Judzis et al. 1997). The definition of an ERD well depends on the results of existing drilling efforts in a particular oilfield (Gerding 1986). Local ERD capability depends on the extent of experience within specific fields and with specific rigs and mud systems. “ERD wells drilled in specific fields and with specific rigs, equipment, personnel, project teams, etc. do not necessarily imply what may be readily achieved in other areas” (Judzis et al. 1997).

Possible challenges to successful ERD include problematic movement of downhole drillstring and well casing, applying sufficient weight to the drill bit, buckling of well casing or drillstring, and running casing successfully to the bottom of the well. Drillstring tension may be a primary concern in vertical wells, but in ERD, drillstring torsion may be the limiting factor. Running normal-weight drill pipe to apply weight to the bit in ERD can lead to buckling of the drill pipe and rapid fatigue failure. Conventional drilling tools are prone to twist-off because of unanticipated failure under high torsional and tensile loads of an extended-reach well (JPT 1994). Torque can be significantly reduced with the use of nonrotating drill pipe protectors (Payne et al. 1995). Advanced equipment for an ERD well may include wider diameter drill pipe, additional mud pumps, enhanced solids control, higher capacity top-drive motors, more generated power, and oil-based drilling fluids (Judzis et al. 1997).

ERD requires longer hole sections, which require longer drilling times; the result is increased exposure of destabilizing fluids to the well bore (JPT 1994). Oil-based muds are superior to water-based muds in ERD (Payne et al. 1995). Water-based muds may not provide the inhibition, lubrication or confining support of oil-based muds (JPT 1994).

Drillstring design for ERD involves: (1) determining expected loads; (2) selecting drillstring components; (3) verifying each component’s condition; (4) setting operating limits for the rig team; and (5) monitoring condition during drilling. Economic and related issues in drillstring planning include cost, availability, and logistics. Rig and logistics issues include storage space, setback space, accuracy of load indicators, pump pressure and volume capacity, and top-drive output torque. Drill hole issues include hole cleaning, hole stability, hydraulics, casing wear, and directional objectives (Judzis et al. 1997).

The working relationship between various components of a drill string must be analyzed carefully. Conventional drill stems are about 30 ft long and are made up of a bit, stabilizer, motor, a measurement-while-drilling (logging) tool, drill collars, more stabilizers, and jars. Typically there are more than 1,600 parts to a drill string in a 24,000-foot well. A modern drill string can be made up of hundreds of components from more than a dozen vendors. These components may not always perform as anticipated and may not meet operational demands of drilling an extended-reach well (JPT 1994).

In a few cases, ERD technology has been used instead of platform installation off the coast of California, where wells are drilled from onshore locations to reach nearby offshore reserves. ERD has been instrumental in developing offshore reserves of the Sherwood reservoir under Poole Bay from shore at Wytch Farm, U.K. The original development plan called for the construction of a $260 million artificial island in the bay (JPT 1994). ERD also has been used successfully in the North Sea, in the Gulf of Mexico, in the South China Sea, and in Alaska (Milne Point, Badami, Point McIntyre, Alpine, and Niakuk fields) (Judzis et al. 1997). The longest ERD well on the North Slope was drilled in the Alpine Pool in 2007, well CD4-07, to a total length of 25,040 ft MD with horizontal displacement of 21,047 ft.

Although a 6.6-mile horizontal displacement was accomplished in 1999 at Cullen Norte 1 well in Argentina (Haliburton 1999), horizontal displacements (departure from vertical) of 0.5 to 2 miles are typical. In October 1998, BP set a long-reach record for horizontal directional wells in the U.S. with a displacement of 19,804 ft in the Niakuk field (Figures C.1 and C.2). Despite its $6 million price, the well represents a cost saving over the other drilling alternatives, such as construction of an offshore artificial gravel island (AJC 1996).

Exploration wells within the license area may be directionally drilled because of a lack of suitable surface locations directly overlying exploration targets. However, until specific sites and development scenarios are advanced and the specific conditions of drill sites are known, the applicability of directional drilling for oil and gas within the license area is unknown. It is anticipated that most development wells will be directionally drilled because of the cost savings realized in pad construction and required facilities.

Many surface use conflicts can be avoided through directional drilling and ERD. However, some reservoirs are located or sized such that directional drilling cannot eliminate all possible conflicts.

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Appendix D: Sample Competitive Oil and Gas Lease

Competitive Oil and Gas Lease

Form #DOG 200604 (rev. 3/2009)

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES

Competitive Oil and Gas Lease **ADL No.**

THIS LEASE is entered into , between the State of Alaska, "the state," and

"the lessee," whether one or more, whose sole address for purposes of notification is under Paragraph 25.

In consideration of the cash payment made by the lessee to the state, which payment includes the first year's rental and any required cash bonus, and subject to the provisions of this lease, including applicable stipulation(s) and mitigating measures attached to this lease and by this reference incorporated in this lease, the state and the lessee agree as follows:

1. GRANT. (a) Subject to the provisions in this lease, the state grants and leases to the lessee, without warranty, the exclusive right to drill for, extract, remove, clean, process, and dispose of oil, gas, and associated substances in or under the following described tract of land:

containing approximately acres, more or less (referred to in this lease as the "leased area"); the nonexclusive right to conduct within the leased area geological and geophysical exploration for oil, gas, and associated substances; and the nonexclusive right to install pipelines and build structures on the leased area to find, produce, save, store, treat, process, transport, take care of, and market all oil, gas, and associated substances and to house and board employees in its operations on the leased area. The rights granted by this lease are to be exercised in a manner which will not unreasonably interfere with the rights of any permittee, lessee or grantee of the state consistent with the principle of reasonable concurrent uses as set out in Article VIII, Section 8 of the Alaska Constitution.

(b) For the purposes of this lease, the leased area contains the legal subdivisions as shown on the attached plat marked Exhibit A.

(c) If the leased area is described by protracted legal subdivisions and, after the effective date of this lease, the leased area is surveyed under the public land rectangular system, the boundaries of the leased area are those established by that survey, when approved, subject, however, to the provisions of applicable regulations relating to those surveys. If for any reason the leased area includes more acreage than the maximum permitted under applicable law (including the "rule of approximation" authorized in AS 38.05.145 and defined in AS 38.05.965 (18)), this lease is not void and the acreage included in the leased area must be reduced to the permitted maximum. If the state determines that the leased area exceeds the permitted acreage and notifies the lessee in writing of the amount of acreage that must be eliminated, the lessee has 60 days after that notice to surrender one or more legal subdivisions included in the leased area comprising at least the amount of acreage that must be eliminated. Any subdivision surrendered must be located on the perimeter of the leased area as originally described. If a surrender is not filed within 60 days, the state may terminate this lease as to the acreage that must be eliminated by mailing notice of the termination to the lessee describing the subdivision eliminated.

(d) If the State of Alaska's ownership interest in the oil, gas, and associated substances in the leased area is less than an entire and undivided interest, the grant under this lease is effective only as to the state's interest in that oil, gas, and associated substances, and the royalties and rentals provided in this lease must be paid to the state in the proportion that the state's interest bears to the entire undivided fee.

(e) The state makes no representations or warranties, express or implied, as to title, or access to, or quiet enjoyment of, the leased area. The state is not liable to the lessee for any deficiency in title to the leased area, nor is the lessee or any successor in interest to the lessee entitled to any refund due to deficiency in title for any rentals, bonuses, or royalties paid under this lease.

2. RESERVED RIGHTS. (a) The state, for itself and others, reserves all rights not expressly granted to the lessee by this lease. These reserved rights include, but are not limited to:

(1) the right to explore for oil, gas, and associated substances by geological and geophysical means;

(2) the right to explore for, develop, and remove natural resources other than oil, gas, and associated substances on or from the leased area;

(3) the right to establish or grant easements and rights-of-way for any lawful purpose, including without limitation for shafts and tunnels necessary or appropriate for the working of the leased area or other lands for natural resources other than oil, gas, and associated substances;

(4) the right to dispose of land within the leased area for well sites and well bores of wells drilled from or through the leased area to explore for or produce oil, gas, and associated substances in and from lands not within the leased area; and

(5) the right otherwise to manage and dispose of the surface of the leased area or interests in that land by grant, lease, permit, or otherwise to third parties.

(b) The rights reserved may be exercised by the state, or by any other person or entity acting under authority of the state, in any manner that does not unreasonably interfere with or endanger the lessee's operations under this lease.

3. TERM. This lease is issued for an initial primary term of 7 years from the effective date of this lease. The term may be extended as provided in Paragraph 4 below.

4. EXTENSION. (a) This lease will be extended automatically if and for so long as oil or gas is produced in paying quantities from the leased area.

(b) This lease will be extended automatically if it is committed to a unit agreement approved or prescribed by the state, and will remain in effect for so long as it remains committed to that unit agreement.

(c) (1) If the drilling of a well whose bottom hole location is in the leased area has commenced as of the date on which the lease otherwise would expire and is continued with reasonable diligence, this lease will continue in effect until 90 days after cessation of that drilling and for so long as oil or gas is produced in paying quantities from the leased area.

(2) If oil or gas in paying quantities is produced from the leased area, and if that production ceases at any time, this lease will not terminate if drilling or reworking operations are commenced on the leased area within six months after cessation of production and are prosecuted with reasonable diligence; if those drilling or reworking operations result in the production of oil or gas, this lease will remain in effect for so long as oil or gas is produced in paying quantities from the leased area.

(d) If there is a well capable of producing oil or gas in paying quantities on the leased area, this lease will not expire because the lessee fails to produce that oil or gas unless the state gives notice to the lessee, allowing a reasonable time, which will not be less than six months after notice, to place the well into production, and the lessee fails to do so. If production is established within the time allowed, this lease is extended only for so long as oil or gas is produced in paying quantities from the leased area.

(e) If the state directs or approves in writing a suspension of all operations on or production from the leased area (except for a suspension necessitated by the lessee's negligence), or if a suspension of all operations on or production from the leased area has been ordered under federal, state, or local law, the lessee's obligation to comply with any express or implied provision of this lease requiring operations or production will be suspended, but not voided, and the lessee shall not be liable for damages for failure to comply with that provision. If the suspension occurs before the expiration of the primary term, the primary term will be extended at the end of the period of the suspension by adding the period of time lost under the primary term because of the suspension. If the suspension occurs during an extension of the primary term under this paragraph, upon removal of that suspension, the lessee will have a reasonable time, which will not be less than six months after notice that the suspension has been removed, to resume operations or production. For the purposes of this subparagraph, any suspension of operations or production specifically required or imposed as a term of sale or by any stipulation made a part of this lease will not be considered a suspension ordered by law.

(f) If the state determines that the lessee has been prevented by force majeure, after efforts made in good faith, from performing any act that would extend the lease beyond the primary term, this lease will not expire during the period of force majeure. If the force majeure occurs before the expiration of the primary term, the primary term will be extended at the end of the period of force majeure by adding the period of time lost under the primary term because of the force majeure. If the force majeure occurs during an extension of the primary term under this paragraph, this lease will not expire during the period of force majeure plus a reasonable time after that period, which will not be less than 60 days, for the lessee to resume operations or production.

(g) Nothing in subparagraphs (e) or (f) suspends the obligation to pay royalties or other production or profit-based payments to the state from operations on the leased area that are not affected by any suspension or force majeure, or suspends the obligation to pay rentals.

5. RENTALS. (a) The lessee shall pay annual rental to the state in accordance with the following rental schedule:

(1) For the first year, $1.00 per acre or fraction of an acre;

(2) For the second year, $1.50 per acre or fraction of an acre;

(3) For the third year, $2.00 per acre or fraction of an acre;

(4) For the fourth year, $2.50 per acre or fraction of an acre;

(5) For the fifth year and following years, $3.00 per acre or fraction of an acre; provided that the state may increase the annual rental rate as provided by law upon extension of this lease beyond the primary term.

(b) Annual rental paid in advance is a credit on the royalty or net profit share due under this lease for that year.

(c) The lessee shall pay the annual rental to the State of Alaska (or any depository designated by the state with at least 60 days notice to the lessee) in advance, on or before the annual anniversary date of this lease. The state is not required to give notice that rentals are due by billing the lessee. If the state's (or depository's) office is not open for business on the annual anniversary date of this lease, the time for payment is extended to include the next day on which that office is open for business. If the annual rental is not paid timely, this lease automatically terminates as to both parties at 11:59 p.m., Alaska Standard Time, on the date by which the rental payment was to have been made.

6. RECORDS. The lessee shall keep and have in its possession books and records showing the development and production (including records of development and production expenses) and disposition (including records of sale prices, volumes, and purchasers) of all oil, gas, and associated substances produced

from the leased area. The lessee shall permit the State of Alaska or its agents to examine these books and records at all reasonable times. Upon request by the state, the lessee's books and records shall be made available to the state at the state office designated by the state. These books and records of development, production, and disposition must employ methods and techniques that will ensure the most accurate figures reasonably available without requiring the lessee to provide separate tankage or meters for each well. The lessee shall use generally accepted accounting procedures consistently applied.

7. APPORTIONMENT OF ROYALTY FROM APPROVED UNIT. The landowners' royalty share of the unit production allocated to each separately owned tract shall be regarded as royalty to be distributed to and among, or the proceeds of it paid to, the landowners, free and clear of all unit expense and free of any lien for it. Under this provision, the state's royalty share of any unit production allocated to the leased area will be regarded as royalty to be distributed to, or the proceeds of it paid to, the state, free and clear of all unit expenses (and any portion of those expenses incurred away from the unit area), including, but not limited to, expenses for separating, cleaning, dehydration, gathering, saltwater disposal, and preparing oil, gas, or associated substances for transportation off the unit area, and free of any lien for them.

8. PAYMENTS. All payments to the State of Alaska under this lease must be made payable to the state in the manner directed by the state, and unless otherwise specified, must be tendered to the state at:

DEPARTMENT OF NATURAL RESOURCES

550 WEST 7TH AVENUE, SUITE 1410

ANCHORAGE, ALASKA 99501-3561

ATTENTION: FINANCIAL SERVICES SECTION

or in person at either of the Department's Public Information Centers located at

550 W. 7th Ave., Suite 1260	3700 Airport Way
Anchorage, Alaska	Fairbanks, Alaska

or to any depository designated by the state with at least 60 days notice to the lessee.

9. PLAN OF OPERATIONS. (a) Except as provided in (b) of this section, a plan of operations for all or part of the leased area must be approved by the commissioner before any operations may be undertaken on or in the leased area.

(b) A plan of operations is not required for:

(1) activities that would not require a land use permit; or

(2) operations undertaken under an approved unit plan of operations.

(c) Before undertaking operations on or in the leased area, the lessee shall provide for full payment of all damages sustained by the owner of the surface estate as well as by the surface owner's lessees and permittees, by reason of entering the land.

(d) An application for approval of a plan of operations must contain sufficient information, based on data reasonably available at the time the plan is submitted for approval, for the commissioner to determine the surface use requirements and impacts directly associated with the proposed operations. An application must include statements and maps or drawings setting out the following:

(1) the sequence and schedule of the operations to be conducted on or in the leased area, including the date operations are proposed to begin and their proposed duration;

(2) projected use requirements directly associated with the proposed operations, including the location and design of well sites, material sites, water supplies, solid waste sites, buildings, roads, utilities, airstrips, and all other facilities and equipment necessary to conduct the proposed operations;

(3) plans for rehabilitation of the affected leased area after completion of operations or phases of those operations; and

(4) a description of operating procedures designed to prevent or minimize adverse effects on other natural resources and other uses of the leased area and adjacent areas, including fish and wildlife habitats, historic and archeological sites, and public use areas.

(e) In approving a lease plan of operations or an amendment of a plan, the commissioner will require amendments that the commissioner determines necessary to protect the state's interest. The commissioner will not require an amendment that would be inconsistent with the terms of sale under which the lease was obtained, or with the terms of the lease itself, or which would deprive the lessee of reasonable use of the leasehold interest.

(f) The lessee may, with the approval of the commissioner, amend an approved plan of operations.

(g) Upon completion of operations, the lessee shall inspect the area of operations and submit a report indicating the completion date of operations and stating any noncompliance of which the lessee knows, or should reasonably know, with requirements imposed as a condition of approval of the plan.

(h) In submitting a proposed plan of operations for approval, the lessee shall provide ten copies of the plan if activities proposed are within the coastal zone, and five copies if activities proposed are not within the coastal zone.

10. PLAN OF DEVELOPMENT. (a) Except as provided in subparagraph (d) below, within 12 months after completion of a well capable of producing oil, gas, or associated substances in paying quantities, the lessee shall file two copies of an application for approval by the state of an initial plan of development that must describe the lessee's plans for developing the leased area. No development of the leased area may occur until a plan of development has been approved by the state.

(b) The plan of development must be revised, updated, and submitted to the state for approval annually before or on the anniversary date of the previously approved plan. If no changes from an approved plan are contemplated for the following year, a statement to that effect must be filed for approval in lieu of the required revision and update.

(c) The lessee may, with the approval of the state, subsequently modify an approved plan of development.

(d) If the leased area is included in an approved unit, the lessee will not be required to submit a separate lease plan of development for unit activities.

11. INFORMATION ACQUIRED FROM OPERATIONS. (a) The lessee shall submit to the state all geological, geophysical and engineering data and analyses obtained from the lease within 30 days following the completion of a well. The lessee shall submit to the state data and analyses acquired subsequent to well completion within 30 days following acquisition of that data. The state may waive receipt of operational data from some development, service or injection wells. The state will inform the operator of the waiver prior to well completion. The lessee shall submit the data and analyses to the Division of Oil and Gas, Department of Natural Resources, at the location specified in paragraph 25 of this lease. The data and analyses shall include the following:

(1) a copy of the completion report (AOGCC form 10-407) with an attached well summary, including daily drilling reports, formation tops encountered, a full synopsis of drillstem and formation testing data, an identification of zones of abnormal pressure, oil and gas shows and cored intervals;

(2) latitudinal and longitudinal coordinates for the completed surface and bottom hole locations;

(3) a copy of the permit to drill (AOGCC form 10-401 only, additional documentation not required) and the survey plat of the well location;

(4) a paper copy (no sepia copies) of all final 2-inch open hole and cased hole logs, including measured depth and true-vertical depth versions, specialty logs (such as Schlumberger's cyberlook, formation microscanners and dipmeter logs), composite mud or lithology log and report, measured-while-drilling (MWD) and logged-while-drilling (LWD) logs, velocity and directional surveys;

(5) a digital version of well logs in LAS, LIS or ASCII format on IBM format floppy disks, a digital version of velocity surveys in SEG Y format, a digital version of directional surveys in ASCII format (other formats may be acceptable upon agreement with the Division of Oil and Gas); and

(6) a paper copy of all available well analyses, including geochemical analyses, core analyses (porosity, permeability, capillary pressure, photos, and descriptions), paleontologic and palynologic analyses, thermal maturation analyses, pressure build up analyses, and fluid PVT analyses (an ASCII format digital version of the above information shall also be submitted, if available). The state may require the lessee to submit additional information in accordance with the applicable statutes and regulations in effect at the time of the completion date of the well.

(b) Any information submitted to the state by the lessee in connection with this lease will be available at all times for use by the state and its agents. The state will keep information confidential as provided in AS 38.05.035(a)(9) and its applicable regulations. In accordance with AS 38.05.035(a)(9)(C), in order for geological, geophysical and engineering information submitted under paragraph 11(a) of this lease to be held confidential, the lessee must request confidentiality at the time the information is submitted. The information must be marked **CONFIDENTIAL.**

12. DIRECTIONAL DRILLING. This lease may be maintained in effect by directional wells whose bottom hole location is on the leased area but that are drilled from locations on other lands not covered by this lease. In those circumstances, drilling will be considered to have commenced on the leased area when actual drilling is commenced on those other lands for the purpose of directionally drilling into the leased area. Production of oil or gas from the leased area through any directional well surfaced on those other lands, or drilling or reworking of that directional well, will be considered production or drilling or reworking operations on the leased area for all purposes of this lease. Nothing contained in this paragraph is intended or will be construed as granting to the lessee any interest, license, easement, or other right in or with respect to those lands in addition to any interest, license, easement, or other right that the lessee may have lawfully acquired from the state or from others.

13. DILIGENCE AND PREVENTION OF WASTE. (a) The lessee shall exercise reasonable diligence in drilling, producing, and operating wells on the leased area unless consent to suspend operations temporarily is granted by the state.

(b) Upon discovery of oil or gas on the leased area in quantities that would appear to a reasonable and prudent operator to be sufficient to recover ordinary costs of drilling, completing, and producing an additional well in the same geologic structure at another location with a reasonable profit to the operator, the lessee must drill those wells as a reasonable and prudent operator would drill, having due regard for the interest of the state as well as the interest of the lessee.

(c) The lessee shall perform all operations under this lease in a good and workmanlike manner in accordance with the methods and practices set out in the approved plan of operations and plan of development, with due regard for the prevention of waste of oil, gas, and associated substances and the entrance of water to the oil and gas-bearing sands or strata to the destruction or injury of those sands or strata, and to the preservation and conservation of the property for future productive operations. The lessee shall carry out at the lessee's expense all orders and requirements of the State of Alaska relative to the prevention of waste and to the preservation of the leased area. If the lessee fails to carry out these orders, the state will have the right, together with any other available legal recourse, to enter the leased area to repair damage or prevent waste at the lessee's expense.

(d) The lessee shall securely plug in an approved manner any well before abandoning it.

14. OFFSET WELLS. The lessee shall drill such wells as a reasonable and prudent operator would drill to protect the state from loss by reason of drainage resulting from production on other land. Without limiting the generality of the foregoing sentence, if oil or gas is produced in a well on other land not owned by the State

of Alaska or on which the State of Alaska receives a lower rate of royalty than under this lease, and that well is within 500 feet in the case of an oil well or 1,500 feet in the case of a gas well of lands then subject to this lease, and that well produces oil or gas for a period of 30 consecutive days in quantities that would appear to a reasonable and prudent operator to be sufficient to recover ordinary costs of drilling, completing, and producing an additional well in the same geological structure at an offset location with a reasonable profit to the operator, and if, after notice to the lessee and an opportunity to be heard, the state finds that production from that well is draining lands then subject to this lease, the lessee shall within 30 days after written demand by the state begin in good faith and diligently prosecute drilling operations for an offset well on the leased area. In lieu of drilling any well required by this paragraph, the lessee may, with the state's consent, compensate the state in full each month for the estimated loss of royalty through drainage in the amount determined by the state.

15. UNITIZATION. (a) The lessee may unite with others, jointly or separately, in collectively adopting and operating under a cooperative or unit agreement for the exploration, development, or operation of the pool, field, or like area or part of the pool, field, or like area that includes or underlies the leased area or any part of the leased area whenever the state determines and certifies that the cooperative or unit agreement is in the public interest.

(b) The lessee agrees, within six months after demand by the state, to subscribe to a reasonable cooperative or unit agreement that will adequately protect all parties in interest, including the state. The state reserves the right to prescribe such an agreement.

(c) With the consent of the lessee, and if the leased area is committed to a unit agreement approved by the state, the state may establish, alter, change, or revoke drilling, producing, and royalty requirements of this lease as the state determines necessary or proper to secure the proper protection of the public interest.

(d) Except as otherwise provided in this subparagraph, where only a portion of the leased area is committed to a unit agreement approved or prescribed by the state, that commitment constitutes a severance of this lease as to the unitized and nonunitized portions of the leased area. The portion of the leased area not committed to the unit will be treated as a separate and distinct lease having the same effective date and term as this lease and may be maintained only in accordance with the terms and conditions of this lease, statutes, and regulations. Any portion of the leased area not committed to the unit agreement will not be affected by the unitization or pooling of any other portion of the leased area, by operations in the unit, or by suspension approved or ordered for the unit. If the leased area has a well certified, under 11 AAC 83.361, as capable of production in paying quantities as defined in 11 AAC 83.395(4) on it before commitment to a unit agreement, this lease will not be severed. If any portion of this lease is included in a participating area formed under a unit agreement, the entire leased area will remain committed to the unit and this lease will not be severed.

16. INSPECTION. The lessee shall keep open at all reasonable times, for inspection by any duly authorized representative of the State of Alaska, the leased area, all wells, improvements, machinery, and fixtures on the leased area, and all reports and records relative to operations and surveys or investigations on or with regard to the leased area or under this lease. Upon request, the lessee shall furnish the State of Alaska with copies of and extracts from any such reports and records.

17. SUSPENSION. The state may from time to time direct or approve in writing suspension of production or other operations under this lease.

18. ASSIGNMENT, PARTITION, AND CONVERSION. This lease, or an interest in this lease, may, with the approval of the state, be assigned, subleased, or otherwise transferred to any person or persons qualified to hold a lease. No assignment, sublease, or other transfer of an interest in this lease, including assignments of working or royalty interests and operating agreements and subleases, will be binding upon the state unless approved by the state. The lessee shall remain liable for all obligations under this lease accruing prior to the approval by the state of any assignment, sublease, or other transfer of an interest in this lease. All provisions of this lease will extend to and be binding upon the heirs, administrators, successors, and assigns of the state and the lessee. Applications for approval of an assignment, sublease, or other transfer must comply with all applicable regulations and must be filed within 90 days after the date of final execution of the instrument

of transfer. The state will approve a transfer of an undivided interest in this lease unless the transfer would adversely affect the interests of Alaska or the application does not comply with applicable regulations. The state will disapprove a transfer of a divided interest in this lease if the transfer covers only a portion of the lease or a separate and distinct zone or geological horizon unless the lessee demonstrates that the proposed transfer of a divided interest is reasonably necessary to accomplish exploration or development of the lease, the lease is committed to an approved unit agreement, the lease is allocated production within an approved participating area, or the lease has a well capable of production in paying quantities. The state will make a written finding stating the reasons for disapproval of a transfer of a divided interest. Where an assignment, sublease, or other transfer is made of all or a part of the lessee's interest in a portion of the leased area, this lease may, at the option of the state or upon request of the transferee and with the approval of the state, be severed, and a separate and distinct lease will be issued to the transferee having the same effective date and terms as this lease.

19. SURRENDER. The lessee at any time may file with the state a written surrender of all rights under this lease or any portion of the leased area comprising one or more legal subdivisions or, with the consent of the state, any separate and distinct zone or geological horizon underlying the leased area or one or more legal subdivisions of the leased area. That surrender will be effective as of the date of filing, subject to the continued obligations of the lessee and its surety to make payment of all accrued royalties and to place all wells and surface facilities on the surrendered land or in the surrendered zones or horizons in condition satisfactory to the state for suspension or abandonment. After that, the lessee will be released from all obligations under this lease with respect to the surrendered lands, zones, or horizons.

20. DEFAULT AND TERMINATION; CANCELLATION. (a) The failure of the lessee to perform timely its obligations under this lease, or the failure of the lessee otherwise to abide by all express and implied provisions of this lease, is a default of the lessee's obligations under this lease. Whenever the lessee fails to comply with any of the provisions of this lease (other than a provision which, by its terms, provides for automatic termination), and fails within 60 days after written notice of that default to begin and diligently prosecute operations to remedy that default, the state may terminate this lease if at the time of termination there is no well on the leased area capable of producing oil or gas in paying quantities. If there is a well on the leased area capable of producing oil or gas in paying quantities, this lease may be terminated by an appropriate judicial proceeding. In the event of any termination under this subparagraph, the lessee shall have the right to retain under this lease any and all drilling or producing wells for which no default exists, together with a parcel of land surrounding each well or wells and rights-of-way through the leased area that are reasonably necessary to enable the lessee to drill, operate, and transport oil or gas from the retained well or wells.

(b) The state may cancel this lease at any time if the state determines, after the lessee has been given notice and a reasonable opportunity to be heard, that:

(1) continued operations pursuant to this lease probably will cause serious harm or damage to biological resources, to property, to mineral resources, or to the environment (including the human environment);

(2) the threat of harm or damage will not disappear or decrease to an acceptable extent within a reasonable period of time; and

(3) the advantages of cancellation outweigh the advantages of continuing this lease in effect. Any cancellation under this subparagraph will not occur unless and until operations under this lease have been under suspension or temporary prohibition by the state, with due extension of the term of this lease, continuously for a period of five years or for a lesser period upon request of the lessee.

(c) Any cancellation under subparagraph (b) will entitle the lessee to receive compensation as the lessee demonstrates to the state is equal to the lesser of:

(1) the value of the cancelled rights as of the date of cancellation, with due consideration being given to both anticipated revenues from this lease and anticipated costs, including costs of compliance with all applicable regulations and stipulations, liability for clean-up costs or damages, or both, in the case of an oil spill, and all other costs reasonably anticipated under this lease; or

(2) the excess, if any, over the lessee's revenues from this lease (plus interest on the excess from the date of receipt to date of reimbursement) of all consideration paid for this lease and all direct expenditures made by the lessee after the effective date of this lease and in connection with exploration or development, or both, under this lease, plus interest on that consideration and those expenditures from the date of payment to the date of reimbursement.

21. RIGHTS UPON TERMINATION. Upon the expiration or earlier termination of this lease as to all or any portion of the leased area, the lessee will be directed in writing by the state and will have the right at any time within a period of one year after the termination, or any extension of that period as may be granted by the state, to remove from the leased area or portion of the leased area all machinery, equipment, tools, and materials. Upon the expiration of that period or extension of that period and at the option of the state, any machinery, equipment, tools, and materials that the lessee has not removed from the leased area or portion of the leased area become the property of the state or may be removed by the state at the lessee's expense. At the option of the state, all improvements such as roads, pads, and wells must either be abandoned and the sites rehabilitated by the lessee to the satisfaction of the state, or be left intact and the lessee absolved of all further responsibility as to their maintenance, repair, and eventual abandonment and rehabilitation. Subject to the above conditions, the lessee shall deliver up the leased area or those portions of the leased area in good condition.

22. DAMAGES AND INDEMNIFICATION. (a) No rights under the AS 38.05.125 reservation may be exercised by the lessee until the lessee has provided to pay the owner of the land, his lessees and permittees, upon which the AS 38.05.125 reserved rights are sought to be exercised, full payment for all damage sustained by the owner by reason of entering the land. If the owner for any reason does not settle the damages, the lessee may enter the land after posting a surety bond determined by the state, after notice and an opportunity to be heard, to be sufficient as to form, amount, and security to secure to the owner, his lessees and permittees, payment for damages, and may institute legal proceedings in a court of competent jurisdiction where the land is located to determine the damages which the owner of the land may suffer. The lessee agrees to pay for any damages that may become payable under AS 38.05.130 and to indemnify the state and hold it harmless from and against any claims, demands, liabilities, and expenses arising from or in connection with such damages. The furnishing of a bond in compliance with this paragraph will be regarded by the state as sufficient provision for the payment of all damages that may become payable under AS 38.05.130 by virtue of this lease.

(b) The lessee shall indemnify the state for, and hold it harmless from, any claim, including claims for loss or damage to property or injury to any person caused by or resulting from any act or omission committed under this lease by or on behalf of the lessee. The lessee is not responsible to the state under this subparagraph for any loss, damage, or injury caused by or resulting from the sole negligence of the state.

(c) The lessee expressly waives any defense to an action for breach of a provision of this lease or for damages resulting from an oil spill or other harm to the environment that is based on an act or omission committed by an independent contractor in the lessee's employ. The lessee expressly agrees to assume responsibility for all actions of its independent contractors.

23. BONDS. (a) If required by the state, the lessee shall furnish a bond prior to the issuance of this lease in an amount equal to at least $5 per acre or fraction of an acre contained in the leased area, but no less than $10,000, and must maintain that bond as long as required by the state.

(b) The lessee may, in lieu of the bond required under (a) above, furnish and maintain a statewide bond in accordance with applicable regulations.

(c) The state may, after notice to the lessee and a reasonable opportunity to be heard, require a bond in a reasonable amount greater than the amount specified in (a) above where a greater amount is justified by the nature of the surface and its uses and the degree of risk involved in the types of operations being or to be carried out under this lease. A statewide bond will not satisfy any requirement of a bond imposed under this subparagraph, but will be considered by the state in determining the need for and the amount of any additional bond under this subparagraph.

(d) If the leased area is committed in whole or in part to a cooperative or unit agreement approved or prescribed by the state, and the unit operator furnishes a statewide bond, the lessee need not maintain any bond with respect to the portion of the leased area committed to the cooperative or unit agreement.

24. AUTHORIZED REPRESENTATIVES. The Director of the Division of Oil and Gas, Department of Natural Resources, State of Alaska, and the person executing this lease on behalf of the lessee shall be authorized representatives for their respective principals for the purposes of administering this lease. The state or the lessee may change the designation of its authorized representative or the address to which notices to that representative are to be sent by a notice given in accordance with Paragraph 25 below. Where activities pursuant to a plan of operations are underway, the lessee shall also designate, pursuant to a notice under Paragraph 25 below, by name, job title, and address, an agent who will be present in the state during all lease activities.

25. NOTICES; PROTEST. (a) Any notices required or permitted under this lease must be by electronic media producing a permanent record or in writing and must be given personally or by registered or certified mail, return receipt requested, addressed as follows:

TO THE STATE:

DIRECTOR, DIVISION OF OIL AND GAS
DEPARTMENT OF NATURAL RESOURCES
550 WEST 7TH AVENUE, SUITE 800
ANCHORAGE, ALASKA 99501-3560

TO THE LESSEE:

(b) Any notice given under this paragraph will be effective when delivered to the above authorized representative.

(c) A lessee who wishes to protest the amount of money due the state under the lease or any action of the state regarding a provision of this lease must file a written protest with the Division of Oil and Gas within 30 days after the mailing date of the state's notice or bill. A lessee who fails to file a protest within the required time waives any further right to protest. The state will establish the administrative appeal procedure to be followed and will inform the lessee of the procedure no later than 30 days after the filing of the written protest.

26. STATUTES AND REGULATIONS. This lease is subject to all applicable state and federal statutes and regulations in effect on the effective date of this lease, and insofar as is constitutionally permissible, to all statutes and regulations placed in effect after the effective date of this lease. A reference to a statute or regulation in this lease includes any change in that statute or regulation whether by amendment, repeal and replacement, or other means. This lease does not limit the power of the State of Alaska or the United States of America to enact and enforce legislation or to promulgate and enforce regulations affecting, directly or indirectly,

the activities of the lessee or its agents in connection with this lease or the value of the interest held under this lease. In case of conflicting provisions, statutes and regulations take precedence over this lease.

27. INTERPRETATION. This lease is to be interpreted in accordance with the rules applicable to the interpretation of contracts made in the State of Alaska. The paragraph headings are not part of this lease and are inserted only for convenience. The state and the lessee expressly agree that the law of the State of Alaska will apply in any judicial proceeding affecting this lease.

28. INTEREST IN REAL PROPERTY. It is the intention of the parties that the rights granted to the lessee by this lease constitute an interest in real property in the leased area.

29. WAIVER OF CONDITIONS. The state reserves the right to waive any breach of a provision of this lease, but any such waiver extends only to the particular breach so waived and does not limit the rights of the state with respect to any future breach; nor will the waiver of a particular breach prevent cancellation of this lease for any other cause or for the same cause occurring at another time. Notwithstanding the foregoing, the state will not be deemed to have waived a provision of this lease unless it does so in writing.

30. SEVERABILITY. If it is finally determined in any judicial proceeding that any provision of this lease is invalid, the state and the lessee may jointly agree by a written amendment to this lease that, in consideration of the provisions in that written amendment, the invalid portion will be treated as severed from this lease and that the remainder of this lease, as amended, will remain in effect.

31. LOCAL HIRE. The lessee is encouraged to hire and employ local and Alaska residents and companies, to the extent they are available and qualified, for work performed on the leased area. Lessees shall submit, with the plans of operations, a proposal detailing the means by which the lessee will comply with this measure. The lessee is encouraged, in formulating this proposal, to coordinate with employment services offered by the State of Alaska and local communities and to recruit employees from local communities.

32. CONDITIONAL LEASE. If all or a part of the leased area is land that has been selected by the state under laws of the United States granting lands to the state, but the land has not been patented to the state by the United States, then this lease is a conditional lease as provided by law until the patent becomes effective. If for any reason the selection is not finally approved, or the patent does not become effective, any rental, royalty, or other production or profit-based payments made to the state under this lease will not be refunded.

33. NONDISCRIMINATION. The lessee and the lessee's contractors and subcontractors may not discriminate against any employee or applicant because of race, religion, marital status, change in marital status, pregnancy, parenthood, physical handicap, color, sex, age, or national origin as set out in AS 18.80.220. The lessee and its contractors and subcontractors must, on beginning any operations under this lease, post in a conspicuous place notices setting out this nondiscrimination provision.

34. DEFINITIONS. All words and phrases used in this lease are to be interpreted where possible in the manner required in respect to the interpretation of statutes by AS 01.10.040. However, the following words have the following meanings unless the context unavoidably requires otherwise:

(1) "oil" means crude petroleum oil and other hydrocarbons, regardless of gravity, that are produced in liquid form by ordinary production methods, including liquid hydrocarbons known as distillate or condensate recovered by separation from gas other than at a gas processing plant;

(2) "gas" means all natural gas (except helium gas) and all other hydrocarbons produced that are not defined in this lease as oil;

(3) "associated substances" means all substances except helium produced as an incident of production of oil or gas by ordinary production methods and not defined in this lease as oil or gas;

(4) "drilling" means the act of boring a hole to reach a proposed bottom hole location through which oil or gas may be produced if encountered in paying quantities, and includes redrilling, sidetracking, deepening, or other means necessary to reach the proposed bottom hole location, testing, logging, plugging, and other operations necessary and incidental to the actual boring of the hole;

(5) "reworking operations" means all operations designed to secure, restore, or improve production through some use of a hole previously drilled, including, but not limited to, mechanical or chemical treatment of any horizon, plugging back to test higher strata, etc.;

(6) "paying quantities" means production in quantities sufficient to yield a return in excess of operating costs, even though drilling and equipment costs may never be repaid and the undertaking considered as a whole may ultimately result in a loss; and

(7) "force majeure" means war, riots, acts of God, unusually severe weather, or any other cause beyond the lessee's reasonable ability to foresee or control and includes operational failure of existing transportation facilities and delays caused by judicial decisions or lack of them.

35. ROYALTY ON PRODUCTION. Except for oil, gas, and associated substances used on the leased area for development and production or unavoidably lost, the lessee shall pay to the state as a royalty 12.50 percent in amount or value of the oil, gas, and associated substances saved, removed, or sold from the leased area and of the gas from the leased area used on the leased area for extraction of natural gasoline or other products.

36. VALUE. (a) For the purposes of computing royalties due under this lease, the value of royalty oil, gas, or associated substances shall not be less than the highest of:

(1) the field price received by the lessee for the oil, gas, or associated substances;

(2) the volume-weighted average of the three highest field prices received by other producers in the same field or area for oil of like grade and gravity, gas of like kind and quality, or associated substances of like kind and quality at the time the oil, gas, or associated substances are sold or removed from the leased or unit area or the gas is delivered to an extraction plant if that plant is located on the leased or unit area; if there are less than three prices reported by other producers, the volume-weighted average will be calculated using the lesser number of prices received by other producers in the field or area;

(3) the lessee's posted price in the field or area for the oil, gas, or associated substances; or

(4) the volume-weighted average of the three highest posted prices in the same field or area of the other producers in the same field or area for oil of like grade and gravity, gas of like kind and quality, or associated substances of like kind and quality at the time the oil, gas, or associated substances are sold or removed from the leased or unit area or the gas is delivered to an extraction plant if that plant is located on the leased or unit area; if there are less than three prices posted by other producers, the volume-weighted average will be calculated using the lesser number of prices posted by other producers in the field or area.

(b) If oil, gas, or associated substances are sold away from the leased or unit area, the term "field price" in subparagraph (a) above will be the cash value of all consideration received by the lessee or other producer from the purchaser of the oil, gas, or associated substances, less the lessee's actual and reasonable costs of transportation away from the leased or unit area to the point of sale. The "actual and reasonable costs of transportation" for marine transportation are as defined in 11 AAC 83.229(a), (b)(2), and (c) – (*l*).

(c) In the event the lessee does not sell in an arm's-length transaction the oil, gas, or associated substances, the term "field price" in subparagraphs (a) and (b) above will mean the price the lessee would expect to receive for the oil, gas, or associated substances if the lessee did sell the oil, gas, or associated substances in an arm's-length transaction, minus reasonable costs of transportation away from the leased or unit area to the point of sale or other disposition. The lessee must determine this price in a consistent and logical manner using information available to the lessee and report that price to the state.

(d) The state may establish minimum values for the purposes of computing royalties on oil, gas, or associated substances obtained from this lease, with consideration being given to the price actually received by the lessee, to the price or prices paid in the same field or area for production of like quality, to posted prices, to prices received by the lessee and/or other producers from sales occurring away from the leased area, and/or to other relevant matters. In establishing minimum values, the state may use, but is not limited to, the methodology for determining "prevailing value" as defined in 11 AAC 83.227. Each minimum value determination will be made only after the lessee has been given notice and a reasonable opportunity to be heard. Under this provision, it is expressly agreed that the minimum value of royalty oil, gas, or associated substances under this lease may not necessarily equal, and may exceed, the price of the oil, gas, or associated substances.

37. ROYALTY IN VALUE. Except to the extent that the state elects to receive all or a portion of its royalty in kind as provided in Paragraph 38 below, the lessee shall pay to the state that value of all royalty oil, gas, and associated substances as determined under Paragraph 36 above. Royalty paid in value will be free and clear of all lease expenses (and any portion of those expenses that is incurred away from the leased area), including, but not limited to, expenses for separating, cleaning, dehydration, gathering, saltwater disposal, and preparing the oil, gas, or associated substances for transportation off the leased area. All royalty that may become payable in money to the State of Alaska must be paid on or before the last federal banking day of the calendar month following the month in which the oil, gas, or associated substances are produced. The amount of all royalty in value payments which are not paid when due under this lease or the amount which is subsequently determined to be due to the state or the lessee as the result of a redetermination will bear interest from the last federal banking day of the calendar month following the month in which the oil, gas, or associated substances were produced, until the obligation is paid in full. Interest shall accrue at the rate provided in AS 38.05.135(d) or as may later be amended. Royalty payments must be accompanied by such information relating to valuation of royalty as the state may require which may include, but is not limited to, run tickets, evidence of sales, shipments, and amounts of gross oil, gas, and associated substances produced.

38. ROYALTY IN KIND. (a) At the state's option, which may be exercised from time to time upon not less than 50 days' notice to the lessee, the lessee shall deliver all or a portion of the state's royalty oil, gas, or associated substances produced from the leased area in kind. Delivery will be on the leased area, unit area, or at a place mutually agreed to by the state and the lessee, and must be delivered to the State of Alaska or to any individual, firm, or corporation designated by the state.

(b) Royalty oil, gas, or associated substances delivered in kind must be delivered in good and merchantable condition, of pipeline quality, and free and clear of all lease expenses (and any portion of those expenses incurred away from the leased area), including, but not limited to, expenses for separating, cleaning, dehydration, gathering, saltwater disposal, and preparing the oil, gas, or associated substances for transportation off the leased area.

(c) After having given notice of its intention to take, or after having taken its royalty oil, gas, or associated substances in kind, the state, at its option, may elect to receive a different portion or none of its royalty in kind. If, under federal regulations, the taking of royalty oil, gas, or associated substances in value by the state creates a supplier-purchaser relationship, the lessee hereby waives its right to continue to receive royalty oil, gas, or associated substances under that relationship, and further agrees that it will require any purchasers of the royalty oil, gas, or associated substances likewise to waive any supplier-purchaser rights.

(d) The lessee shall furnish storage for royalty oil, gas, and associated substances produced from the leased or unit area to the same extent that the lessee provides storage for the lessee's share of oil, gas, and associated substances. The lessee shall not be liable for the loss or destruction of stored royalty oil, gas and associated substances from causes beyond the lessee's ability to control.

(e) If a state royalty purchaser refuses or for any reason fails to take delivery of oil, gas, or associated substances, or in an emergency, and with as much notice to the lessee as is practical or reasonable under the circumstances, the state may elect without penalty to underlift for up to six months all or a portion of the state's royalty on oil, gas, or associated substances produced from the leased or unit area and taken in kind. The state's right to underlift is limited to the portion of royalty oil, gas, or associated substances that the royalty purchaser refused or failed to take delivery of, or the portion necessary to meet the emergency condition.

Underlifted oil, gas, or associated substances may be recovered by the state at a daily rate not to exceed 100 percent of its royalty interest share of daily production at the time of the underlift recovery.

39. REDUCTION OF ROYALTY. Lessee may request a reduction of royalty in accordance with the applicable statutes and regulations in effect on the date of application for the reduction.

40. EFFECTIVE DATE. This lease takes effect on .

BY SIGNING THIS LEASE, the state as lessor and the lessee agree to be bound by its provisions.

STATE OF ALASKA

By: ______________________________________

Kevin R. Banks

Director, Division of Oil and Gas

STATE OF ALASKA)

) ss.

Third Judicial District)

On , before me appeared _____________________________ of the Division of Oil and Gas of the State of Alaska, Department of Natural Resources, and who executed this lease and acknowledged voluntarily signing it on behalf of the State of Alaska as lessor.

____

Notary public in and for the State of Alaska

My commission expires _______________

LESSEE: ______________________________________

Signature: ______________________________________

Printed Name/Title: ________________________________

INSERT NOTARY ACKNOWLEDGMENT OF LESSEE'S SIGNATURE HERE.

LESSEE: _______________________________________

Signature: _______________________________________

Printed Name/Title: ________________________________

INSERT NOTARY ACKNOWLEDGMENT OF LESSEE'S SIGNATURE HERE.

LESSEE: _______________________________________

Signature: _______________________________________

Printed Name/Title: ________________________________

INSERT NOTARY ACKNOWLEDGMENT OF LESSEE'S SIGNATURE HERE.