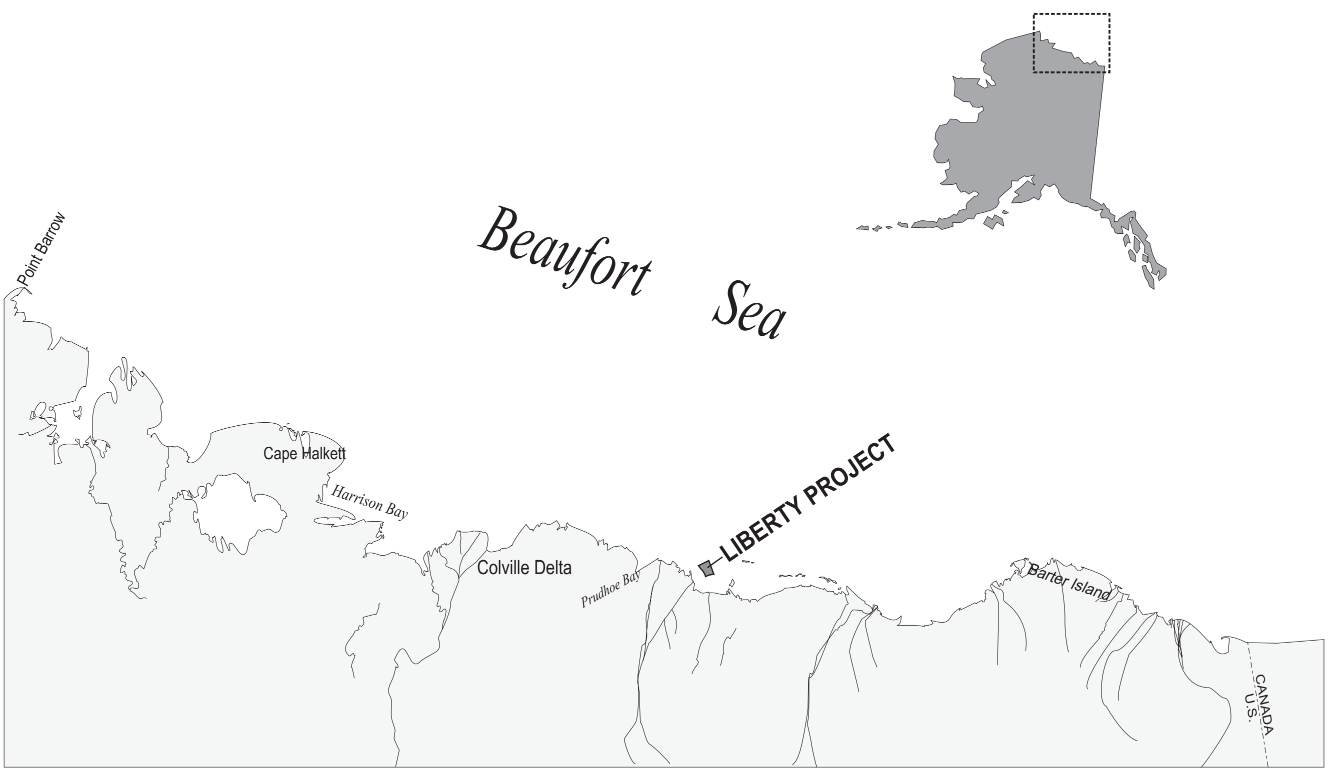
Alaska Outer Continental Shelf

OCS EIS/EA
MMS 2002-020

Liberty Development and Production Plan

Final Environmental
Impact Statement

Executive Summary



U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

Liberty Development and Production Plan, Final Environmental Impact Statement,
OCS EIS/EA, MMS 2002-019, in 4 volumes:
Volume I, Executive Summary, Sections I through V,
Volume II Sections VI through IX, Bibliography, Index
Volume III, Tables, Figures, and Maps for Volumes I and II
Volume IV, Appendices

The summary is also available as a separate document:
Executive Summary, **MMS 2002-020.**

The complete EIS is available on CD-ROM (**MMS 2002-019 CD**) and on the Internet (**http://www.mms.gov/alaska/cproject/liberty/**).

This Environmental Impact Statement (EIS) is not intended, nor should it be used, as a local planning document by potentially affected communities. The exploration, development and production, and transportation scenarios described in this EIS represent best-estimate assumptions that serve as a basis for identifying characteristic activities and any resulting environmental effects. Several years will elapse before enough is known about potential local details of development to permit estimates suitable for local planning. These assumptions do not represent a Minerals Management Service recommendation, preference, or endorsement of any facility, site, or development plan. Local control of events may be exercised through planning, zoning, land ownership, and applicable State and local laws and regulations.

With reference to the extent of the Federal Government's jurisdiction of the offshore regions, the United States has not yet resolved some of its offshore boundaries with neighboring jurisdictions. For the purposes of the EIS, certain assumptions were made about the extent of areas believed subject to United States' jurisdiction. The offshore-boundary lines shown in the figures and graphics of this EIS are for purposes of illustration only; they do not necessarily reflect the position or views of the United States with respect to the location of international boundaries, convention lines, or the offshore boundaries between the United States and coastal states concerned. The United States expressly reserves its rights, and those of its nationals, in all areas in which the offshore-boundary dispute has not been resolved; and these illustrative lines are used without prejudice to such rights.

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U.S. Environmental Protection Agency
Region 10

U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

May 2002

Notice to Readers Regarding the Status of the Liberty Development and Production Plan (DPP)

In January 2002, BP Exploration (Alaska) Inc. (BPXA) publicly announced they were putting the Liberty Project on hold pending an ongoing re-evaluation of project configuration and costs. On March 5, 2002, BPXA sent a letter to Minerals Management Service (MMS) and others saying that pending completion of project re-evaluation, affected agencies should consider submitted permit applications incomplete and recommended processing of these applications be suspended. Also in March, BPXA indicated informally that submission of a modified DPP for the Liberty Project would likely take six months or more.

The MMS has decided to publish and file with Environmental Protection Agency (EPA) this final environmental impact statement (EIS) for the Liberty DPP because it includes substantial changes made in response to comments on the draft EIS. Also, MMS expects this final EIS will serve as a reference document for future projects.

The U.S. Army Corps of Engineers (Corps) and EPA, as cooperating agencies, had intended to use this final EIS as the NEPA document supporting permitting decisions by these agencies. The Corps and EPA hereby solicit comments on the adequacy of, and alternatives considered in, this final EIS.

Due to the applicant's re-evaluation of the project design, and the incomplete status of permit applications, the Corps and EPA are not soliciting comments on their permit decisions at this time. When revised permit applications are received with project changes, the Corps and EPA will issue public notices to request comments on the project proposal. Depending on the changes made, comments received, and any new information available, the three agencies will evaluate whether or not to use this final EIS as the primary NEPA documentation, issue a supplemental EIS or issue new environmental documentation to meet the agencies' respective NEPA compliance and permit evaluation requirements.

COVER SHEET

Beaufort Sea Oil and Gas Development

Liberty Development and Production Plan
Environmental Impact Statement

2002

Draft ( ) **Final (X)**

Type of Action:

Administrative (X) Legislative ( )

Area of Proposed Effect:

Offshore Beaufort Sea marine environment and onshore North Slope of Alaska Coastal Plain

Lead Agency:

U.S. Department of the Interior,
Minerals Management Service

Cooperating Agencies:

U.S. Army Corps of Engineers,
Alaska District Office

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ABSTRACT

To help prepare this EIS, the MMS created an Interagency EIS Team. The U.S. Army Corps of Engineers and the Environmental Protection Agency are cooperating agencies. Participating agencies include the U.S. Department of the Interior, Fish and Wildlife Service; U.S. Department of Commerce, National Marine Fisheries Service; State of Alaska, Pipeline Coordinator's Office; State of Alaska, Division of Governmental Coordination; and the North Slope Borough.

BP Exploration (Alaska) Inc. (BPXA) proposes to produce oil from the Liberty Prospect (OCS Lease Y-01650) located approximately 5 miles offshore and 1.5 miles west of the abandoned Tern Exploration Island in Foggy Island Bay in the Alaskan Beaufort Sea. For the Liberty Prospect, BPXA proposes to construct a self-contained offshore drilling operation (development) with processing (production) facilities located on an artificial gravel island in 22 feet of water in Foggy Island Bay.

BPXA proposes to construct a 12-inch common-carrier oil pipeline buried in an undersea trench, approximately 6.1 miles long, from offshore Liberty Island to an onshore landfall. The pipeline would then connect to an elevated 1.5-mile long onshore pipeline to a tie in with the existing onshore Badami oil pipeline. This infrastructure will transport sales-quality oil (hydrocarbons) to the Trans-Alaska Pipeline System. In addition to two internal monitoring systems along the length of the project, the buried portion of the pipeline will be equipped with an external detection system able to detect leaking hydrocarbons.

BPXA determined that the Liberty Prospect contains approximately 120 million barrels of recoverable crude oil. Production facilities on Liberty Island would include producing wells designed to produce up to 65,000 barrels of crude oil and 120 million standard cubic feet of natural gas per day. The life of the proposed Liberty Prospect development is anticipated to be approximately 15-20 years.

This Environmental Impact Statement (EIS) covers the proposed Beaufort Sea Oil and Gas Development/Liberty Development and Production Plan. This document includes the purpose and background of the proposed action, alternatives, description of the affected environment, and the estimated environmental effects of the proposed action and the alternatives. The alternative analysis evaluates five sets of component alternatives (island location and pipeline route, pipeline design, upper slope-protection system, gravel mine site, and pipeline burial depth) that focus on the different effects of modifying major project elements. The EIS also evaluates the range of alternatives that could be chosen by combining different options from the component alternatives. In addition to the mitigation MMS requires in the lease and those built into BPXA's Proposal, the EIS evaluates two proposed mitigating measures and their potential effects. The EIS also evaluates potential cumulative effects resulting from the BPXA Proposal and alternatives.

The EIS also describes and analyzes the potential effects of the MMS's Agency-Preferred Alternative and the Environmental Protection Agency's Agency-Preferred Alternative.

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EXECUTIVE SUMMARY

Executive Summary: Liberty Development and Production Plan, Environmental Impact Statement

In February 1998, BP Exploration (Alaska) Inc. (BPXA) submitted a Development and Production Plan (Plan) to the Minerals Management Service (MMS) for the proposed Liberty Project; a pipeline Right-of-Way application was submitted March 3, 1998. The Plan has been revised; Revision 1 was issued in November 1998 and Revision 2 in July 2000. The Plan and application initiated a Federal review process for BPXA's proposed project. The Liberty Prospect is in Federal waters of the Beaufort Sea northeast of the Prudhoe Bay oil field. This project would develop and produce oil and gas from the Liberty Prospect for transport and sale to U.S. and world markets. The MMS's Regional Supervisor for Field Operations must consider BPXA's Plan and applications. If he approves the proposed Plan and applications, he would monitor the project to ensure that activities comply with MMS regulations. No development activity can occur on the lease until the Plan is approved.

This document includes the purpose and background of the proposed action, the alternatives, the description of the affected environment, and the proposed environmental effects of the proposed action and the alternatives. The alternative analyses in the environmental impact statement (EIS) evaluate the effects of modifying five project components (island location and pipeline route, pipeline design, upper slope-protection system, gravel mine site, and pipeline burial depth). The EIS also evaluates three alternatives that could be chosen by combining project components and compares them to each other and to the BPXA Proposal.

In addition to the mitigation required by MMS in the lease and those built into the BPXA Proposal, the EIS evaluates the effectiveness of two potential mitigating measures. The EIS also evaluates potential cumulative effects resulting from the BPXA Proposal and alternatives.

A. LIBERTY PROJECT, PLAN, AND SCHEDULES

1. Environmental Impact Statement Schedule

We (MMS) determined that approving BPXA's Plan would be "a major Federal action that may significantly affect the quality of the human environment pursuant to the National Environmental Policy Act" and, therefore, we should prepare an EIS. Under this Act, the EIS evaluates reasonable alternatives, including BPXA's Proposal and a No Action Alternative, and how each alternative may affect the environment. The draft EIS was issued in January 2001, and MMS intends to issue the final EIS in early 2002. We will use information in the EIS in our Record of Decision to either approve the Plan and applications or decide on other actions. Under the Outer Continental Shelf Land Act, MMS needs to make a decision within 60 days of issuance of the final EIS. Under the National Environmental Policy Act, however, no decisions can be made until 30 days after the issuance of the final EIS. Final agency decisions would be made in early 2002. Some of the alternatives, if chosen, may result in delays in the Liberty Project of 18-24 months to collect additional engineering data and allow time for specific design and testing work. This information would be necessary for technical approval of the project but is not expected to change the environmental effects. For purposes of analysis in the EIS, we have not adjusted the timelines for starting the different alternatives. Therefore, all the alternatives are of equal rank for the analysis of environmental effects.

We have responded to comments received to the draft EIS in Section VII. Both the MMS and the U.S. Environmental Protection Agency have identified agency-preferred alternatives in Section IV.E, as required by National Environmental Policy Act Council on Environmental

Quality regulations. The U.S. Army Corps of Engineers is prohibited by their regulations from identifying an agency-preferred alternative in the EIS. However, we will continue to maintain an open mind throughout the final EIS comment period and decision processes. We will continue to consider and evaluate all comments and reasonable options.

2. The Need and Purpose for the Liberty Project

Need: To satisfy the demand for domestic oil and decrease the dependence of the United States on foreign oil imports.

Purpose: To recover oil from the Liberty Prospect and transport it to market.

This project helps satisfy the mandate of the Outer Continental Shelf Lands Act to explore for and develop offshore mineral resources by developing the oil resources of OCS Lease Y-01650 issued by the MMS in Foggy Island Bay in the Alaskan Beaufort Sea.

For purposes of analysis in this EIS, “transporting oil to market” is evaluated as delivering oil to the Trans-Alaska Pipeline System Pump Station 1. At this point, the Liberty oil would be combined with all other North Slope oil and become indistinguishable from other oil in the pipeline. In the cumulative case, the potential effects are evaluated over a much larger area.

3. Description of the Plan

The Outer Continental Shelf Lands Act requires the MMS to analyze the environmental effects of BPXA’s proposed action, as described in the Development and Production Plan (Section II.A of the EIS).

Note: We have included in the Executive Summary, several tables, and a map from the EIS. To lessen confusion, we are keeping the same table or map number used in the EIS. References to sections in the Executive Summary begin with a letter (A, B, etc.) and to sections in the EIS begin with a Roman numeral (I, II, etc.). Appendices are located in Volume IV of the EIS. Citations are found at the end of the Executive Summary.

BPXA proposes to develop the Liberty oil field from an artificial gravel island constructed on the Federal Outer Continental Shelf in Foggy Island Bay (see Map 1). The gravel island would be located in water about 22 feet deep and inside the barrier islands. The Liberty Project is about 5 miles off the coast nearly midway between Point Brower to the west and Tigvariak Island to the east. The proposed gravel island would be between the McClure Islands and the coast. The overall project includes the following:

- an artificial offshore gravel island;
- stand-alone processing facilities and associated infrastructure on the island;
- about 6.1 miles of offshore buried oil pipeline;
- about 1.5 miles of onshore elevated pipeline connecting the island facilities to the Badami pipeline;
- an onshore gravel mine site at the Kadleroshilik River used during construction and then rehabilitated; and
- onshore and offshore ice roads.

4. Development Schedule

If the project is approved, construction of the ice roads are planned to begin in November or December of 2002, which would be Year 1 of the project as described in the EIS. The planned construction process would take place over 2 years. The gravel island would be constructed in 1 year (Year 2), and the offshore pipeline would be constructed the next year (Year 3). Construction would take place during the winter, to the extent possible. If construction were delayed, all construction would take place in a single season (Year 3).

A drill rig would be barged to the island in summer of Year 2 or moved over an ice road in winter of Year 3. An infrastructure module would be sealifted to the island in July/August of Year 2. Process modules would be sealifted to the island in July/August of Year 3. Drilling would start in the first quarter of Year 3. Oil shipment (production) would start in the fourth quarter of Year 3. The economic life of the field is estimated at about 15-20 years.

B. COLLABORATION WITH OTHER AGENCIES

1. Interagency Team Meetings

The Liberty Interagency Team was created in spring 1998 to discuss a broad range of issues related to the development and content of the Liberty EIS. The Liberty Interagency Team consists of five Federal Agencies (MMS, Fish and Wildlife Service, U.S. Army Corps of Engineers, National Marine Fisheries Service, and the Environmental Protection Agency); two State of Alaska Agencies (State Pipeline Coordinator’s Office and the Division of Governmental Coordination); and the North Slope Borough. The Interagency Team met periodically during EIS preparation. Scoping and EIS alternatives were major issues of discussion for the Interagency Team.

2. EIS Partnerships

The Corps of Engineers and the Environmental Protection Agency are cooperating agencies in the preparation of this EIS. They, along with the MMS, will consider using this EIS as their National Environmental Policy Act documentation for review of the Liberty Project. Both the Corps of Engineers and the Environmental Protection Agency have attended frequent meetings with the MMS and have reviewed draft EIS text. The Corps of Engineers Preliminary Section 404(b)(1) *Evaluation - Liberty Development Project* and *Evaluation of Proposed Liberty Project Ocean Disposal Sites for Dredged Material at Foggy Island Bay* is found in Appendices G and H of the EIS. The Environmental Protection Agency's draft National Pollution Discharge Elimination System draft permit is found in Appendix I-2 of the EIS. The Fish and Wildlife Service, National Marine Fisheries Service, North Slope Borough, State Pipeline Coordinator's Office, and the State Division of Governmental Coordination entered into a participating relationship with MMS and attended meetings and exchanged information, as time permitted.

The MMS prepared Biological Assessments on the Liberty Project for both the Fish and Wildlife Service and the National Marine Fisheries Service. Those agencies prepared individual Biological Opinions on species specific to their jurisdiction regarding the Liberty Project in accordance with Section 7 Endangered Species Act consultation procedures. See Appendix C for the full text of both biological opinions. The Fish and Wildlife Service and the Biological Resources Division of the U.S. Geological Survey each prepared an analysis that is found in Appendix J of the EIS. The Fish and Wildlife Service prepared the report *Exposure of Birds to Potential Oil Spills at the Liberty Project,* and the Biological Resources Division evaluated potential effects to polar bears in their report *Estimating Potential Effects of Hypothetical Oil-Spills from the Liberty Oil Production Island on Polar Bears*.

The National Marine Fisheries Service and Fish and Wildlife Service are responsible for the authorization of certain small takes under Section 101(a)(5) of the Marine Mammal Protection Act and/or the issuance of Incidental Take Statements for the taking of threatened or endangered species. The EIS describes the type and extent of such takings.

C. ISSUES

1. Scoping

"Scoping" is an ongoing public process to determine the public concerns about BPXA's proposed plan and to identify issues to be analyzed in depth in the EIS. Scoping also is used to develop alternatives to BPXA's Plan and mitigating measures that could eliminate or reduce potential development impacts. Alternatives could include technological modifications to the Plan or different drilling locations or pipeline routes. The scoping process includes an evaluation of the issues, alternatives, and mitigating measures that will be addressed further in the EIS and those that will not.

As part of the scoping process, we received comments in response to our Notice of Intent to Prepare an EIS in the *Federal Register* Notice of February 23, 1998, and from public meetings and the Liberty Interagency Team. We received seven comment letters in response to the Notice. Scoping meetings were held during March and April 1998 in Nuiqsut, Barrow, Anchorage, Kaktovik, and Fairbanks. Additional scoping comments were provided as part of the information update meetings in these communities in October and November 1999.

During scoping meetings, attendees expressed concerns about the effects of development on the physical and biological resources in and adjacent to the Liberty Prospect and on the Inupiat inhabitants of Alaska's North Slope. These concerns, characterized as issues, are associated with planned activities or accidental events that are or may be part of the construction and operation of oil and gas facilities.

The planned activities would alter the local environment. These disturbances, often in the form of noise, may last only a few years; however, physical changes to the environment, such as construction of the gravel island, may last 15-20 years or more. Short-term disturbances include noise from aircraft overflights or marine transport of facilities and supplies. Disturbances also may last up to several months; these include noise and physical changes to the environment associated with mining and hauling gravel for island construction, changes to seafloor sediments, and suspension of sediments that result from trenching for the pipeline.

Accidental events include crude oil spills that happen during production, transportation through the pipelines, or from diesel fuel used to power electrical generators if natural gas, produced from the Liberty reservoir, is not available.

The issues primarily express concerns about the effects of disturbances and large offshore oil spills on the environment. These effects are analyzed in the EIS for the following essential resources and systems:

- endangered and threatened species (bowhead whales and spectacled and Steller's eiders)
- seals
- walruses
- beluga whales
- polar bears
- marine and coastal birds
- terrestrial mammals

- fishes and essential fish habitat
- lower trophic-level organisms
- vegetation-wetland habitats
- subsistence harvests
- sociocultural systems
- archaeological resources
- economy
- water quality
- air quality
- environmental justice

Associated with disturbance and oil-spill issues are concerns that include:

- chance of damage to the island and production facilities from storm waves, currents, and ice forces
- chance of damage to the offshore pipeline from ice gouging, strudel scouring, and permafrost melting
- leak detection for the buried pipeline
- offshore pipeline design and the chance of failure and leaks
- height of onshore pipeline
- erosion in the area where the pipeline crosses the shoreline
- oil-spill-response and cleanup capability, especially in broken ice
- waste disposal
- discharges of production fluids
- air emissions
- abandonment
- population growth and balance between modern lifestyles and the lifestyle of the Inupiat people
- timing and size of the prospective workforce and how it would affect community economies
- use of gravel bags to prevent gravel erosion of the island
- disregard for local traditional knowledge in making decisions
- use of Tern Island as either a drilling site or a source of gravel
- locating the Liberty drilling and production facility either onshore or in waters no deeper than 6 feet
- global climate change
- alternative energy sources

The issues raised during scoping also are used to develop alternatives and mitigating measures for this EIS.

2. Traditional Knowledge

We include in the EIS analysis what local indigenous people on the North Slope say and have said about development on the outer continental shelf. We developed a protocol to extract, from past testimony and community meetings, traditional knowledge that relates to oil and gas activities in the Alaskan Beaufort Sea. Various sources of traditional knowledge (TK) were queried to provide this information. Sections III.C.3.h and i (Subsistence-Harvest Patterns and Sociocultural Systems) in the EIS illustrate how traditional knowledge was incorporated into the EIS and into the design, construction, and planned operations of the proposed project to minimize potential conflicts with subsistence users.

This information endeavors to capture the traditional Inupiat perspective about the potential effects of the Liberty Project and other oil and gas development activities on the North Slope. In some instances, the words of individual speakers are incorporated and cited. In other cases, when several people shared an observation or concern, it is paraphrased in a single statement and cited.

The TK-gathering efforts undertaken specifically for the Liberty Project include: (1) meeting minutes from the 1999 community meetings conducted under the auspices of Environmental Justice (see the following and Appendix E of the EIS); (2) use of an interim portion of the Inupiat TK collection study by the Barrow nonprofit Ukpeagvik Inupiat Corporation; (3) the *Arctic Nearshore Impact Monitoring in Development Area* study that includes a task for gathering subsistence whaling TK from Nuiqsut whalers; and (4) an in-depth assessment and use by MMS analysts of existing TK sources. These sources include TK citations for the Northstar final EIS; the TK database developed by Dames and Moore for the Northstar Project from MMS hearing transcripts; Native interviews from the North Slope Borough's *Mid-Beaufort Sea Traditional Resource Survey*; TK from the document *Cross Island: Inupiat Cultural Continuum*; and TK gleaned from the North Slope Borough's *Subsistence Harvest Documentation Project Data for Nuiqsut, Alaska* (North Slope Borough, 1997a).

3. Environmental Justice, Indian Trust Resources, and Government-to-Government Coordination

Executive Order 12898, Environmental Justice, requires that Federal Agencies identify and address disproportionately high and adverse human health and environmental effects of its actions on minority and low income populations.

To meet the direction of this Order (*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*) and the accompanying memorandum from President Clinton to the heads of all departments and agencies, the MMS held Environmental Justice Meetings in Barrow, Nuiqsut, and Kaktovik. An analysis of Environmental Justice is found in Section III.D.12 of the EIS. The MMS met with local tribal governments to discuss subsistence issues and the Liberty Project during scoping meetings in the community of Nuiqsut on March 18, 1998; in the community of Barrow on March 19, 1998; and in the community of Kaktovik on

March 31, 1998. In these first meetings, the MMS established a dialogue on environmental justice with these communities. Followup meetings to address environmental justice issues were held in Barrow on November 1, 1999; in Nuiqsut on November 2, 1999; and in Kaktovik on November 5, 1999.

The environmental justice concerns raised during scoping and from the Environmental Justice meetings are covered in the EIS in the sections on Subsistence-Harvest Patterns, Sociocultural Systems, and marine mammals (see Section III.C.3 of the EIS). The analyses in these sections incorporate TK of the Inupiat people of the North Slope communities of Barrow, Nuiqsut, and Kaktovik, along with Western scientific knowledge. For a discussion of Environmental Justice, see Section III.D.12.

The Department of the Interior and the MMS are responsible for ensuring that Indian Trust Resources of federally recognized Indian Tribes and their members that may be affected by these project activities are identified, cared for, and protected (Appendix B, Part D of the EIS). No significant impacts were identified during the EIS scoping process, including the Environmental Justice meetings, that pertain to this topic. Native allotments in the project are discussed in Section III.C.3.i of the EIS.

Executive Order 13175 (*Consultation and Coordination with Indian Tribal Governments*) states that the U.S. Government will "establish regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indians" and Alaskan Natives. To meet that direction, MMS has met with the local tribal governments of Barrow, Nuiqsut, and Kaktovik; the Inupiat Community of the Arctic Slope (the recognized regional tribal government); and an important nongovernmental Native organization, the Alaska Eskimo Whaling Commission. Notes from the 1999 meetings are included in Appendix E of the EIS. These tribal governments were contacted by letter and given the opportunity to participate in the development of this EIS. None of the letters sent received a response; nonetheless, in Liberty meetings held on the North Slope, we have met with these groups to keep them informed of this Proposal and will continue to do so. Local Inupiat government representatives are members of our Outer Continental Shelf Lease Sale Advisory Committee that meets to discuss and resolve issues that arise from recent lease sales.

4. Major Issues

Based on scoping concerns, the MMS has determined that the major issues are:

- disturbances from planned project activities;
- oil spills from accidental events; and
- cumulative effects of past, present, and future development on the people and environment of Alaska's North Slope.

Generally, the above issues are analyzed more fully than other concerns that include:

- discharges (water discharges and air emissions)
- gravel mining
- small oil spills
- seawater intake
- economic effects
- abandonment of the project
- global climate change
- alternative energy sources

Air pollution also is an important issue for North Slope inhabitants. The effects of emissions from burning fossil fuels during Liberty drilling and production operations are analyzed in detail in the discussion of discharges under the heading of Other Issues.

These issues served as the basis for the development of alternatives and were used to configure the analysis in the alternatives as well as the analysis of the proposed Development and Production Plan. The major issues/perturbations mentioned in the following apply to each analyzed alternative as well as the proposed Development and Production Plan.

a. Disturbances

The Liberty Project involves constructing a gravel island about 5 miles offshore, using gravel hauled by truck over ice roads to a prepared subsea pad, and construction of a pipeline from the island to an existing onshore pipeline. The island and pipelines would be constructed mainly in winter, and most potential disturbance from construction would occur in that season. Construction of the subsea pipeline trench and the onshore pipeline would permanently disturb habitats. The following are examples of disturbances:

- sediment and turbidity from the dumping of gravel during construction of the proposed island and from the pipeline trenching and backfilling activities;
- noise from construction and drilling activities; and
- noise from the transportation of people and materials to and from the gravel island.

Helicopters, supply boats, and some barges would provide transport over water. Long-term disturbances would include noise from various kinds of transportation and any other drilling that might occur over the operational life of the field.

Releases of particulate matter and attendant turbidity in the water may come from remnant fill from the pipeline trench, particulate leaching from the island, and final island preparation (reshaping). When refilling pipeline trenches, the excess fill not deposited back into the trench would be placed on the ice parallel to the pipeline and would filter into the Beaufort Sea as breakup progresses. Particulate matter would leach from the island after initial construction and before the placement of filter fabrics and cement blocks; some island reshaping may be necessary, but this would be a short-term action.

The project descriptions in Section II.A.1 of the EIS more thoroughly discuss Liberty development and potential sources of noise and habitat disturbance. The types and levels of activities associated with development are summarized in Table II.A-1.

b. Large Offshore Oil Spills

The potential effects of oil spills were a major concern raised during scoping. For purposes of analysis, we divide oil spills into three classes, small, large and very large. We define large oil spills as greater than or equal to 500 barrels, and small spills as less than 500 barrels. We define very large oil spills as greater than or equal to 150,000 barrels. See Sections IX.A and B in the EIS for an analysis of a very large oil spill.

BPXA's revised Oil Discharge Prevention and Contingency Plan prohibits the drilling of new wells or sidetracks from existing wells into major liquid hydrocarbon zones at its drill sites during the defined period of broken ice and open water (BPXA, 2001:Section 2.1.7). This period begins on June 13 of each year and ends with the presence of 18 inches of continuous ice cover for one-half mile in all directions from Liberty Island. The drilling moratorium eliminates the environmental effects associated with a well blowout during drilling operations in the Beaufort Sea during broken-ice or open-water conditions.

(1) Spill Assumptions and Sizes

The assumptions about large oil spills are a mixture of project-specific information, modeling results, statistical analysis, and professional judgement. We evaluate the chance of a large oil spill occurring and, for purposes of analysis, we assume that one large spill occurs from the proposed or alternative Liberty gravel island location or along the proposed or alternative offshore/onshore pipeline route. Although the chance of one or more large spills occurring and entering offshore waters is low (on the order of 1% over the life of the field), we analyze the consequences of an oil spill because it is a significant concern to all stakeholders. The MMS uses the term low to characterize the relative chance of a large spill occurring; it is based on our familiarity with oil-spill rates and sizes. We recognize that multiple stakeholders have different interests and different analytical perspectives that shape the way they think about spill occurrence and how they identify a preferred policy response. For some stakeholders, a 1% chance of a large spill over the life of the field may be high. For purposes of analysis, we use the term low to mean on the order of 1% over the life of the field.

The chance of an oil spill occurring and entering the waters of Foggy Island Bay is estimated for the estimated 15-20-year life of the field. The analysis of a large spill represents the range of effects that might occur from a range of offshore or onshore spill sizes at Liberty facilities. Table III.C-4 shows the large spill sizes we assume for analysis. These hypothetical spills range from 715-2,956 barrels for crude and diesel oil. The spills are broken out as follows:

Crude Oil

- gravel island: 925 barrels
- offshore pipeline: 715, 1,580, and 2,956 barrels
- onshore pipeline: 720 and 1,142 barrels

Diesel

- storage tank: 1,283 barrels

A large spill from the Liberty facilities could happen at any time of the year. We assume that the island would not absorb any oil. Depending on the time of year, we assume that a spill reaches the following environments:

- gravel island and then the water or ice
- open water
- broken ice
- on top of or under solid ice
- shoreline
- tundra or snow

(2) Oil-Spill-Trajectory Analysis

We analyze spills from nine locations. We use the location of the Liberty, Southern, and Tern gravel islands as the sites where large oil spills would originate, if they were to occur from an island. (Liberty Island is the site proposed by BPXA. Southern and Tern Islands are alternative sites selected by MMS for the EIS analysis.) We also use the Liberty, Tern, and eastern pipeline sites, with each pipeline divided into two segments. The two pipeline segments represent spills that would occur nearshore and offshore. (Similarly, the Liberty pipeline route was proposed by BPXA and the Tern and eastern routes were selected for analysis as EIS alternatives.)

In general, there is a 0-2% difference in the chance of oil-spill contact with the majority of the environmental resource areas and land segments, when we compare Liberty Island, Southern Island, and Tern Island to each other. Each of these islands is within 1.2-1.4 miles of each other, and no geographic barriers to spills exist between these island locations. There is a 3-12% difference in the chance of contact with resources directly adjacent to the area where we hypothesize a spill would start. For example, the largest difference (12%) is to the Boulder Patch, because Liberty Island is directly adjacent to it, and Southern Island and Tern islands are slightly farther away. Changing the location of the island would cause an insignificant change in the chance of oil-spill contact to the majority of the environmental resource areas.

The reader should note, however, that the closer the island is located to shore, the greater the chance of oil contacting the nearby coastline. The coastline between the Sagavanirktok and Kadleroshilik rivers has a 3-4% difference in the chance of contact from Southern Island or Tern Island when we compare them to Liberty Island. While these differences are measurable, they do not result in effects to the resources that are substantial.

(3) The Chance of a Large Spill Occurring

The analysis of historical oil-spill rates and failure rates and their application to the Liberty Project provides insights, but not definitive answers, about whether oil may be spilled from a site-specific project. Engineering risk abatement and careful professional judgment are key factors in confirming whether a project would be safe.

We conclude that the designs for the Liberty Project would produce minimal chance of a significant oil spill reaching the water. If an estimate of chance must be given for the offshore production island and the buried pipeline, our best professional judgment is that the chance of an oil spill greater than or equal to 500 barrels occurring from the Liberty Project and entering the offshore waters is on the order of 1% over the life of the field. We use the volume of oil produced and pipeline mile-year as the basis for estimating the chance of oil spills occurring. Therefore, the chance of an oil spill essentially is the same for all alternatives evaluated in this EIS.

We base our conclusion on the results gathered from several spill analyses done for Liberty that applied trend analysis and looked at causal factors. All showed a low likelihood of a spill, on the order of a 1-6% chance or less over the estimated 15-20-year life of the field. In addition to the chance of a spill occurring based on historical spill rates, we also base our conclusion on the engineering design factors that BPXA has included in the project, especially for the buried pipeline. The combination of pollution-prevention measures, design, testing, quality assurance, and proactive monitoring lead us to conclude that the proposed and alternative pipelines would be safe.

(4) Assumptions for Analysis of Effects

We base the analysis of effects on the following assumptions:

- One large spill occurs.
- The spill size is one of the sizes shown in Table III.C-4.
- All the oil reaches the environment; the island absorbs no oil.
- The spill starts at the gravel island or along the pipeline.
- The spill could occur at any time of the year.
- A spill under ice does not move significantly until the ice breaks up (Appendix A.2).
- The spill area varies over time and is calculated from Ford (1985).
- The time and chance of contact from an oil spill are calculated from an oil-spill-trajectory model.
- Effects are analyzed for the location where the chance of contact is highest.

The analysis in Section III.C.2 first considers context and intensity effects of an oil spill to the resources and then considers whether the effects would be local or regional. The analysis next evaluates the adverse effects resulting from the oil-spill-cleanup efforts on the resource (noise, disturbance, etc.) and provides an assessment of the mitigation benefits that might occur. However, the effectiveness of oil-spill recovery and cleanup is uncertain and depends on weather conditions, wind and wave conditions, and other variables at the time of the spill. Oil-spill recovery can range from very little to almost all of the oil.

(5) Description of Leak-Detection Systems

The BPXA Proposal includes the use of either the “Leak-Detection and Location System” (LEOS) for detecting any leaks from the pipeline or the use of an equivalent system. Siemens developed LEOS about 30 years ago. The LEOS system detects leaks by means of a low-density polyethylene tube, which is highly permeable to oil and gas molecules. The tube is pressure tight and contains air at atmospheric pressure when installed. In the event of an oil leak, some of the leaking oil diffuses into the tube due to the concentration gradient. The air in the tube is tested every day when a pump at the island pulls the air at a constant speed through the tube into a detector unit. The detector unit is equipped with semiconductor gas sensors that can detect very small amounts of hydrocarbons. An electrolytic cell onshore injects a specific amount of hydrogen gas into the tube just before each daily test. This gas is transported through the tube at each test and generates a “marking peak” that not only notes the test is complete but helps to verify that the equipment is functioning and properly calibrated. The LEOS system can detect a leak, when the total volume of the leak reaches 0.3 barrel, within 24 hours. Because the air moves through the tube at a specific rate, this system can accurately determine within meters the location of a pipeline leak. Should a leak be detected, an alarm sounds.

This system has been installed in underground pipelines and in aquatic environments, mostly in Europe. Recently, LEOS was successfully installed as part of the Northstar development. During testing in September 2000, it pinpointed hydrogen gas coming from the pipeline anodes (Franklin, 2000, pers. commun.). In Europe, the LEOS system has detected two hydrocarbon leaks in the soils saturated with water. The sizes of both leaks were below the detection threshold by conventional leak-detection systems (INTEC, 1999b). While the LEOS system is operating to specifications for the Northstar Project, its long-term effectiveness in the arctic undersea has not been demonstrated.

The BPXA Proposal also includes the combination of a pressure-point analysis and mass-balance line-pack compensation leak detection systems, which currently is the best available technology. Operating experience demonstrates the combination of pressure-point analysis and mass-balance line-pack compensation systems will achieve a minimum leak-detection threshold of 1% based on the daily rate for a large leak. If the these systems are operating ideally (according to the vendors), the performance of the systems could approach 0.15% under steady-state-flow conditions. Additionally, the leak-detection threshold of approximately 1 barrel of oil within a 24-hour period that would be provided by the LEOS system means that the threshold for this system could approach 0.3 barrels in a 24-hour period If an actual leak were detected by any of these three systems, the pipeline would be shut down.

c. Cumulative Effects of Past, Present, and Future Development

Oil and gas activities considered in the analysis include past development and production, present development, reasonably foreseeable future development, and speculative development. Some activities beyond the 20-year life of the Liberty Project are considered too speculative to include at this time, while other similar activities are included in this analysis. Furthermore, we exclude future actions from the cumulative-effects analysis, if those actions are outside the geographic boundaries or timeframes established for the cumulative-effects analysis. For additional information and background concerning the cumulative analysis, please see Section V.B. We address uncertainty through monitoring, and note that monitoring is the last step in determining the cumulative effects that ultimately might result from an action.

To keep the cumulative-effects analysis useful, manageable, and concentrated on the effects that are meaningful, we weigh more heavily other activities that are more certain and geographically close to Liberty, and we analyze more intensively effects that are of greatest concern. This would include activities in the Beaufort Sea and on the North Slope. To be consistent with the MMS 5-Year OCS Oil and Gas Program, the Liberty cumulative analysis also evaluates effects from transporting oil through the Trans-Alaska Pipeline System and tankering from Valdez to ports on the U.S. west coast.

Activities other than those associated with oil and gas also are considered. These include the sport harvest of wildlife, commercial fishing, subsistence hunting, and loss of overwintering range for certain wildlife species. More details on the cumulative-effects analysis are presented at the end of the Executive Summary.

5. Other Issues

a. Discharges (Water Discharges and Air Emissions)

The majority of wastes generated during construction and developmental drilling would consist of drill cuttings and spent muds. Some waste also would be generated during operations from well-workover rigs. Drilling fluids would be disposed of through onsite injection into a permitted disposal well or would be transported offsite to permitted disposal locations. In addition, domestic wastewater, solid waste, and produced waters would be generated during the project and injected into the disposal well. Solid wastes, including scrap metal, would be hauled offsite for disposal at an approved facility.

In case the disposal well cannot be used, BPXA has applied for a National Pollution Discharge Elimination System permit authorizing marine discharges of treated sanitary and domestic wastewater from the seawater-treatment plant, the desalination-unit filter backwash, construction dewatering, and fire-control test water.

Chronic discharges of contaminants would occur during every breakup from fluids entrained in the ice roads. Entrained contaminants from vehicle exhaust, grease, antifreeze, oil, and other vehicle-related fluids would pass into the Beaufort Sea system at each breakup. These discharges are not expected to be major; however, they would exist over the life of the field.

Sources of potential air emissions would be oil or gas turbine electric generators; heavy construction equipment; tugboats and support vessels; and drill-rig-support equipment, including boilers and heaters. The use of best available control technology and compliance with the Environmental Protection Agency’s emission standards would be required. Water discharge and air emission considerations would apply to all alternatives.

b. Gravel Mining

BPXA would need about 990,000 cubic yards of gravel to construct the following elements of the Liberty Project:

- the drilling and production island and, if needed, potential relief-well island(s);
- pads for pipeline landfall;
- backfill for parts of the pipeline trench; and
- a pad for the tie in with the Badami pipeline.

BPXA has proposed mining a new site in the winter, approximately 53 acres on a partially vegetated island in the Kadleroshilik River floodplain, located about 1.4 miles upstream from the Beaufort Sea. Mining activities are planned to occur in two phases and would occur on about

31.5 acres; about 24 acres of wetlands would be lost or disturbed by the mining activities (see Table III.D-6). A reserve area, covering about 22.5 acres (about 17 acres of wetland area), would be used if additional gravel were needed. Gravel required for alternative island locations and pipeline routes would range from 792,000 cubic yards to 877,300 cubic yards. The alternative island design (Use Steel Sheetpile) would require about 50,000 additional cubic yards of gravel.

c. Small Oil Spills from Liberty Facilities

We analyze the consequences of small spills of crude and refined oil (for the proposed Development and Production Plan and all alternatives) to address concerns about chronic effects from numerous small spills. For purposes of analysis, we assume the following spill sizes:

Offshore or onshore crude oil:
17 spills less than 1 barrel and
6 spills greater than or equal to 1 barrel and less than 25 barrels.
Onshore or offshore refined oil:
53 spills of 0.7 barrels (29 gallons).

We assume the following:

- Offshore crude spills can begin anywhere on the Liberty gravel island or along the offshore pipeline.
- Small spills on the Liberty gravel island are kept within containment or cleaned up and do not reach the water.
- Onshore crude spills can begin anywhere along the onshore pipeline.
- Onshore or offshore refined oil spills can occur along the ice road, from barges, from helicopters, from the gravel island, or from trucks along the road system.
- Most of these spills are contained or cleaned up.

Typical refined products that spill on the Alaskan North Slope are aviation fuel, diesel fuel, engine lube oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. Diesel spills on the Alaskan North Slope are 61% of refined oil spills by frequency and 75% by volume.

d. Seawater Intake

BPXA plans to locate a vertical intake pipe for a seawater-treatment plant on the south side of Liberty Island. The pipe would have an opening 8 feet by 5.67 feet and would be located approximately 7.5 feet below the mean low-water level. Recirculation pipes located just inside the opening would help keep large fish, other animals, and debris out of the intake. Two vertically parallel screens (6 inches apart) would be located in the intake pipe above the intake opening. They would have a mesh size of 1 inch by 1/4 inch. Maximum water velocity would be 0.29 feet per second at the first screen and 0.33 feet per second at the second screen. These velocities typically would occur only for a few hours each week while testing the fire-control water system. At other times, the velocities would be considerably lower. Periodically, the screens would be removed, cleaned, and replaced. The seawater intake system would be part of all alternatives.

e. Economic Effects

Employment, wages, royalties, and income to Federal, State, and local governments were noted as issues during scoping.

Local hire likewise was identified as an issue. This section evaluates the economic impacts of the project for those issues. Economic-effects considerations apply to all alternatives.

f. Abandonment of the Project

In Section III.D.6 of the EIS, we evaluate the effects of general actions (removal of all gravel bags used for upper island slope protection, all facilities on the island, etc.) that would occur at abandonment. However, exact abandonment procedures of the Liberty Project would be developed before the end of the project's life. A goal for restoration of any project is to restore the affected environment to its original condition. In our effort to achieve that goal, we do not want to cause unnecessary environmental effects. At the time of abandonment, we likely would have new technologies, and we expect to have additional environmental information concerning the area and its resources. We want to evaluate both the new technologies and the additional environmental data in the abandonment plan. Therefore, we do not evaluate all the specific items of abandonment at this time. Those specific items would be evaluated in an environmental assessment on the abandonment plan that would be required at the end of the project. All environmental regulations in place at that time would be enforced. The MMS, Corps of Engineers, and applicable State agencies would review BPXA's abandonment plan and decide what actions are appropriate at the end of the project. Abandonment considerations apply to all alternatives.

g. Global Climate Change and Alternative Energy Sources

Global climate change and alternative energy sources are addressed in the MMS 1997-2002 Outer Continental Shelf Oil and Gas Leasing Program (USDOI, MMS, Herndon, 1996a) and are incorporated here by reference. In addition, the Council on Environmental Quality, in its *Draft Guidance Regarding Consideration of Global Climate*

Change in Environmental Documents Prepared Pursuant to the National Environmental Policy Act, October 8, 1997, recommends addressing this issue at the program level rather than at the project level.

h. Environmental Justice

Alaska Inupiat Natives, a recognized minority, are the predominant residents of the North Slope Borough, the area potentially most affected by Liberty development. Effects on Inupiat Natives could occur because of their reliance on subsistence foods, and Liberty development may affect subsistence resources and harvest practices. The Inupiat community of Nuiqsut, and possibly Kaktovik, within the North Slope Borough, could experience potential effects. In the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. However, effects are not expected from routine activities and operations. When we consider the little effect from routine activities and the low likelihood of a large spill event, disproportionately high adverse effects would not be expected on Alaskan Natives from Liberty development under the Proposal. Any potential effects to subsistence resources and subsistence harvests are expected to be mitigated substantially, though not eliminated.

6. Alternatives to the Proposed Plan

Through the planning and scoping process, five sets of component alternatives were developed from the issues and concerns noted in A.4 above (See Table I-1). They were configured around major project components: Drilling and Production Island Location and Pipeline Route; Pipeline Design; Upper Island Slope-Protection System; Gravel Mine Site; and Pipeline Burial Depth. The component alternatives (which include the BPXA-proposed project component) are described and analyzed further in Section E.3.a of the Executive Summary.

Combination Alternatives are the second grouping of alternatives developed in the EIS. They build on the analysis of effects identified by each component alternative and provide decisionmakers and readers with the range of possible effects that may result from selecting and combining different project component alternatives. The Interagency Team developed three combination alternatives that are compared to each other and to the BPXA Proposal (see Table I-1 and Section E.3.c of the Executive Summary).

The last alternative described and evaluated in the EIS is the MMS Agency-Preferred Alternative. It is described and evaluated in Section E.3.d.

7. Significance Thresholds

Our EIS impact analysis addresses the significance of the impacts on the resources and systems listed in Section D.1 of the Executive Summary. It considers such factors as the nature of the impact (for example, habitat disturbance or mortality); the spatial extent (local or regional effect); the temporal effect and recovery times (years, generations); and the effects of mitigation (for example, implementation of the oil-spill-response plan).

The Council on Environmental Quality National Environmental Policy Act regulations (40 CFR 1508.27) defines the term “significantly” in terms of both context and intensity. “Context” considers the setting of the Proposed Action, what the affected resource may be, and whether the effect on this resource would be local or more regional in extent. “Intensity” considers the severity of the impact, taking into account such factors as whether the impact is beneficial or adverse; the uniqueness of the resource (for example, threatened or endangered species); the cumulative aspects of the impact; and whether Federal, State, or local laws may be violated. The analysis in this document uses terminology that is consistent with that definition. Impacts may be beneficial or adverse. Impacts are described in terms of frequency, duration, general scope and/or size and intensity. The analysis in this EIS also considers whether the mitigation that is proposed as part of the project can reduce or eliminate all or part of the potential adverse effects.

For the EIS, we have defined a “significance threshold” for each resource as the level of effect that equals or exceeds the adverse changes indicated in the following impact situations:

- **Threatened and Endangered Species** (bowhead whale, spectacled and Steller’s eiders): An adverse impact that results in a decline in abundance and/or change in distribution requiring one or more generations for the indicated population to recover to its former status.
- **Other Biological Resources** (seals, walruses, beluga whales, polar bears, marine and coastal birds, terrestrial mammals, lower trophic-level organisms, fishes, and vegetation-wetland habitats): An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations (one or more generations for polar bears) for the indicated population to recover to its former status.
- **Subsistence-Harvest Patterns:** One or more important subsistence resources would become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1-2 years.
- **Sociocultural Systems:** Chronic disruption of sociocultural systems occurs for a period of 2-5 years, with a tendency toward the displacement of existing social patterns.

- **Archaeological Resources:** An interaction between an archaeological site and an effect-producing factor occurs and results in the loss of unique, archaeological information.
- **Economy:** Economic effects that will cause important and sweeping changes in the economic well-being of the residents or the area or region. Local employment is increased by 20% or more for at least 5 years.
- **Water Quality:** A regulated contaminant is discharged into the water column, and the resulting concentration outside a specified mixing zone is above the acute (toxic) State standard or Environmental Protection Agency criterion more than once in a 1-year period and averages more than the chronic State Standard or Environmental Protection Agency criterion for a month. Turbidity exceeds 7,500 parts per million suspended solid concentration outside the mixing zone specified for regulated discharges more than once in a 3-year period and averages more than chronic State standards or Environmental Protection Agency criteria for a month. The accidental discharge of crude or refined oil in which the total aqueous hydrocarbons in the water column exceeds 1,500 micrograms per liter (1.5 parts per million)—the assumed acute (toxic) criteria—for more than one day and 15 micrograms per liter (0.015 parts per million)—the assumed chronic criteria and the State of Alaska ambient-water-quality standard—for more than 5 days.

  Violating the effluent limits of the National Pollution Discharge Elimination System Permit (Appendix I-2) might cause an adverse effect and could result in an enforcement action by the Environmental Protection Agency. Violations would be caused by exceeding an effluent limit or creating an oil sheen. The accidental discharge of a small volume of crude or refined oil also might cause an adverse impact and could result in concentrations of hydrocarbons that are greater than the acute criteria in a local area (less than 1 square mile) for less than a day and concentration that are greater than the chronic criteria in a larger area (less than 100 square miles) for less than 5 days. However, an action of violation or accidental discharge of a small volume of crude or refined oil would not necessarily constitute a significant environmental impact as defined in 40 CFR 1508.27.
- **Air Quality:** Emissions cause a regional increase in pollutants that exceeds half the increase permitted under the Prevention of Significant Deterioration criteria or the National Ambient Air Quality Standards for nitrogen dioxide, sulfur dioxide, particulate matter less than 10 microns in diameter; exceeds half the increase permitted under the National Ambient Air Quality Standards for carbon monoxide or ozone; causes readily identifiable adverse long-term effects on human health or vegetation; or causes a significant decrease in onshore visibility, as determined by the Environmental Protection Agency's visibility analysis guidelines.
- **Environmental Justice**: The significance threshold for environmental justice would be disproportionate, high adverse human health and environmental effects on minority and low income populations. This threshold would be reached if one or more important subsistence resources becomes unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1-2 years, or chronic disruption of sociocultural systems occurs for a period of 2-5 years, with a tendency toward the displacement of existing social patterns.

D. EFFECTS SUMMARIES

These summaries are divided into two types of effects, if the Proposal or an alternative is approved:

- those from routine operations, such as noise and disturbance from island and pipeline construction; and
- those that might occur from accidental events, such as oil spills.

In both instances, most of the effects would be minor, localized, and short term. Some of the effects would be more serious, but the resources are expected to recover. Recovery of a few resources might occur very slowly; therefore, the effects would be classified as significant as defined by Council on Environmental Quality National Environmental Policy Act Regulations.

For this EIS, we identify as "significant" those impacts where the effects exceed the significance threshold defined above. All other impacts are, therefore, insignificant; that is, they fail to exceed the threshold. We found that repeatedly including the statement of "insignificant" effects for each resource to be very distracting and unnecessarily redundant. We hope the limited use of the terms "significant" and "insignificant" help the reader to focus on those effects we found to exceed the "significant" threshold. Significant resource thresholds are identified in Section III.A.1.a of the EIS and Section C.7 of the Executive Summary.

Overview of Impacts: We do not expect significant impacts to result from any of the planned activities such as discharges and disturbances associated with Alternative I (Liberty Development and Production Plan) or any of the other alternatives. Some significant impacts—adverse effects to spectacled eiders, king and common eiders, long-tailed ducks, subsistence-harvest patterns, sociocultural systems, and local water quality—could occur in the unlikely event of a large oil spill. However, the very low chance of such an event occurring (a less than 1% chance over the life of the field of oil entering the environment), combined with the seasonal nature of the resources inhabiting the area (for example, eiders are present in the

Liberty area 1-4 months of the year), make it highly unlikely that an oil spill would occur and contact the resources. A resource may be present in the area but may not necessarily be contacted by the oil. Furthermore, Alternative I and the other alternatives include mitigation such as extra-thick-walled pipelines, pipeline burial depths more than twice the maximum 100-year ice-gouging event, and advanced leak-detection systems (LEOS). Together, they reduce the likelihood of an oil spill and can detect very small volumes of oil and limit the size of potential chronic leaks to about 100 barrels of oil.

Alternative II (No Action) would eliminate all potential impacts, including significant impacts, from the proposed action. However, the contribution of this project to the cumulative impacts are small, and elimination of the No Action Alternative would not change any of the significant cumulative impacts discussed.

None of the component or combination alternatives evaluated in Section IV of this EIS are expected to generate significant impacts from planned activities. If an unlikely oil spill occurred, similar significant effects could occur to spectacled eiders, king and common eiders, long-tailed ducks, subsistence harvests, sociocultural systems, and local water quality for all alternatives.

The MMS does not expect any significant cumulative impacts to result from any of the planned activities associated with the exploration and development of the North Slope and Beaufort Sea oil and gas fields. In the unlikely event of a large offshore oil spill, some significant cumulative impacts could occur, such as adverse effects to spectacled eiders, long-tailed ducks, king eiders, common eiders, subsistence resources, sociocultural systems, and local water quality. However, the chance of such an event, combined with the seasonal nature of the resources inhabiting the area, make it highly unlikely that an oil spill would occur and contact these resources. The potential for adverse effects to some key resources (bowhead whales, subsistence, the Boulder Patch, polar bears, and caribou) is of primary concern and warrants continued close attention. Effective mitigation practices (winter construction, an advanced leak-detection system, thick-walled pipeline designs, etc.) also should be considered in future projects.

While the potential mitigating measures evaluated in this EIS may lower the potential effects of this or other potential oil and gas projects, none of them would lower the above cumulative effects below the significant threshold.

General Conclusions: The MMS found the following general conclusions were applicable and informative:

- The incremental contribution of the Liberty Project to cumulative effects is likely to be quite small. Construction and operations related to the Liberty Project would be confined to a relatively small geographic area, and oil output would be a small percentage (approximately 1%) of the total estimated North Slope/Beaufort Sea production.
- The Liberty Project would contribute a small percentage risk (about 4%) to resources in State and Federal waters in the Beaufort Sea from potential large offshore oil spills.

The effects to Environmental Justice essentially are the same for all alternatives. Although the likelihood of a large oil spill is low for all alternatives, an oil spill could affect subsistence resources. Potential effects would be experienced by the Inupiat community of Nuiqsut, and possibly of Kaktovik, within the North Slope Borough. In the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. However, effects are not expected from routine activities and operations. When we consider the little effect from routine activities and the low likelihood of a large spill event, disproportionately high adverse effects would not be expected on Alaskan Natives from Liberty development under any of the alternatives (see Section III.D.12). Any potential effects to subsistence resources and subsistence harvests are expected to be mitigated substantially, though not eliminated.

1. Effects Summary from Construction and Routine Operations from the BPXA Proposal

These are effects from construction and operations of the Liberty Project.

a. Bowhead Whales

Noise sources associated with the Liberty Project that may affect endangered bowhead whales are drilling and other noise associated with production operations, vessel traffic, aircraft traffic, construction, and oil-spill cleanup. Underwater industrial noise from these sources, including drilling noise measured from artificial gravel islands, has not been audible in the water more than a few kilometers away. Because the main bowhead whale migration corridor is 10 kilometers or more seaward of the barrier islands, drilling and production noise from Liberty Island is not likely to reach many migrating whales, based on existing studies. Noise also is unlikely to affect the few whales that may be in lagoon entrances or inside the barrier islands due to the rapid attenuation of industrial sounds in a shallow water environment. Subsistence whalers have stated that noise from some drilling activities in the whale migration corridor displaces whales farther offshore away from their traditional hunting areas.

Marine-vessel traffic outside the barrier islands probably would include only seagoing barges transporting modules and other equipment and supplies from Southcentral Alaska to the Liberty location, most likely between mid-August and mid- to late September in Year 2 and Year 3. Barge traffic continuing into September could disturb some bowheads. Whales are likely to avoid being within 1-4 kilometers of barges, although a few whales may react only when the vessel is less than 1 kilometer away. Fleeing behavior usually stops within minutes after a vessel has passed but may last longer. Vessels and aircraft activities inside the barrier islands that are associated with the Liberty Project are not likely to affect bowhead whales.

Because island and pipeline construction would occur during the winter and be well inside the barrier islands, it is not likely to affect bowhead whales. Reshaping of the island and placement of slope-protection material should be completed by mid-August, before bowhead whales start their migration. Bowhead whales are not likely to be affected by sediment or turbidity from placing fill for island construction, island reshaping before placing slope-protection material, or pipeline trenching or backfilling. Whales should not be affected by these activities, even during the migration, because the island is well shoreward of the barrier islands, and whales infrequently go there.

b. Spectacled Eiders

Helicopter flights to Liberty Island during breakup of pack ice may disturb any threatened spectacled eiders feeding in open water off the Sagavanirktok River Delta. If eiders relocate to other areas, competition for food available during this period following migration may result in lowered fitness. Summer flights to the island may displace some eiders from preferred marine foraging areas or coastal habitats occupied after young have fledged. These flights are not likely to directly cause bird mortality, but extra energy and time used in response to disturbance and to find alternate areas may result in decreased survival to breeding age. Alternate foraging habitat, similar in appearance and with similar prey organisms evident, apparently is readily available, although the amount of high-quality foraging habitat in the Beaufort Sea area remains unknown.

Frequent overflights of nesting or broodrearing eiders may cause them to relocate in less favorable habitat; eiders that abandon a nest probably will not renest. Females temporarily displaced from a nest by occasional onshore pipeline inspection flights or other activity may expose eggs to predation. Either situation may result in fewer young produced. Most onshore activities in the Liberty area are likely to affect at most only a few individuals, and careful selection of aircraft routes could eliminate most disturbance of nesting eiders. Development of the Liberty Prospect is expected to result in only a small amount of habitat loss, involving displacement of few eiders to alternate sites.

Displacement of eiders from the vicinity of disturbing activities would eliminate them from only a small proportion of apparently comparable habitat. This could be a minor effect, unless it results in decreased survival either by itself or in combination with other factors. Spectacled eider mortality from collisions with island structures is estimated to be two or less per year. Collisions with the onshore pipeline are considered unlikely.

The small losses and displacements likely to result from the above activities may cause population effects that would be difficult to separate from natural variation in population numbers. However, any decline in productivity or survival resulting from the Liberty Project would be additive to natural mortality and interfere with the recovery from any declines of the Arctic Coastal Plain (USDOI, Fish and Wildlife Service, 2001) spectacled eider population. Disturbance of spectacled eiders probably would be considered a take under the Endangered Species Act.

Steller's eiders are not expected to be found in the Liberty Project area.

c. Seals, Walruses, Beluga Whales, and Polar Bears

Construction activity would displace some ringed seals within perhaps 1 kilometer of the island and along the pipeline route in Foggy Island Bay. Seals and polar bears would be exposed to noise and disturbance from pipeline dredging and burial activities in Foggy Island Bay. This disturbance of seals and polar bears would be local, within about 1 mile along the pipeline route, and would persist for one season. Walruses and beluga whales would not be affected by construction activities, because these species do not occur in the project area during the winter season when these activities are assumed to occur.

Food smells coming from the camp on the island may attract a few bears to the production island. This attraction could require deliberate hazing of these polar bears, but the effects of these activities by themselves are not expected to affect bear abundance or distribution.

Low-flying helicopters or boats would cause some ringed and bearded seals, walruses, and beluga whales to dive into the water, and a few females might be temporarily separated from their pups or calves. This displacement is expected to be brief (a few minutes to less than 1 hour). Low-flying helicopters moving to and from the Liberty Project area could briefly disturb a few polar bears. These disturbances would not affect overall seal, walrus, beluga whale, or bear abundance and distribution in Foggy Island Bay.

Vehicle traffic on the ice roads from the Endicott causeway directly to the Liberty production island and along the coast to Foggy Island Bay/Kadleroshilik River could disturb and displace a few denning polar bears and a small number of denning ringed seals. The number of bears and seals potentially displaced is expected to be low and would not affect the populations of ringed seals and polar bears.

d. Marine and Coastal Birds

Helicopter flights to Liberty Island during breakup of the pack ice may disturb some loons and king or common eiders feeding in open water off the Sagavanirktok River Delta. If they relocate to other areas, competition for food available during this period following migration may result in lowered fitness. During the summer, flights to the island may displace some long-tailed ducks, eiders, glaucous gulls, and other species from preferred marine foraging areas and snow goose and brant family groups from coastal broodrearing areas. These flights are not likely to directly cause bird mortality, but extra energy and time used in response to disturbance and to find alternate areas may result in decreased fitness and, potentially, survival to breeding age in some individuals. Alternate foraging habitat, superficially similar in appearance and with similar prey organisms evident, apparently is readily available, although the amount of high-quality foraging habitat in the Beaufort Sea area remains unknown. Collision of birds with Liberty Island or structures under conditions of poor visibility could result in adverse effects, especially if they involve species whose Arctic Coastal Plain populations are declining.

Frequent flights over nesting or broodrearing waterfowl and shorebirds on the mainland may cause birds to relocate in less favorable habitat. Birds that abandon a nest might not renest or might be delayed to a less favorable period. Adults temporarily displaced from nests by occasional onshore pipeline inspection flights may expose eggs or nestlings to predation. Any of these situations may result in fewer young produced.

Most onshore activities in the Liberty area are likely to disturb relatively few birds. Construction and vehicle traffic in winter may displace a few ptarmigan from near the activity. Spill-cleanup activities may displace some nesting, broodrearing, juvenile, or staging waterfowl and shorebirds from preferred habitats, resulting in lower survival. Development of the Liberty Prospect is expected to result in a small amount of habitat loss involving displacement of a few birds to alternate sites. This is likely to be a minor effect, unless it results in decreased survival either by itself or in combination with other factors. Excavation of a proposed gravel mine site could eliminate a mating area of the buff-breasted sandpiper. Mortality from collisions with onshore structures is expected to be negligible.

The small losses and displacements likely to result from the above activities are expected to cause minor changes in numbers that may be difficult to separate from natural variation in population numbers for any species. Such changes are not expected to require lengthy recovery periods. However, any mortality resulting from development of the Liberty Prospect would be additive to natural mortality, requiring some time for recovery from such losses, and may interfere with the recovery of Arctic Coastal Plain populations should declines in these species (for example, long-tailed ducks and common eiders) take place.

e. Terrestrial Mammals

Helicopter and ice-road traffic, encounters with people, and mining and construction operations could disturb individuals or small groups of these mammals for a few minutes to a few days or no more than about 6 months within about 1 mile of these activities. These disturbances would not affect populations. This traffic could briefly disturb some caribou, muskoxen, and grizzly bears, when the aircraft pass overhead or nearby, but would not affect terrestrial mammal populations.

Traffic for constructing the ice roads, production island, pipeline, gravel pads, and for hauling gravel and supplies could disturb some caribou and muskoxen along the ice roads during the 2 years of development and during other winters, when further work on the project is needed. This traffic would occur during December though early May, with more ice-road construction and traffic occurring during the 2 years of development. Some continued ice-road activity would occur during the 15-20 years of production to support project operations. These disturbances would have short-term effects on individual animals and would not affect populations.

Encounters between grizzly bears and oil workers or with facilities could lead to the removal of problem bears. However, the amount of onshore activity associated with Liberty (1.4 miles of onshore pipeline with no onshore camp facilities) is not likely to result in the loss of any bears. Arctic fox numbers could increase in the project area because of the possible availability of food and shelter on the production island. However, the amount of onshore activity associated with Liberty would not result in a substantial increase in fox abundance. BPXA's wildlife interaction plan and treatment of galley wastes should help to reduce the availability of food to foxes.

f. Lower Trophic-Level Organisms

These organisms include those in the Boulder Patch kelp habitat. The Boulder Patch is the largest known kelp community along the Alaskan arctic coast. Sections of the Boulder Patch with more than 10% coverage of the seafloor are located about a mile west of both BPXA's proposed Liberty Island location and pipeline route (see Figure III.C-1 and Section VI.A.5 of the EIS).

BPXA's proposed Development and Production Plan would disturb lower trophic-level organisms in three primary ways:

(1) island construction would bury up to 23 acres of typical benthic organisms; (2) pipeline trenching would disturb additional benthos, burying up to 14 acres with very low (1%) coverage of kelp and marginal kelp substrate; and (3) sediment plumes from pipeline and island construction probably would reduce Boulder Patch kelp production by 2-4% per year. The buried 14 acres are estimated to equal less than 0.1% of the Boulder Patch kelp habitat. The 1% coverage of the kelp and marginal substrate in the pipeline corridor means that the lost kelp biomass and production probably would be less than 0.001% of the Boulder Patch total. However, the effect (kelp substrate burial) probably would last forever.

Sediment plumes from pipeline trenching and island construction probably would drift over other parts of the Boulder Patch, reducing light penetration and kelp production. The production probably would be reduced slightly due to winter construction of the island, but the reduction is expected to be within levels of natural variation. Pipeline-installation activities during kelp-growth Year 2 probably would reduce annual production by about 4%. In Year 3, the kelp production probably would be reduced by 2% during the summer growth season due to sediment dispersal from stockpile Zone 1. Therefore, the overall effect would extend over three consecutive kelp-growth years, and about one-third of the effect would be due to the proposed stockpile.

Kelp and other organisms that grow on hard substrates would colonize the island's concrete slope from 6-feet deep to the seafloor. This 3-acre portion of the concrete slope probably would become a kelp habitat within a decade. Upon abandonment, the concrete mats probably would become buried naturally or would be removed, cutting back on the new kelp habitat.

g. Fishes

Noise and discharges from dredging, gravel mining, island construction, island reshaping, and pipeline trenching associated with Liberty are expected to have no measurable effect on fish populations. While a few fish could be harmed or killed, most in the immediate area could avoid these activities and would be otherwise unaffected. Effects on most overwintering fish are expected to be short term and sublethal, with no measurable effect on overwintering fish populations. Placement of the concrete mat could create additional food resources for fishes and could have a beneficial effect on nearshore fish populations in the Beaufort Sea. Gravel mining would create potential new fish habitat at the mine site.

h. Essential Fish Habitat

The Magnuson Fishery Conservation and Management Act (16 U.S.C. 1801-1882) established and delineated an area from the State's seaward boundary out 200 nautical miles as a fisheries conservation zone for the United States and its possessions. The Act established national standards for fishery conservation and management, and created eight Regional Fishery Management Councils to apply those national standards in fishery management plans. Another provision of the Act requires that Fishery Management Councils identify and protect essential fish habitat for every species managed by a fishery management plan (50 CFR 600). The essential fish habitat is defined as the water and substrate necessary for fish spawning, breeding, feeding, and growth to maturity. The Act also requires Federal Agencies to consult on activities that may adversely affect essential fish habitats designated in the fishery management plans. An adverse effect is "…any impact which reduces the quality or quantity of EFH." Activities may have direct (for example, physical disruption) or indirect (for example, loss of prey species) effects on essential fish habitats and be site-specific or habitatwide. Loss of prey is considered an adverse effect on essential fish habitat, because one component of the essential fish habitat is that it be necessary for feeding. Adverse effects must be evaluated individually and cumulatively.

Habitat areas of particular concern have been recognized for salmon in Alaska. These include all anadromous streams, lakes, and other freshwater areas used by salmon and nearshore marine and estuarine habitats such as eel grass beds, submerged aquatic vegetation, emergent vegetated wetlands, and certain intertidal zones. Although it is possible that all five species of salmon that live in Alaskan waters could be found in the Beaufort Sea, there are no commercial salmon fisheries there. Only pink salmon appear to be present in the Liberty area in sufficient numbers to permit small (0-1.5 kilograms per year per person) subsistence fisheries for residents of Nuiqsut and Kaktovik (State of Alaska, Dept. of Fish and Game, 1998). Although chum salmon are believed to be present in the Liberty area, in recent years, they appear to be little used for subsistence purposes by those villages.

The waters surrounding the development have been designated as essential fish habitat for Alaskan salmon. None of the lifestages of Pacific salmon have been documented to use or inhabit the areas expected to be disturbed directly by Liberty construction and operations. Regardless, essential fish habitat would be adversely affected by disturbances to potential prey, to prey habitat, to potential substrate, and to marine and freshwaters. All of these disturbances are expected to be fairly localized and short term.

i. Vegetation-Wetland Habitats

Disturbances mainly come from constructing gravel pads and ice roads and installing the onshore pipeline and tie in with the Badami pipeline. The development of the Kadleroshilik River Mine site would result in the loss of about 24 acres of wetland habitat. Gravel pads, the pipeline trench, and the 1.4-mile-long onshore pipeline would destroy only 0.8 acre of vegetation and affect a few acres of nearby vegetation and have only local effects on the tundra ecosystem. Ice roads would have local effects (compression of tundra under the ice roads and the tearing and breaking of some plants in drier habitats) on vegetation, with recovery expected within a few years, and no vegetation would be killed. The construction and installation of the onshore pipeline and gravel pads on State land would require a Section 404/10 permit and approval by the Corps of Engineers, as stated in the *Liberty Development and Production Plan* (BPXA, 2000a). The permit and approval process is expected to minimize adverse effects on wetlands.

j. Subsistence-Harvest Patterns

For the communities of Nuiqsut and Kaktovik, disturbances periodically could affect subsistence resources, but no resource or harvest area would become unavailable and no resource population would experience an overall decrease. Disturbance and noise could affect subsistence species that include bowhead whales, seals, polar bears, caribou, fish, and birds. Disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species and, therefore, alter or extend the normal subsistence hunt; but potential disruptions to subsistence resources should not displace traditional practices for harvesting, sharing, and processing those resources. Beluga whales rarely appear in the Liberty Project area. We do not expect belugas to be affected by noise or other project activities; neither do we expect changes in Kaktovik's subsistence harvest of beluga whales.

k. Sociocultural Systems

Effects on the sociocultural systems of communities near the Liberty Project area could occur as a result of disturbance from industrial activities; changes in population and employment; and effects on subsistence-harvest patterns. They could affect the social organization, cultural values, and social health of the communities. Together, effects may periodically disrupt, but not displace, ongoing social systems, community activities, and traditional practices for harvesting, sharing, and processing subsistence resources.

l. Archaeological Resources

Any bottom- or surface-disturbing activity, such as pipeline construction, island installation, anchoring of vessels, or oil-spill-cleanup activities could damage previously unidentified archaeological sites. Physical disturbance of sites could cause destruction of artifacts, disturbance or complete loss of site context, and result in the loss of data. Archaeological sites are a nonrenewable resource and could not be replaced.

Archaeological surveys are required both onshore and offshore in areas where there is the potential for archaeological resources to occur. Therefore, potential archaeological resources from physical disturbance would be mitigated. If a previously unknown archaeological site is discovered during construction, the MMS and the State Historic Preservation Officer will be contacted immediately.

m. Economics

We examined the effects of construction activities on the Alaskan economy and the subsistence aspects of the economy. We do not expect disturbances to affect the cash economies. Some of the general effects of developing the Liberty Prospect are noted below and discussed in more detail in Section III.D.5 of the EIS.

Employment and wages are a function of the types of activities shown in Table II.A-1 and described in Section II.A.1 of the EIS, the amount of time required to complete them, and where they occur.

Royalties to the State and Federal Governments and a spill conservation tax are a function of the production of oil. Federal income tax (and State income tax, if instituted by the State) is a function of the wages paid to workers. The ad valorem tax to the North Slope Borough is a function of the value of onshore infrastructure. The North Slope Borough and Nuiqsut would have an opportunity to see a share of the State royalty share.

BPXA has committed to hiring local workers on the North Slope and within Alaska. However, the oil industry employs few village residents, although they provide training programs and try to recruit. Many of the contractors BPXA hires for design, construction, drilling, and operations are Native corporations, subsidiaries of such corporations, or otherwise affiliated with such corporations through joint ventures or other relationships. This relationship should benefit the local economy.

The North Slope Borough has tried to improve employment of its Inupiat people in the oil industry at Prudhoe Bay. The Borough believes the oil industry has not done enough to train unskilled laborers or to allow them to go subsistence hunting, which is central to their traditional culture. The Borough also is concerned that the oil industry uses recruiting methods common to Western industry and would like to see the industry become more serious about hiring its residents.

Disruptions to the harvest of subsistence resources could affect the economic well-being of North Slope Borough residents mainly by the loss of some part of those resources.

n. Water Quality

The greatest effect on water quality from gravel island and pipeline construction would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality (Section III.C.3.l(2) of the EIS); exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction activities generally are temporary and expected to occur during the winter and end within a few days after construction stops. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. This material would be similar in composition to seafloor sediments in the trenching and disposal areas, and its contribution to the future turbidity from waves and currents is expected to be about the same as the sediments existing at the seafloor surface prior to pipeline construction. Available data from site-specific chemical studies indicate construction activities are not expected to introduce or add any chemical pollutants.

o. Air Quality

We believe that essentially no disturbances to wildlife, plants, or people would occur due to degradation of air quality caused by Liberty Project activities. The Liberty Proposal would cause a small, local increase in the concentrations of criteria pollutants. Concentrations would be within the Prevention of Significant Deterioration Class II limits and National Ambient Air Quality Standards. Therefore, the effects would be low. (See supporting materials and discussions in Sections III.D.1.m and VI.C.3. of the EIS). The air-quality analysis is based on the specific emission controls and emission limitations that BPXA would apply to meet the appropriate Environmental Protection Agency regulations. This would include the requirement to use dry, low nitrogen oxide technology for the turbines to further reduce emissions. These controls become part of the proposed project and are written into the permit and, thus, are binding. The use of best available control technology and compliance with the Environmental Protection Agency's emission standards is the primary factor in reducing emissions of criteria pollutants (such as nitrogen oxides and sulfur dioxide). BPXA also plans voluntary reduction of greenhouse gases (notably carbon dioxide); this also would result in a slight additional reduction in emissions of other pollutants. These voluntary measures, however, would not be part of the permit and, therefore, are not enforceable. BPXA's Development and Production Plan, especially Sections 12.3 and 6.2.1, have some additional information; their *Part 55 Permit Application for the BP Exploration (Alaska) Inc. Liberty Development Project*, includes a thorough discussion of control measures.

p. Environmental Justice

When we consider the little effect from routine activities and the low likelihood of a large spill event, disproportionately high adverse effects would not be expected on Alaskan Natives from Liberty development under the Proposal.

For a summary of Environmental Justice effects, see Section C.5.h of this Executive Summary.

2. Effects Summary for a Large Oil Spill

In the following, we discuss effects that would be expected in the unlikely event of an oil spill.

a. Bowhead Whales

We do not know with certainty what effects an oil spill would have on bowhead whales, but some conclusions can be drawn from studies that have looked at the effects of oil spills on other cetaceans. If a spill occurred and contacted bowhead habitat during the fall whale migration, it is likely that some whales would be contacted by oil. Some of these whales likely would experience temporary, nonlethal effects, including one or more of the following symptoms:

- oiling of their skin, causing irritation
- inhaling hydrocarbon vapors
- ingesting oil-contaminated prey
- fouling of their baleen
- losing their food source
- moving temporarily from some feeding areas

Some whales could die as a result of contact with spilled oil. Geraci (1990) reviewed a number of studies on the physiologic and toxic effects of oil on whales and concluded there was no evidence that oil contamination had been responsible for the death of a cetacean. Nevertheless, the effects of oil exposure to the bowhead whale population are uncertain, speculative, and controversial. The effects would depend on how many whales contacted oil, the duration of contact, and the age/degree of weathering of the spilled oil. If oil got into leads or ice-free areas frequented by migrating bowheads, a substantial portion of the population could be exposed to spilled oil. Prolonged exposure to freshly spilled oil could kill some whales, but we expect that number to be very small with such a low chance of contact.

The potential for bowhead whales to be affected by spilled oil from the Liberty Project is relatively small, based on the estimated size of a spill and the relatively low chance of spilled oil reaching the main bowhead fall migration route outside the barrier islands (16% or less).

b. Spectacled Eiders

A large spill from Liberty Island or an associated marine pipeline would have the highest probability of contacting nearshore and offshore areas of Foggy Island Bay and the eastern Sagavanirktok River Delta, where spectacled eiders may be staging in open waters in spring following migration, or throughout this area prior to fall migration. Oil could contact these eiders from early June to September. A Fish and Wildlife Service report, *Exposure of Birds to Assumed Oil Spills at the Liberty Project,* estimates mortality of spectacled eiders to modeled oil spills originating in the Liberty Project area in summer. To calculate the potential numbers of birds oiled, an overlay of spectacled eider densities was used with MMS oil-spill-trajectory maps, using a Geographic Information System model developed by the Fish and Wildlife Service. See Appendix J of the EIS for the full report. The Fish and Wildlife Service model estimates that few spectacled eiders would be oiled by a large spill in the area between the Kogru River (west) and Brownlow Point (east). Recent aerial survey data indicating a nonsignificant downward trend in the Arctic Coastal Plain (USDOI, Fish and Wildlife Service, 2001) spectacled eider population suggests that recovery from even small losses is not likely to occur quickly due to the species' low reproductive rate, especially in this eastern coastal plain area where eider numbers are relatively low. Any losses would be considered a take under the Endangered Species Act. Any substantial mortality resulting from an oil spill would represent a significant loss to this eastern segment of the coastal plain population. Mortality resulting from the Liberty Project would be additive to natural mortality and could interfere with recovery from any declines the coastal plain population experiences. Spill-cleanup activities may disturb broodrearing or staging eiders occupying coastal habitats, resulting in decreased survival.

The MMS estimates that small oil spills could cause a few deaths among nesting, broodrearing, or staging spectacled eiders. Reduction of prey populations from a spill could have a negative effect on the foraging success of spectacled eiders in the local area, especially in spring when there is limited open water. Alternate foraging habitat, similar in appearance and with similar prey organisms evident, apparently is available, however the amount of high-quality foraging habitat in the Beaufort Sea area remains unknown. Potentially, one or two spectacled eiders and their productivity could be lost as a result of an onshore spill, and spill-cleanup activity could disturb nesting individuals. The threatened Steller's eider is not expected to occur in the Liberty Project area.

c. Seals, Walruses, Beluga Whales, and Polar Bears

Seals, polar bears, and possibly a few individual beluga whales and walruses most likely would contact a large spill in the Foggy Island Bay and Mikkelsen Bay areas. An estimated 60-150 ringed seals (out of a resident population of 40,000) and fewer than 50 bearded seals (based on their sparse distribution in the project area) could be affected by the large spill. An estimated 5-30 polar bears could be lost if a spill contacted Cross Island when and where that many polar bears might be concentrated during a whale harvest. This represents a severe event. The more likely loss from Liberty development would be no more than one or two bears. A small number of beluga whales and maybe a few walruses could be exposed to the spill and may be affected from the exposure.

The seal, walrus, beluga whale, and polar bear populations are expected to recover individuals killed by the spill within 1 year, and there would be no effect on the population.

Amstrup, Durner, and McDonald (2000) estimated that a 5,912-barrel spill could contact from 0-25 polar bears in open-water conditions and from 0-61 polar bears in autumn mixed-ice conditions (out of an estimated resident Beaufort Sea population of 1,800 individuals). The 5,912-barrel-spill size used in the Fish and Wildlife Service model is twice the size of the large spill (2,956 barrels) estimated by MMS. The Fish and Wildlife Service used this larger size as a type of worst-case analysis. The oil-spill trajectories contacted small numbers of bears far more often than they contacted large numbers of bears. In October, 75% of the trajectories oiled 12 or fewer polar bears while in September, 75% of the trajectories oiled 7 or fewer polar bears (Amstrup, Durner, and McDonald; 2000). The median number of polar bears that could be affected by a 5,912-barrel spill in October was 4.2. These results are comparable to the estimate of 5-30 bears given. We conclude that a spill from Liberty is likely to affect 12 or fewer polar bears. The polar bear population is expected to recover this likely loss within 1 year.

Secondary effects on polar bears could come from oil contaminating food sources. A spill might affect the abundance of some prey species in local, coastal areas of Foggy Island Bay where epibenthic food such as amphipods (small shrimp) concentrate, but a spill should not greatly decrease abundant food, such as arctic cod. Local changes in the abundance of some food sources would not affect the seal populations or, in turn, affect the polar bear population in the Beaufort Sea.

d. Marine and Coastal Birds

A large spill would have the highest probability of contacting nearshore and offshore areas of Foggy Island Bay and the eastern Sagavanirktok River Delta, where waterfowl and other aquatic birds may be molting, staging before migration, or pausing during migration. The long-tailed duck is one of the dominant sea ducks in the Arctic. Fish and Wildlife aerial surveys of lagoons and other protected nearshore areas from Harrison Bay to Brownlow Point in 1999 and 2000 estimated that mortality from a spill contacting long-tailed ducks in such habitats where these ducks concentrate during the molt period, could be 1,443-2,062 individuals at the average bird densities determined. This is equivalent to about 1-2% of the average population present on the coastal plain as determined by aerial breeding pairs surveys (or 6-7% of the population estimated to be present in the marine survey area). The 5,912-barrel-spill size used in the Fish and Wildlife Service model is twice the size of the large spill (2,956 barrels) estimated by the MMS. The Fish and Wildlife Service used this larger size as a type of worst-case analysis. According to estimates by the model, total kill could range from a small fraction to many times this number (minimum to maximum numbers estimated killed = 0.01-35% of the birds estimated present in this central Beaufort area during aerial surveys) depending on the severity of oil contact and the number of birds present. Mortality at the higher end of this range would be considered a significant adverse effect on population numbers and productivity. Should long-tailed ducks be contacted by a spill outside the barrier islands, mortality is likely to be considerably lower than this number due to lower bird density.

Flocks of staging king and common eiders could contact oil in nearshore and/or offshore areas. According to counts of spring migrants at Point Barrow, these eider populations have declined 50% or more in the past 20 years, and substantial oil-spill mortality could aggravate this effect. These species, plus the long-tailed duck and red-throated loon, that have a low reproductive rate limiting their population growth (loons and sea ducks, in general), are expected to recover slowly from oil-spill mortality. Those that are declining probably will not return to target population levels until the trend is reversed. In particular, because of historic or current declines in king and common eiders, these species could experience significant losses from a large oil spill.

For most bird species, the relatively small losses likely to result from a spill may be difficult to separate from the natural variation in population numbers, but their populations are not expected to require lengthy recovery periods.

A spill that enters open water off river deltas in spring could contact migrant loons and eiders. Some of the several hundred broodrearing, molting, or staging brant and snow geese could contact oil in coastal habitats. Also, several thousand shorebirds could encounter oil in shoreline habitats, and the rapid turnover of migrants during the migration period suggests that many more could be exposed.

An onshore pipeline spill in summer probably would affect only a few nests, even considering all species. If the oil spread to streams or lakes, long-tailed ducks, brant, and greater white-fronted geese that gather on large lakes to molt could be adversely affected in larger numbers. Losses of oiled birds in this case could range up to a few hundred individuals, a minor effect for species whose populations are relatively abundant and stable or increasing. Reduction of prey populations from a spill may reduce foraging success of shorebirds and sea ducks that depend on this local energy source for molt or migration. However, alternate foraging habitat, similar in appearance and with similar prey organisms evident apparently is readily available during the open-water season following the breeding period, although the amount of high-quality foraging habitat in the Beaufort Sea area remains unknown.

e. Terrestrial Mammals

A large offshore spill is most likely to contact some coastal areas from the Sagavanirktok River Delta east to Mikkelsen Bay. Caribou may use some of these areas for relief from insects. The main potential effect on terrestrial mammals that contact spilled oil could be the loss of fewer than 100 caribou (out of an estimated resident population of the Central Arctic Herd of 27,000 individuals) and a few muskoxen, grizzly bears, and arctic foxes. These losses are expected to be replaced by normal reproduction within about 1 year.

A large onshore pipeline spill could occur and oil less than 5 acres of vegetation along the pipeline landfall to the Badami tie in. Such a spill is not expected to directly affect caribou or other terrestrial mammals and would cause very minor ecological harm.

Secondary effects could come from disturbance associated with spill-cleanup activities and temporary local displacement of some caribou, muskoxen, grizzly bears, and foxes. These activities, however, would not affect the terrestrial mammals' movements or overall use of habitat.

f. Lower Trophic-Level Organisms

A large, offshore oil spill probably would have short-term effects on plankton and long-term effects on the fouled coastlines. Up to one-third of the Stefansson Sound coastline would be affected by a large spill in open water. While the ice-gouged coastline is inhabited by mobile, seasonal invertebrate species that probably would recover within a year, fractions of the oil probably would persist in the sediments for about 5 years in most areas, and probably would persist up to 10 years in areas where water circulation is reduced. Liberty crude is highly viscous and particularly resistant to natural dispersion; therefore, very little probably would be dispersed down in the water column and affect benthic communities such as the Boulder Patch kelp habitat. However, diesel oil, which would be used on the island for startup and emergency fuel, could be dispersed down to the seafloor. If 1,283 barrels of diesel were spilled from a fuel-delivery barge at the island during the open-water season, the concentration is estimated to be toxic within an area of about 18 square kilometers (7 square miles), as calculated in Section III.C.2.l Water Quality of the EIS. Such toxicity probably would stunt the seasonal growth of kelp plants and reduce the population size of associated invertebrates for several years. Oil-spill response in general would have both minor beneficial and adverse effects on these organisms.

g. Fishes

The likely effects on arctic fishes from a large crude-oil spill, diesel-fuel spill or pipeline spill that entered offshore waters would depend primarily on the season and location of the spill, the lifestage of the fishes, and the duration of the oil contact. Due to their very low numbers in the spill area, no measurable effects are expected on fishes in winter. Effects would be more likely to occur from an offshore oil spill moving into nearshore waters during summer, where fishes concentrate to feed and migrate. The probability of an offshore oil spill contacting nearshore waters in summer ranges from less than 1-26%. If an offshore spill did occur and contact the nearshore area, some marine and migratory fish may be harmed or killed. However, it would not be expected to have a measurable effect on fish populations, and recovery would be expected within 5 years. In general, the effects of fuel spills on fish are expected to be less than the effects of crude-oil spills.

If a pipeline oil spill occurred onshore and contacted a small waterbody with restricted water exchange supporting fish, it would be expected to kill or harm most of the fish within the affected area. Recovery would be expected in 5-7 years. Because of the small amount of oil or diesel fuel likely to enter freshwater habitat, the low diversity and abundance of fish in most of the onshore area, and the unlikelihood of spills blocking fish migrations or occurring in overwintering areas or small waterbodies, an onshore spill of this kind is not expected to have a measurable effect on fish populations on the Arctic Coastal Plain.

h. Essential Fish Habitat

The most likely threat to salmon in essential fish habitat would occur if spilled oil contacted spawning areas or migratory pathways. However, salmon are not believed to spawn in the intertidal areas or the mouths of streams or rivers of the Beaufort Sea. Therefore, contact between spilled oil and spawning areas is very unlikely. If spilled oil concentrated along the coastline at the mouths of streams or rivers, the potential movements of a small number of salmon could be disrupted during migrations.

Zooplankton and fish form most of the diet for salmon in the Beaufort Sea. Zooplankton populations could be subjected to short-term, localized, negative effects from oil spilled as a result of Liberty development. Juvenile lifestages of salmon inhabit fresh or estuarine waters and generally feed on insects. Oil spilled in wetland habitat could kill vegetation and associated insect species and, thus, have an adverse effect on essential fish habitat lasting from less than 10 years to several decades. Because of the predominance of shorefast ice in the Liberty area, there is no resident marine flora in waters less than 6 feet deep. Therefore, no effects are expected on marine plants in those waters.

Salmon and their prey require relatively clean water in which to live and perform their basic life functions. Essential fish habitat would be adversely affected to the extent that water quality would be degraded. Water quality would be significantly degraded over a fairly large area for a period from days to months, if a large spill of crude or diesel oil occurred. The relative effect of an oil spill on water quality during times of open water would be relatively long lived and widespread, as compared to times of broken or complete ice cover. The effects of a diesel spill generally would be more acute and widespread than the effects of a crude oil spill under similar environmental conditions.

i. Vegetation-Wetland Habitats

Main potential effects of a large offshore spill on vegetation and wetlands include oil fouling, smothering, asphyxiation, and poisoning of plants and associated insects and other small animals. In this case, complete recovery of moderately oiled wetlands of the Sagavanirktok River east to Mikkelsen Bay would take perhaps 10 years or longer (if the oil contaminated both plant surface and subsurface structures during the summer period of maximum thaw). A second main effect is the disturbance of wetlands from cleanup activities. Complete recovery of heavily oiled coastal wetlands from these disturbances and oil could take several decades. However, the local persistence of oil in coastal wetlands is not expected to have significant effects on the distribution and abundance of plant species (vegetation-wetlands) in the region.

A large onshore spill would oil no more than 5 acres of vegetation along the pipeline landfall to the Badami tie in and would cause some ecological harm. Oiled vegetation should recover within a few years but may take more than 10 years to fully recover.

j. Subsistence-Harvest Patterns

The chance of a large spill from the offshore production island and the buried pipeline occurring and entering offshore waters is estimated to be low. Based on the assumption that a spill has occurred, the chance of an oil spill during summer, from either Liberty Island or the pipeline contacting the important traditional bowhead whale and seal harvest areas of Cross and McClure islands over a 360-day period, would be up to 16%. A spill also could affect other subsistence resources and harvest areas used by the communities of Nuiqsut and Kaktovik.

In the unlikely event of a spill, many harvest areas and some subsistence resources would be unavailable for use. Some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. Tainting concerns in communities nearest the spill event seriously could curtail traditional practices for harvesting, sharing, and processing bowheads and threaten a pivotal underpinning of Inupiat culture. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree these resources were contaminated.

k. Sociocultural Systems

Effects on the sociocultural systems of the communities of Nuiqsut and Kaktovik could come from disturbance from small changes in population and employment and periodic interference with subsistence-harvest patterns from oil spills and oil-spill cleanup. Effects from these sources are not expected to displace ongoing sociocultural systems, but community activities and traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term if there are concerns over the tainting of bowhead whales from an oil spill. For a summary of Environmental Justice effects, see Section C.5.h of this Executive Summary.

l. Archaeological Resources

The geography, prehistory, and history of the Liberty Prospect is very different from that of Prince William Sound where the effects of the *Exxon Valdez* oil spill were concentrated; therefore, direct analogies cannot be drawn regarding the numbers and types of sites that might be affected should such a spill occur in the Liberty Prospect area. However, general finds and conclusions regarding the types and severity of impacts to archaeological sites present within the *Exxon Valdez* oil-spill area are applicable to this proposed project. The most important understanding that came from the *Exxon Valdez* oil spill was that the greatest impacts to archaeological sites were not from effects from the oil itself, but from the cleanup activities (Bittner, 1993, Dekin, 1993). The effects from cleanup activities were due to physical disturbance of sites from cleanup equipment and vandalism by cleanup workers. Regardless, researchers concluded that less than 3% of the archaeological resources within the spill area suffered any substantial effects (Mobley, et al., 1990, Wooley and Haggarty, 1993) and that a similar level of effect would be projected in the unlikely event that an oil spill occurred from Liberty development.

m. Economics

Employment generated to clean up possible large oil spills of 715-2,956-barrels is estimated to be 30-125 cleanup workers for 6 months in the first year, declining to zero by the third year following the spill.

n. Water Quality

During open water, hydrocarbons dispersed in the water column from a large (greater than or equal to 500 barrels) crude oil spill could exceed the 0.015-parts per million chronic criterion for 10-30 days in an area that ranges from 30-45 square kilometers (11.6-17.4 square miles) to 51-186 square kilometers (19.7-71.8 square miles). Hydrocarbons in the water could exceed the 1.5-parts per million acute (toxic) criterion during the first day in the immediate vicinity of the spill. A large crude oil spill in broken sea ice or when the sea ice melts could exceed the chronic criterion for several days in an area of about 7.6 square kilometers (2.9 square miles). Hydrocarbons from a 1,283-barrel diesel oil spill during open water could exceed the acute (toxic) criterion for about 7 days in an area of about 18 square kilometers (7 square miles). During broken sea ice or melting ice conditions, a 1,283-barrel diesel spill could exceed the acute (toxic) criterion for about 1 day in an area of about 1 square kilometer (0.4 square mile) and the chronic criterion for more than 30 days in an area of about 103 square kilometers (39.8 square miles). The effects from a spill occurring under the ice would be similar to those described for broken-ice or melting conditions; the oil would be trapped and essentially remain unchanged until breakup occurred and the ice began to melt.

A large crude or refined oil spill (greater than or equal to 500 barrels) would have a significant effect on water quality by increasing the concentration of hydrocarbons in the water column to levels that greatly exceed background concentrations; however, the chance of a large spill occurring and oil entering the offshore waters is estimated to be about 1%. Also, regional (more than 1,000 square kilometers [386 square miles]), long-term (more than 1 year) degradation of water quality to levels above State and Federal criteria because of hydrocarbon contamination is very unlikely.

o. Air Quality

Oil spills from the offshore gravel island and the buried pipeline could cause a small, local increase in the concentrations of gaseous hydrocarbons (volatile organic compounds) due to evaporation from the spill. The concentrations of volatile organic compounds would be very low and normally be limited to only 1 or 2 square kilometers (0.4-0.8 square mile). During open-water conditions, spreading of the spilled oil and action by winds, waves, and currents would disperse the volatile organic compounds so that they would be at extremely low levels over a relatively larger area. During broken-ice or melting ice conditions, because of limited dispersion of the oil, there would be some increase in volatile organic compounds for several hours, possibly up to 1 day. The effects from a spill occurring under the ice would be similar to but less than those described for broken ice or melting conditions; the oil would be trapped and essentially remain unchanged until the ice began to melt and breakup occurred. Some of the volatile organic compounds, however, would be released from the oil and dispersed, even under the ice. In any of these situations, moderate or greater winds would further reduce the concentrations of volatile organic compounds in the air. Concentrations of criteria pollutants would remain well below Federal air-quality standards. The overall effects on air quality would be minimal.

E. ALTERNATIVES AND MITIGATION

1. Decision Options

The project as proposed by BPXA and described in their Development and Production Plan (BPXA, 2000a) is presented in the EIS and is being evaluated by the MMS and other permitting and regulatory agencies. Construction of the project would not take place unless these agencies approve the project or a modified project.

At the completion of this EIS process, the decisionmakers will have three options available:

- Accept the Project as proposed in the Liberty Development and Production Plan (Alternative I);
- Deny the Project (No Action - Alternative II); or
- Accept the project with modification by choosing one or more of component alternatives or one of the combination alternatives described below and/or any proposed mitigating measures.

Alternative I was briefly described in Section A, and the effects of Alternative I were summarized previously in Section D.

2. Alternative II – No Action

A decisionmaker not wanting to approve the project would select the second decision option, Alternative II, the No Action Alternative. Under this alternative, the Liberty Development and Production Plan would not be approved. None of the potential 120 million barrels of oil would be produced, and none of the environmental effects that would result from the proposed development would occur. There would be no potential oil spills and no effects to the flora and fauna in the Foggy Island Bay. Economic benefits, royalties, and taxes to Federal and State governments would be forgone.

To replace the potential 120 million barrels of oil not developed from Liberty, a large portion of the oil would be imported from other countries. The associated environmental impacts from producing oil and transporting it to market still would occur. These imports have attendant environmental effects and other negative effects on the Nation's balance of trade.

The Most Important Substitutes for Lost Production: The energy that would have flowed into the United States' economy from this development would need to be provided from a substitute source. Possible sources include:

- other domestic oil production
- imported oil production
- other alternative energy sources such as
  - imported methanol
  - gasohol
  - compressed natural gas
  - electricity
- conservation in the areas of transportation, heating, or reduced consumption of plastics
- fuel switching
- reduction in the consumption of energy

Environmental Impacts from the Most Important Substitutes: If imports increased to satisfy oil demands, effects to the environment would be similar in kind to those of the Proposal but would occur in different locations. The species of animals and plants affected might be different and would depend on the location of the development. Some effects still could occur within the United States from accidental or intentional discharges of oil from tankers or pipelines. These events would:

- generate greenhouse gases and air pollutants from transportation and dockside activities;
- degrade air quality from emissions of nitrogen oxides and volatile organic compounds;
- degrade water quality; and
- destroy flora and fauna.

Imported oil imposes negative environmental impacts in producing countries and in countries along trade routes. By importing oil, we are exporting environmental impacts to those countries from which the United States imports and to countries along or adjacent to the transportation routes as well.

Substituting energy-saving technology or consuming less energy would conserve energy and result in positive net gains to the environment. However, these efforts may require additional manufacturing. The amount of gain would depend on the extent of negative impacts from capital-equipment fabrication.

Onshore oil production has notable negative impacts on surface water, groundwater, and wildlife. It also can cause negative impacts on soils, air quality, and vegetation and cause or increase noise and odors. Offshore oil production may result in impacts similar to those of the Proposal, but they would occur in a different location.

Consumers probably could switch to natural gas to heat their homes and businesses or for industrial uses. While natural gas production would create environmental impacts, they would be at a lower level than those impacts normally associated with oil spills. Other alternative transportation fuels may constitute part of the fuel-substitution mix that depends on future technical and economic advances.

Natural resources in the Arctic Ocean, Beaufort Sea and, to a more limited extent, Foggy Island Bay still would be exposed to other ongoing oil and gas activities in the area, as described in Section I.F of the Executive Summary and Section V of the EIS.

3. Component and Combination Alternatives and Their Effects

For the balance of our alternatives analyses, we use both "component alternatives" and "combination alternatives." First, we define and discuss five sets of component alternatives. Each set varies a single project component identified during scoping as being important. Each component alternative is a "complete" alternative in that it includes all the same elements as the BPXA Proposal except for the one component at issue. For ease in making comparisons, each set of component alternatives also includes the BPXA proposed project component (see Table II.A-1).

The five sets of component-alternative areas follow:

- **Three island locations and pipeline routes** (Liberty Island/Liberty pipeline route, Tern Island/Tern pipeline route, and Southern Island/eastern pipeline route) (see Map 1).
- **Four pipeline designs** (single-wall pipe, steel pipe-in-steel pipe, steel pipe-in-plastic pipe, and flexible pipe) (see Figure II.C-3).
- **Two types of upper slope protection for the production island** (gravel bags and steel plate) (see Figures II.A-13 and II.C-4, respectively).
- **Two gravel mine sites** (Kadleroshilik River and Duck Island) (see Map 1).
- **Two pipeline burial depths** (design trench depth and a 15-foot trench depth) (see Figure II.C-10).

The decisionmakers for this project can select one alternative from each of the above five sets of component alternatives. That means there are 96 possible combinations of components to choose from, including the components proposed by BPXA (3 x 4 x 2 x 2 x 2 = 96).

Some of the alternatives (Island Location and Pipeline Routes and/or Pipeline Design), if chosen, may result in delays in the Liberty Project of 18-24 months to collect additional engineering data and to allow time for specific design and testing work. This information would be necessary for technical approval of the project but is not expected to change the environmental effects. For purposes of analysis in the EIS, we have not adjusted the timelines for starting the different alternatives. Therefore, all the alternatives are on the same footing for the analysis of environmental effects.

After the evaluation of the component alternatives, we define and discuss three "combination alternatives." The Liberty Interagency Team formulated each of these combinations by selecting one alternative from each of the five sets of component alternatives. In Section IV.D of the EIS, these three combination alternatives are compared with each other and with the Proposal to assess their relative effects on the environment (see Tables IV.D-1 and IV.D-2).

Because this approach of analyzing "component alternatives" and "combination alternatives" is a bit unusual, the following should help explain our rationale for using both in this EIS.

As a first step, we evaluated each alternative in each set of component alternatives and compared it to the other alternatives in the set. Because all the component alternatives are "complete" alternatives, the comparisons can be made on an even footing. The Liberty Interagency Team believes that using component alternatives is a good way to focus analysis on the issues and concerns related to a particular component. It also facilitates comparison among the choices in each set.

However, by using this approach, the component alternatives are all the same as the BPXA Proposal except for the one component that we vary within each set. This approach also does not provide for concurrent evaluation of two or more components. In essence, analyzing only component alternatives does not facilitate either evaluating a reasonable range of alternatives or selecting multiple alternative components as required under the National Environmental Policy Act.

We therefore took a second step to overcome these limitations. Using the component alternatives as building blocks, the Liberty Interagency Team developed three more alternatives that we refer to as "combination alternatives."

These were selected from the possible 96 combinations mentioned previously. Each combination alternative also is a "complete" alternative, and each varies substantially from the other combination alternatives.

The Combination Alternatives, with the BPXA Proposal shown for comparison, are:

Combination Alternative A
- Use Liberty Island and Liberty Pipeline Route
- Use Pipe-in-Pipe System
- Use Steel Sheetpile for Upper Slope Protection
- Use Duck Island Gravel Mine
- Use a 7-Foot Burial Depth

Combination Alternative B
- Use Southern Island and Eastern Pipeline Route
- Use Pipe-in-HDPE System
- Use Gravel Bags for Upper Island Slope Protection
- Use the Kadleroshilik River Mine Site
- Use the 6-Foot Burial Depth as designed for the Pipe-in-HDPE Pipeline System

Combination Alternative C
- Use Tern Island and Tern Pipeline Route
- Use Pipe-in-Pipe System
- Use Steel Sheetpile for Upper Slope Protection
- Use Duck Island Mine Site
- Use a 15-Foot Burial Depth

The BPXA Proposal (Liberty Development and Production Plan)
- Use Liberty Island and Liberty Pipeline Route
- Use Single-Wall Pipeline Design
- Use Gravel Bags for Upper Island Slope Protection
- Use the Kadleroshilik River Mine Site
- Use a 7-Foot Burial Depth

Note that one of these options, Combination C, has none of the component alternatives included in the BPXA Proposal, while Combination A and Combination B have some components in common with the BPXA Proposal and some that are different. Therefore, as a group, the combination alternatives range from the BPXA Proposal to a proposal as different from BPXA's as possible. Evaluating a reasonable number of examples that cover the spectrum of 96 alternatives in this manner allows the decisionmaker to ultimately select any of those 96 possibilities. (See Questions 1a and 1b, *Forty Most Asked Questions Concerning the Council on Environmental Quality National Environmental Policy Act Regulations*, 46 *Federal Register* 18026, as amended.)

Many of the Liberty Project key elements are shown in Table II.A-1. Elements that also are part of the project and would apply to all alternatives, but which are not shown in the table, include the following:
- Island and pipeline construction would occur over 2 years.
- Excess trenching material would be disposed of at approved ocean dumping sites.
- Natural gas would be used to fuel all activities on the island when production begins.
- Ice roads would be constructed annually in winter to provide access to the island.
- During broken-ice and open-water conditions, marine vessels would be used to transport personnel and materials to the island; helicopters would be used year-round as needed.
- Waste materials from the island would either be reinjected into the disposal well or disposed of at approved sites.
- Drilling waste material (muds, cuttings, and produced waters) would be reinjected into a disposal well.
- The field would be developed using waterflood and gas reinjection to maintain reservoir pressure.
- The Oil Discharge Prevention and Contingency Plan (BPXA, 2000b) would apply to all alternatives.

For the most part, the effects to the natural resources and species affected by a change in one component of the project (one alternative) differ from the effects to natural resources and species affected by a change in another component (another alternative). The overall effects of any combination of alternatives can be seen by simply combining or adding the effects identified for each natural resource.

The EIS devotes extensive text to the effects of the component alternatives but only includes the highlights of the benefits, concerns, and effects of the combination alternatives. Our rationale for this is that the component alternatives are the building blocks for the combination alternatives. With a thorough understand of the building blocks, the reader or decisionmaker can easily review the combination alternatives formulated by the Liberty Interagency Team or use the blocks to construct and assess whatever combination is preferred.

a. Significant Impacts to Resources for All of the Alternatives

The MMS does not expect any significant impacts to result from any of the planned activities associated with any of the alternatives. Significant adverse impacts to spectacled eiders, king and common eiders, and long-tailed ducks; local water quality; subsistence-harvest patterns, and sociocultural systems, could occur in the unlikely event of a large accidental oil spill for all component and combination alternatives. These significant adverse impacts essentially are the same as those identified for the Proposal in Section III.A.1. These effects to resources for each of the alternatives did not increase or decrease the effects to resources such that the significant adverse impacts were measurably changed by component or combination alternatives. No new significant impacts were identified in the alternative analysis. However, the adverse impacts from a large oil spill have not been reduced by any of the alternatives such that the impact to resources would drop below the significant threshold.

For a summary of Environmental Justice effects, see Section C.5.h of this Executive Summary.

b. Effects of Component Alternatives

For ease of reading up to this point, we have not attached roman numerals to the component alternatives, but will do so in the following. Also, the reader should note that for the purpose of alternative analysis, MMS assumes an oil spill would occur, and that the probability of an oil spill occurring (less than 1% over the life of the field) is the same for all alternatives.

(1) Effects of Alternative Drilling and Production Island Locations and Pipeline Routes

This set of component alternatives evaluates the different impacts of using three different island locations and their corresponding pipeline routes (see Map 1):

- Alternative I - Use the Liberty Island and Pipeline Route (Liberty Development and Production Plan)
- Alternative III.A - Use the Southern Island Location and Eastern Pipeline Route
- Alternative III.B - Use the Tern Island Location and Pipeline Route

(Note that this set and each of the other four sets of component alternatives include BPXA's Proposal for comparison.) Spill rates and the chance of occurrence of small, large, and very large oil spills are the same for the proposed Development and Production Plan, component alternatives, and combination alternatives.

The Eastern and Tern Pipeline Routes share the same shoreline crossing as well as the onshore pipeline route. If either Alternative III.A or III.B were selected, BPXA would be required to submit for our review additional geophysical survey data that sufficiently cover the proposed area of offshore disturbance. An archaeological report would be prepared to address whether the data show any evidence of areas having prehistoric or historic site potential. Based on this analysis, we would require that any areas of archaeological site potential either be investigated further to determine conclusively whether a site exists at the location or that the area of the potential site be avoided by all bottom-disturbing activities.

As indicated, the differences in island locations and pipeline routes for Alternatives I, III.A, and III.B do not provide measurable differences in effects to the following resources:

- Bowhead Whales
- Seals Walruses, Beluga Whales, and Polar Bears
- Fishes
- Subsistence-Harvest Patterns
- Sociocultural Systems
- Archaeological Resources
- Air Quality
- Environmental Justice

(a) Alternative I – Use Liberty Island Location and Pipeline Route (Liberty Development and Production Plan)

The Liberty Island and its pipeline route are shown in Map 1. This alternative is the Proposed Action - BPXA's Liberty Development and Production Plan. The features of this alternative are shown in Table II.A-1. Liberty Island is in about 22 feet of water and about 5 miles from shore. The Liberty pipeline route would go southwest to shore. The offshore pipeline is about 6.1 miles long. The distance for hauling the gravel is about 7 miles to the island from the Kadleroshilik River Mine Site. The proposed Liberty gravel island would be centered above the Liberty reservoir. This location would minimize the number of high-departure wells needed to develop the reservoir and maximize the total oil recovered. The present island location had no observed permafrost to a minimum of 50 feet below the island location. Liberty Island would be about 1mile southeast of the Boulder Patch. For purposes of analysis, we assume a trench with a 7-foot minimum burial depth.

Alternative I would have effects to the following resources:

Spectacled Eiders: Disturbance of nesting or broodrearing spectacled eiders may result in loss of eggs or young to predators; however, displacement of more than a few eiders (or females with broods) by onshore activities or placement of facilities is considered unlikely. Significant adverse population effects are not expected to occur as a result of disturbance.

A large oil spill from Liberty Island or associated marine pipeline would have the highest probability of contacting nearshore and offshore areas of Foggy Island Bay and the eastern Sagavanirktok River Delta, where spectacled eiders may be staging before migration. Recovery of the Arctic Coastal Plain (USDOI, Fish and Wildlife Service, 2001) spectacled eider population from even small losses is not likely to occur quickly. Any substantial spill-related mortality in this area is expected to represent a significant loss for this population.

Marine and Coastal Birds: Helicopter flights to Liberty Island might disturb some loons and king or common eiders feeding in open water off the Sagavanirktok River Delta during breakup or displace long-tailed ducks and eiders from preferred marine foraging areas in summer, adversely affecting fitness in some individuals. Snow goose and brant family groups could be displaced from coastal broodrearing areas, but alternative sites generally are available. Spill-cleanup activities may displace some nesting, broodrearing, juvenile, or staging waterfowl and shorebirds from preferred habitats, resulting in lowered fitness. The small losses and displacements likely to result from the above activities are expected to cause minor changes in numbers but are not expected to require lengthy recovery periods.

A large oil spill from Liberty Island or the associated marine pipeline would have the highest probability of contacting nearshore and offshore areas of Foggy Island Bay and the eastern Sagavanirktok River Delta, where waterfowl and other aquatic birds may be molting or staging before migration. Mortality from a spill contacting long-tailed ducks in lagoons or other protected nearshore areas, where they concentrate during the molt period, is estimated to involve an average of 1,443 individuals, equivalent to about 1% of the average coastal plain population, or 6-7% of the individuals determined to be present in the Fish and Wildlife Service central Beaufort Sea survey area during aerial surveys. Species that have a limited capacity for population growth (loons and sea ducks, in general), are expected to recover slowly from oil-spill mortality. Those that are declining (eiders, red-throated loons) probably would not return to a target population level until the trend is reversed. In particular, because of historic or current declines and/or vulnerability during specific periods, mortality of king and common eiders and long-tailed ducks from a large offshore spill could represent a significant impact. Losses of other species (for example, the northern pintail, geese, glaucous gull, most shorebirds, and songbirds) through oiling could range up to a few hundred individuals, a minor effect for species whose populations are relatively abundant and stable or increasing.

Terrestrial Mammals: Disturbances would have short-term effects on individual animals and would not affect populations.

Crude oil or diesel fuel is most likely to contact some coastal areas from the Sagavanirktok River Delta east to Mikkelsen Bay. Caribou may use some of these areas for relief from insects. The main potential effect on terrestrial mammals that contact spilled oil could be the loss of fewer than 100 caribou and a few muskoxen, grizzly bears, and arctic foxes. These losses are expected to be replaced by normal reproduction within about 1 year. Secondary effects could come from disturbance associated with spill-cleanup activities and temporary local displacement of some caribou, muskoxen, grizzly bears, and foxes. These activities, however, would not affect the terrestrial mammals' movements or overall use of habitat.

Lower Trophic-Level Organisms: Alternative I would disturb lower trophic-level organisms in three primary ways: (1) island construction would bury up to 23 acres of typical benthic organisms; (2) pipeline trenching would disturb additional benthos, burying up to 14 acres with very low (1%) coverage of kelp and marginal kelp substrate; and (3) sediment plumes from pipeline and island construction probably would reduce Boulder Patch kelp production by 2-4% per year. The buried 14 acres are estimated to equal less than 0.1% of the Boulder Patch kelp habitat. The 1% coverage of the kelp and marginal substrate in the pipeline corridor means that the lost kelp biomass and production probably would be less than 0.001% of the Boulder Patch total. However, the effect (burial of kelp substrate) probably would last forever.

Sediment plumes from pipeline trenching and island construction probably would drift over other parts of the Boulder Patch, reducing light penetration and kelp production. The production probably would be reduced slightly due to winter construction of the island, but the reduction is estimated to be within levels of natural variation. Pipeline-installation activities during kelp-growth Year 2 probably would reduce annual production by about 4%. In Year 3, the kelp production probably would be reduced by 2% during the summer growth season due to sediment dispersal from stockpile Zone 1. Therefore, the overall effect would extend over three consecutive kelp-growth years, and about one-third of the effect would be due to the proposed stockpile.

Kelp and other organisms that grow on hard substrates would colonize the island's concrete slope from 6-feet deep to the seafloor. This 3-acre portion of the concrete slope probably would become a kelp habitat within a decade. Upon abandonment, the concrete mats probably would become buried naturally or would be removed, cutting back on the new kelp habitat. BPXA also could mitigate some trenching effects, if excess quarry boulders were placed on the backfill in the outer portion of the trench. Boulder Patch studies showed that bare rocks were colonized by kelp within a decade, and quarry boulders probably would help to reduce the longevity of trenching effects from "permanent" to approximately "decade long."

Kelp growth within about 14 acres or 0.1% of the Boulder Patch probably would be decreased annually by thickened ice roads during the life of the project. BPXA could mitigate the effect by extending the proposed route about 5% around the southern part of the Boulder Patch.

A large, offshore oil spill probably would have short-term effects on plankton and long-term effects on the fouled coastlines. Up to one-third of the Stefansson Sound coastline would be affected by a large spill in open water. While the ice-gouged coastline is inhabited by mobile, seasonal invertebrate species that probably would recover within a year, fractions of the oil probably would persist in the sediments for about 5 years in most areas, and probably would persist up to 10 years in areas where water circulation is reduced. Liberty crude is highly viscous and particularly resistant to natural dispersion; therefore, very little probably would be dispersed down in the water column and affect benthic communities such as the Boulder Patch kelp habitat. However, diesel oil, which would be used on the island for startup and emergency fuel, could be dispersed down to the seafloor. If 1,283 barrels of diesel were spilled from a fuel-delivery barge at the island during the open-water season, the concentration is estimated to be toxic within an area of about 18 square kilometers (7 square miles), as calculated in Section III.C.2.1 Water Quality. Such toxicity probably would stunt the seasonal growth of kelp plants and reduce the population size of associated invertebrates for several years. Oil-spill responses in general would have both minor beneficial and adverse effects on these organisms. The spill risk from fuel barges to the Boulder Patch specifically could be reduced by installing larger fuel tanks on Liberty Island and by filling them primarily by fuel trucks on proposed winter ice roads.

Essential Fish Habitat: As a result of disturbances caused by Liberty Island construction and operation, fish and zooplankton might experience short-term, localized but unmeasurable effects.

Vegetation-Wetland Habitat: Disturbances mainly come from constructing gravel pads and ice roads and installing the onshore pipeline and tie-in with the Badami pipeline. Gravel pads, pipeline trench, and the 1.4-mile-long onshore pipeline would destroy only 0.8 acre of vegetation and affect a few acres of nearby vegetation and have only local effects on the tundra ecosystem. Ice roads would have local effects (compression of tundra under the ice roads) on vegetation, with recovery expected within a few years, and no vegetation would be killed.

The main potential effects of a large offshore spill on vegetation and wetlands include oil fouling, smothering, asphyxiation, and poisoning of plants and associated insects and other small animals. In this case, complete recovery of moderately oiled wetlands of the Sagavanirktok River east to Mikkelsen Bay would take perhaps 10 years or longer. A second main effect is the disturbance of wetlands from cleanup activities. A large onshore spill would oil no more than 5 acres of vegetation along the pipeline landfall to the Badami tie-in and would cause very minor ecological harm. Complete recovery of heavily oiled coastal wetlands from these disturbances and oil could take several decades.

Economy: The Liberty Project could generate approximately $100 million in wages and 870 full-time equivalent construction jobs for 1 year in Alaska during 14-18 months of construction; 1,248 indirect full-time equivalent jobs during the 14-18 months of construction; and $480 million capital expenditure.

Water Quality: The greatest effect on water quality from gravel island and pipeline construction would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality; exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction activities generally are temporary and expected to occur during the winter and end within a few days after construction stops. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. This material would be similar in composition to seafloor sediments in the trenching and disposal areas and its contribution to the future turbidity from waves and currents is expected to be about the same as the sediments existing at the seafloor surface prior to pipeline construction. Available data from site-specific chemical studies indicate construction activities are not expected to introduce or add any chemical pollutants.

(b) Alternative III.A – Use the Southern Island Location and Eastern Pipeline Route

The Southern Island location and eastern pipeline route are shown in Map 1. The features of this alternative are shown in Table II.A-1. This alternative was developed in response to scoping comments requesting analysis of island locations in shallower water to eliminate or reduce effects to bowhead whales.

The features of Alternative III.A that affect the resources differently than Alternative I are island size, island and pipeline location closer to shore, island and pipeline location farther from the Boulder Patch, and offshore and onshore pipeline lengths. The Southern Island is in shallower water, requires about 20% less gravel than Liberty Island, and is about 2 miles closer to shore than Liberty Island. The Southern Island and the offshore end of the eastern pipeline are about 2.5 miles from the Boulder Patch, whereas Liberty Island and the offshore end of the Liberty pipeline are about 1 mile away. The offshore segment of the eastern pipeline is about 1.9 miles shorter than the Liberty pipeline, but the onshore part is 1.6 miles longer.

The effects of disturbances decrease the level of suspended sediments because of the smaller island size, shorter offshore pipeline length, and longer distance to the Boulder Patch. Noise levels increase because of the longer onshore pipeline. The likelihood of a large oil spill contacting the shore in Foggy Island Bay increases because of the shorter distance between the island and the shore. Compared to Alternative I, these differences would change impacts to the following resources in the ways described:

Spectacled Eiders: Compared to Alternative I, helicopter inspections of the onshore pipeline would slightly increase disturbances to nesting (from 0.75-1.5 nests) and broodrearing spectacled eiders.

The probability of contact from a large oil spill on nesting or broodrearing spectacled eiders in the southern part of Foggy Island Bay (Environmental Resource Areas 34, 36; Land Segment 26 (Appendix A, Map A-2)) after 30 days from the island or outer pipeline spill points (L1, AP1) is 3% lower to 10% higher than for Alternative I (Tables A-12, -13, -16, -19, -20, -23 (Appendix A)). Any substantial spill-related mortality in this Arctic Coastal Plain area (USDOI, Fish and Wildlife Service, 2001) is expected to represent a significant loss.

Marine and Coastal Birds: Disturbances to nesting and broodrearing birds from helicopter inspections of the onshore pipeline would increase compared to Alternative I.

The probability of a large oil spill contacting nesting or broodrearing birds in the southern part of Foggy Island Bay after 30 days is 3% lower to 10% higher than for Alternative I (reference details as for spectacled eiders).

Terrestrial Mammals: Terrestrial mammals may frequent coastal habitats, and the probability of a large oil spill contacting these habitats after 30 days is 0-4% greater than for Alternative I.

Lower Trophic-Level Organisms: Trenching for the eastern pipeline would not bury any kelp habitat in contrast to trenching for the Liberty pipeline, which would bury about 14 acres. There would be only minor, short-term effects to organisms in the silty/sandy sediments. Suspended sediments from constructing the eastern pipeline would reduce kelp production in the Boulder Patch about 1% less than from Liberty pipeline construction.

The general effects of a crude oil spill on lower trophic-level organisms would be similar to those for Alternative I; however, the longer distance between the alternative island site and the Boulder Patch kelp habitat would reduce slightly the chance of diesel fuel spill effects to the kelp community.

Essential Fish Habitat: The potential adverse effects of this alternative on essential fish habitat could be reduced slightly, because the size of the island footprint and amount of offshore trenching would be reduced.

Vegetation-Wetland Habitats: The probability of a large oil spill contacting coastal vegetation and wetland habitats after 30 days is 0-4% greater than for Alternative I.

Economy: Alternative III.A could generate fewer jobs, less wages, and less revenue to the government than the Proposal. This alternative would result in a decrease of approximately $1.7 million in wages for 12 months, 9 direct jobs in Alaska for 12 months, 14 indirect jobs in Alaska for 12 months, and $10 million in net present value to the company. The net present value to the government is estimated to be $107 million, or $7 million less than the Proposal.

Water Quality: Southern Island construction requires less gravel and time than Liberty Island, and eastern pipeline construction requires less excavating and backfilling than the Liberty pipeline. The amount of suspended sediments in the water column is estimated to be 14% less during Southern Island construction and 32% less during eastern pipeline construction, compared to the amounts suspended by Liberty Island and pipeline construction, respectively. Suspended sediments from Southern Island and eastern pipeline construction are estimated to be in the water column 3-5 and 15 days less, respectively, compared to Liberty Island (45-60 days) and pipeline (49 days).

(c) Alternative III.B - Use the Tern Island Location and Tern Pipeline Route

The Tern Island and Tern Pipeline Route are shown in Map 1. The features of this alternative are shown in Table II.A-1. This alternative was developed in response to scoping comments regarding the use of the abandoned exploration island as a source of gravel or as a drilling/production island.

The features of Alternative III.B that affect the resources differently than Alternative I are the amount of gravel used to construct the island, the island and pipeline location closer to shore, the island and pipeline location farther from the Boulder Patch, and the offshore pipeline length. Tern Island is in deeper water than Liberty Island but requires about 25% less gravel because of gravel that has remained after the island was abandoned as an exploration drilling site. Tern Island is about 0.6 mile closer to shore than Liberty Island. Tern Island and the offshore end of the pipeline are about 4 miles from the Boulder Patch, whereas Liberty Island and the offshore end of the Liberty pipeline are about 1 mile away. The offshore segment of the Eastern Pipeline is about 0.6 mile shorter than the Liberty pipeline.

The effects of disturbance associated with suspended sediments decrease because of the smaller amount of gravel used to construct the island, the shorter offshore pipeline length, and longer distance to the Boulder Patch. The likelihood of a large oil spill contacting the shore in Foggy Island Bay decreases slightly because of the location of the island and pipeline in relation to the nearshore currents. Compared to Alternative I, these differences would change impacts to the following resources in the ways described:

Spectacled Eiders: The probability of a large oil spill contacting spectacled eiders in the southern part of Foggy Island Bay (Environmental Resource Areas 34, 36; Land Segment 26 (Appendix A, Map A-2)) after 30 days from the island or outer spill points (L1, T1) is 1-5% lower to 4% higher (i.e., similar) than for Alternative I (Tables A-12, -13, -14, -15, 16, -19, 24, -27 (Appendix A)). Any substantial spill-related mortality in this Arctic Coastal Plain area (USDOI, Fish and Wildlife Service, 2001) is expected to represent a significant loss.

Marine and Coastal Birds: The probability of a large oil spill contacting nesting or broodrearing birds in the southern part of Foggy Island Bay after 30 days is 1-5% lower to 4% higher (i.e., similar) than for Alternative I (reference details as for spectacled eiders).

Terrestrial Mammals: Terrestrial mammals may frequent coastal habitats, and the probability of a large oil spill contacting these habitats after 30 days is 0-4% less than Alternative I.

Lower Trophic-Level Organisms: Trenching for the Tern Island pipeline route would not bury any kelp habitat in contrast to trenching for the Liberty pipeline route, which would bury about 14 acres. There would be only minor, short-term effects to organisms in the silty/sandy sediments. Suspended sediments from constructing the Tern Island pipeline route would reduce kelp production in the Boulder Patch by about 1% of that for Liberty pipeline construction.

The general effects of a crude oil spill on lower trophic-level organisms would be similar to those for Alternative I; however, the longer distance between the alternative island site and the Boulder Patch kelp habitat would reduce slightly the chance of effects to the kelp community from diesel fuel spills.

Essential Fish Habitat: The potential adverse effects of this alternative on essential fish habitat could be slightly reduced primarily because of expected smaller effects on fish and algae at the Boulder Patch. The longer distance between Tern Island and the Boulder Patch would reduce the chance of diesel fuel spills to the kelp and associate fish communities. The disturbance effects would be slightly lower for this alternative, because pipeline trenching would not eliminate kelp. Less material would be used to construct Tern Island than Liberty Island, and the total amount of particulate matter suspended would be less. The turbidity plume would be expected to have a shorter duration than the plume associated with Liberty.

Vegetation-Wetland Habitats: The probability of a large oil spill contacting coastal vegetation and wetland habitats after 30 days is 0-4% less than for Alternative I.

Economy: Alternative III.B could generate fewer jobs, less wages, and less revenue to the government than Alternative I. This alternative would result in a decrease of approximately $1.7 million in wages for 12 months, 9 direct jobs in Alaska for 12 months, 14 indirect jobs in Alaska for 12 months, and $10 million in net present value to the company. The net present value to the government is estimated to be $107 million, or $7 million less than Alternative I.

Water Quality: Tern Island construction requires less gravel and time than Liberty Island, and Tern pipeline construction requires less excavating and backfilling than the Liberty pipeline. The amount of suspended sediments in the water column is estimated to be 25% less during Tern Island construction and 10% less during Tern pipeline construction, compared to the amounts suspended by Liberty Island and pipeline construction, respectively. Suspended sediments from Tern Island and pipeline construction are estimated to be in the water column 15 and 5 days less, respectively, compared to Liberty Island (45-60 days) and pipeline (49 days).

(2) Effects of Alternative Pipeline Designs

This set of component alternatives evaluates the different impacts of using four different pipeline designs:

- Alternative I - Use Single Steel Wall Pipe System (Liberty Development and Production Plan)
- Alternatives IV.A - Use Pipe-in-Pipe System
- Alternative IV.B - Use Pipe-in-HDPE System
- Alternative IV.C - Use Flexible Pipe System

Alternatives IV.A, IV.B, and IV.C were identified during scoping by members of the Liberty Interagency Team. Some of the team members expressed concern about pipeline safety and wanted MMS to investigate further whether alternative pipeline designs could reduce the potential for oil spills to enter the marine environment. Each of the alternatives in this section evaluates the impacts of using different pipeline designs. Each of these design alternatives is based on a conceptual engineering report by INTEC (2000).

Evaluation of the pipeline designs in the EIS is based on the following reports:

An Engineering Assessment of Double Versus Single Wall Designs for Offshore Pipelines in an Arctic Environment (Center for Cold Oceans Resource Engineering [C-CORE], 2000). This study compared the advantages and disadvantages of pipe-in-pipe and single-wall pipe designs in general and was not based on a specific project.

Pipeline System Alternatives - Liberty Development Project Conceptual Engineering (INTEC, 1999a). The INTEC report contains conceptual engineering designs for the four pipeline designs that are described as the pipeline design alternatives: single-wall pipeline, a steel-in-steel pipe-in-pipe system, a steel pipe-in-HDPE (high-density polyethylene) system, and a flexible pipe system.

Independent Evaluation of Liberty Pipeline System Design Alternatives (Stress Engineering Services, Inc. [Stress], 2000). This study provides an independent review of the INTEC (1999a) report.

INTEC revised their *Pipeline System Alternatives - Liberty Development Project Conceptual Engineering Report* (INTEC, 1999a) after receiving comments from members of the Interagency EIS Team and reviewing the results of the report prepared by Stress. The main body of the revised report is identical to the original report, but INTEC's responses to comments and an addendum, in which all pipeline systems are designed with a 7-foot burial depth, were added to the report. The revised report is referred to in this EIS as INTEC (2000).

Independent Risk Evaluation for the Liberty Pipeline (Fleet Technology Limited [Fleet], 2000). This study was done to get an independent assessment to the risks of spills from the four conceptual pipeline designs in the INTEC (2000) report. The analysis was performed both for the original designs and the designs contained in Addendum A of the INTEC (2000) report, which all have a 7-foot burial depth.

The four studies above generally concurred with, or concluded the following:

- All four pipeline designs proposed by INTEC could be constructed and operated safely.

- The probability of a spill is low for any of the four pipeline designs.
- The steel pipe-in-pipe design provides secondary containment for certain types of failures that, with other design factors held constant, lowers the probability of oil entering the environment.
- The pipe-in-pipe designs would be more complex to construct and repair than the single-walled designs.

For the purpose of this draft EIS, we have categorized all pipeline failures as either functional or containment failures. A functional failure is one where the pipeline is no longer capable of operating as designed, such as excessive bending, becoming oval instead of staying round; in the case of a pipe-in-pipe system, a leak develops in one but not both pipes, but the failure does not result in a leak to the environment. A containment failure is one that would allow oil to enter the environment; in the case of a pipe-in-pipe system, this would require a leak in both pipelines. Both functional and containment failures would require the pipeline to be returned to within design basis parameters or require the operator to prove to the proper regulatory agency(ies) that it is safe to continue operating the pipeline before it can be returned to service.

"Risk" is the product of the probability of a spill and the associated consequences. Pipelines have low probabilities of failure when compared to other types of oil-transportation systems. This is attributed to their simplistic design and the fact that most of them are buried out of harm's way. Any pipeline can be designed to satisfy a target safety level but has certain inherent advantages and disadvantages. Double-wall pipelines reduce the probability of a containment failure but increase the probability of functional failures. The reduction in the probability of containment failure potentially is larger than the increase in the probability of functional failure. The single-wall pipe has a lower probability of functional failure but a higher probability of a containment failure.

The MMS believes that, in general, it is more prudent to spend both time and money trying to reduce the likelihood of an oil spill than in trying to mitigate spill consequences. Because no amount of effort absolutely could guarantee that a pipeline leak would not occur, the MMS participates in and supports oil-spill-cleanup research and testing, and insures compliance with the Oil Pollution Act of 1990 readiness requirements. Pipeline failure rates and expected spill volumes are shown in Table II.C-5.

All of these designs are expected to be able to be constructed in a single construction season. However, it is possible that a second construction season might be needed if there are problems with construction for any of the designs. The more complex the construction processes, the higher the potential for multiple-year construction. All offshore pipeline systems evaluated would be constructed during Year 3 of the project, which is the second winter construction season. This pipeline would be constructed using construction equipment similar to what is used onshore, such as the process used for the Northstar Project. Fabrication and construction of the pipeline would occur from the surface of the ice. The LEOS leak-detection system would be installed on all pipelines. In addition to the LEOS system, pressure-point analysis and mass-balance line-pack compensation leak-detection systems would be installed for all pipeline alternatives. Excess trenching material would be disposed at approved ocean dumping sites.

Higher pipeline construction costs result in higher pipeline tariffs. Higher pipeline tariffs reduce royalty revenue to the Federal Government from the project and, likewise, reduce Section 8(g) payments to the State.

For purposes of analysis, MMS assumes and evaluates an offshore oil spill for all pipeline alternatives. This analysis does not include differences in pipeline failure rates as calculated by the four pipeline studies. While the decisionmaker may consider the differences in failure rates, they do not provide measurable differences of environmental impacts to the following resources:

- Bowhead Whales
- Eiders
- Seals, Walruses, Beluga Whales, and Polar Bears
- Marine and Coastal Birds
- Terrestrial Mammals
- Fishes
- Vegetation-Wetland Habitats
- Subsistence-Harvest Patterns
- Sociocultural Systems
- Archaeological Resources
- Air Quality
- Environmental Justice

(a) Alternative I – Use Single-Wall Pipe System (Liberty Development and Production Plan)

The major advantages of a single-wall pipeline are simpler construction, lower construction costs, lower life-cycle costs, and greater inspection reliability (C-CORE, 2000).

The single-wall pipeline system does not have many of the same construction, operations, and maintenance concerns as the other systems, because it is the most widely used type of pipeline, and the inspection and monitoring tools were developed to work on these types of systems. However, by its very design, it does not provide any secondary containment capabilities and, therefore, has a higher risk of a containment failure than the steel pipe-in-pipe system.

For the offshore pipeline, BPXA proposes constructing a single-wall steel pipeline system that would have an outside diameter of 12.75 inches and a wall thickness of 0.688 inch. The system would be protected from corrosion by a dual-layer fusion-bonded epoxy coating and sacrificial anodes. The system would be buried with a minimum burial depth of 7 feet.

Alternative I would have effects to the following resources:

Lower Trophic-Level Organisms: Alternative I would disturb lower trophic-level organisms in three primary ways: (1) island construction would bury up to 23 acres of typical benthic organisms; (2) pipeline trenching would disturb additional benthos, burying up to 14 acres with very low (1%) coverage of kelp and marginal kelp substrate; and (3) sediment plumes from pipeline and island construction probably would reduce Boulder Patch kelp production by 2-4% per year. The buried 14 acres are estimated to equal less than 0.1% of the Boulder Patch kelp habitat. The 1% coverage of the kelp and marginal substrate in the pipeline corridor means that the lost kelp biomass and production probably would be less than 0.001% of the Boulder Patch total. However, the effect (burial of kelp substrate) probably would last forever.

Sediment plumes from pipeline trenching and island construction probably would drift over other parts of the Boulder Patch, reducing light penetration and kelp production. The production probably would be reduced slightly due to winter construction of the island, but the reduction is estimated to be within levels of natural variation. Pipeline-installation activities during kelp-growth Year 2 probably would reduce annual production by about 4%. In Year 3, the kelp production probably would be reduced by 2% during the summer growth season due to sediment dispersal from stockpile Zone 1. Therefore, the overall effect would extend over three consecutive kelp-growth years, and about one-third of the effect would be due to the proposed stockpile.

Kelp and other organisms that grow on hard substrates would colonize the island's concrete slope from 6-feet deep to the seafloor. This 3-acre portion of the concrete slope probably would become a kelp habitat within a decade. Upon abandonment, the concrete mats probably would become buried naturally or would be removed, cutting back on the new kelp habitat. BPXA also could mitigate some trenching effects, if excess quarry boulders were placed on the backfill in the outer portion of the trench. Boulder Patch studies showed that bare rocks were colonized by kelp within a decade, and quarry boulders probably would help to reduce the longevity of trenching effects from "permanent" to approximately "decade long."

Kelp growth within about 14 acres or 0.1% of the Boulder Patch probably would be decreased annually by thickened ice roads during the life of the project. BPXA could mitigate the effect by extending the proposed route about 5% around the southern part of the Boulder Patch.

Essential Fish Habitat: As a result of disturbances caused by Liberty Island construction and operation, fish and zooplankton might experience short-term, localized, but unmeasurable effects.

Economy: The Liberty Project could generate approximately $100 million in wages and 870 full-time equivalent construction jobs for 1 year in Alaska during 14-18 months of construction; 1,248 indirect full-time equivalent jobs during the 14-18 months of construction; and $480 million in capital expenditure.

Water Quality: The greatest effect on water quality from gravel island and pipeline construction would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality; exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction activities generally are temporary and expected to occur during the winter and end within a few days after construction stops. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. This material would be similar in composition to seafloor sediments in the trenching and disposal areas, and its contribution to the future turbidity from waves and currents is expected to be about the same as the sediments existing at the seafloor surface prior to pipeline construction. Available data from site-specific chemical studies indicate construction activities are not expected to introduce or add any chemical pollutants.

(b) Alternative IV.A – Use Pipe-in-Pipe System

The primary benefit provided by this pipeline design is that it reduces the probability of a containment failure.

The C-CORE (2000) study indicated that pipe-in-pipe systems have several advantages over a single-wall pipeline. The primary benefit is the ability to contain leaks from the carrier pipe in the annulus. It is possible that some oil may spill during pipeline repair operations, but spill volumes would be small and spill-response equipment would be onsite; therefore, the effects this would have on the environment would be minor. Containing a leak in the annulus of the pipeline could provide some flexibility in scheduling pipeline repair to minimize the impacts on the species that inhabit the area. For example, if a leak occurred during spring breakup, it might be possible to wait and repair the leak the following winter rather than in the summer, when waterfowl and bowhead whales are in the area. Another benefit of pipe-in-pipe is that the annulus surrounding the carrier pipeline may provide an advantage for leak detection.

The conceptual pipe-in-pipe system would be constructed with a steel inner pipe with an outside diameter of 12.75 inches and a wall thickness of 0.500 inch. The inner pipe would be placed in a steel outer pipe with an outside diameter of 16.00 inches and a wall thickness of 0.844 inch. The inner pipe would be supported in the outer pipe with annular spacers, or centralizers. The outer pipe would be protected from external corrosion by a dual-layer fusion-bonded epoxy and sacrificial anodes. The inner pipe would be protected from corrosion by a dual-layer fusion-bonded epoxy. For the EIS analysis, we assume the double-wall pipeline design, as well as the other pipeline designs, can be built in a single winter construction season. However, due to the substantially increased weight of the double-wall system, as compared to the other designs, INTEC (2000) calculated that floating sea ice along the pipeline route would have to be 2 feet thicker for the pipe-in-pipe design than the other alternatives to ensure safe working conditions. This additional ice thickness would take approximately 10 additional days to achieve. Because this alternative requires additional time to prepare a safe worksite when compared to the others, it is more sensitive to weather delays and, therefore, would have a higher potential for requiring a second winter construction season. The added complexity of the construction process also increases the potential for construction-related problems and further would increase the potential for a second winter construction season. The system would be buried with a minimum burial depth of 5 feet.

Using a pipe-in-pipe design adds some complexity to construction, operations, maintenance, and monitoring plans. The added complexity is a result of the following concerns. The steel outer pipe can be cathodically protected in the same fashion as a single-wall pipeline and the status of the cathodic protection monitored at the island and shore crossing, but it cannot be smart pigged; therefore, its overall corrosion-monitoring capabilities are somewhat reduced when compared to a single-wall pipeline. The design does not incorporate a cathodic protection system for the inner pipe and instead relies on protective coatings to prevent corrosion of the inner pipe. The Stress (2000) report suggests that it may be feasible to install a cathodic protection system to the inner pipe that should work in the event that the annulus becomes contaminated with water. There are approximately twice as many welds. Some cannot be tested by both nondestructive testing methods that would be used on the other welds. While either test alone should be sufficient to determine if a weld is acceptable, each test method works differently and is better at detecting certain types of weld imperfections. The U.S. Department of Transportation has expressed concern about the inability to perform the full suite of tests on some of the welds.

The feature of Alternative IV.A that affects the resources differently than Alternative I is the pipeline burial depth. The pipe-in-pipe pipeline system is heavier than the single steel wall pipeline system in Alternative I and, thus, needs less of the overburden fill material to prevent upheaval buckling from thermal expansion when oil flows through the pipeline. The minimum burial depth for the pipe-in-pipe and single steel wall systems are 5 and 7 feet, respectively; the average minimum trench depths are 9 and 10.5 feet, respectively. The volume of material excavated and later used as backfill for the pipe-in-pipe and single steel wall trenches is 557,300 and 724,000 cubic yards, respectively (Table II.C-3).

The effects of disturbances from pipeline construction would decrease because of the shallower excavation depth and smaller seafloor surface area affected. Disturbances from suspended sediments would decrease because of the smaller volume, about 23% less, of sediment excavated and used as backfill.

This alternative, compared to Alternative I, would change the impacts to the following resources in the ways described:

Lower Trophic-Level Organisms: Shallower burial along the Alternative I pipeline route would permanently eliminate 15 fewer acres of very diffuse kelp, boulder, and suitable substrate than would the Alternative I burial depth. The amount of turbidity generated by shallower burial would be only two-thirds of that for Alternative I, probably causing less reduction in annual kelp production during the construction phase.

Essential Fish Habitat: Water quality is expected to be improved, because the total amount of suspended-particulate matter would be less than under Alternative I (Liberty Development and Production Plan).

Economy: Alternative IV.A could generate more jobs, greater wages, and greater capital expenditure than Alternative I. This alternative would result in an increase of $4 million in wages for 7 months; 45 direct jobs in pipeline construction in Alaska for 7 months; 68 indirect jobs in Alaska for 7 months; and $20 million in capital expenditures. The increased cost of this alternative is based primarily on additional labor, welding, and material costs.

Water Quality: The duration of turbidity from pipe-in-pipe pipeline construction is expected to be 11 days shorter than the Liberty pipeline (49 days). The overall effects of turbidity are expected to be about 23% less for the pipe-in-pipe pipeline construction compared to the Liberty pipeline construction.

(c) Alternative IV.B – Use Pipe-in-HDPE System

The primary benefits provided by this pipeline design are that it provides secondary containment against small leaks, and the outer pipe cannot corrode.

This alternative uses a steel carrier pipe, which is identical to Alternative I. That carrier pipe is placed inside a high-density polyethylene sleeve with a diameter of 16.25 inches and a wall thickness of 0.75 inches.

Using a pipe-in-HDPE design adds some complexity to the construction, operations, maintenance, and monitoring of the system. The complexity arises from concerns in the following areas. The HDPE system is more susceptible to damage during installation than the other alternatives due to weaker material properties of the HDPE as compared to steel. The design does not incorporate a cathodic protection system for the inner pipe and instead relies on protective coatings to prevent corrosion of the inner pipe. The Stress (2000) report suggests that it may be feasible to install a cathodic protection system to the inner pipe that should work in the event the annulus becomes contaminated with water. The condition of the HDPE outer pipe cannot be monitored as effectively as a single-wall pipeline. Because corrosion is not a concern for the outer HDPE pipe, the lack of outer pipe monitoring capabilities for the pipe-in-HDPE design are not as relevant a concern as they are with the steel pipe-in-pipe design. However, the outer pipe of the pipe-in-HDPE design is weaker than the outer pipe of the steel pipe-in-pipe design; therefore, the reduced outer pipe defect monitoring capabilities are more of a concern as they relate to physical damage to the outer pipe. As designed, the HDPE casing would not be able to contain the operating pressure of the pipeline. It would be possible to design an HDPE pipe to contain the full operating pressure of the pipeline, but the diameter and wall thickness of the pipe would be so large that pipeline buoyancy would become a major concern during design and installation. The ability to verify the joining of the HDPE and the ability to repair HDPE to original integrity is unknown.

The minimum burial depth for the pipe-in-HDPE is 6 feet; the average minimum trench depth is 10 feet. The volume of material excavated and later used as backfill for the pipe-in-HDPE is 673,920 cubic yards (Table II.C-3).

The effects of disturbance from pipeline construction would decrease because of the shallower excavation depth and the smaller seafloor surface area affected. Disturbance from suspended sediments would decrease because of the smaller volume, about 7% less, of sediment excavated and used as backfill.

This alternative, compared to Alternative I, would change the impacts to the following resources in the ways described:

Lower Trophic-Level Organisms: The pipe-in-HDPE would require less burial depth, causing fewer effects than Alternative I in two important ways: (1) shallower burial in the Alternative I pipeline route would permanently eliminate 2 fewer acres of very diffuse kelp, boulder, and suitable substrate than the Alternative I burial depth; and (2) the amount of turbidity generated by shallower burial would be only two-thirds of that for Alternative I, probably causing less reduction in annual kelp production during the construction phase.

Essential Fish Habitat: Water quality is expected to be improved slightly, because the total amount of suspended-particulate matter would be slightly less than under Alternative I.

Economy: Alternative IV.B could generate more jobs, greater wages, and greater capital expenditures than Alternative I. This alternative could result in an increase of \$2.1 million in wages for 7 months; 19 direct jobs in pipeline construction in Alaska for 7 months; 29 indirect jobs in Alaska for 7 months; and \$12.9 million in capital expenditures. The increased cost of this alternative is based primarily on additional installation costs, and they reflect the new costs developed by INTEC for single season construction of the pipeline. Note that all pipeline designs have a standard 10% contingency (see INTEC, 2000).

Water Quality: The duration of turbidity from pipe-in-pipe pipeline construction is expected to be 4 days shorter than the Liberty pipeline (49 days). The overall effects of turbidity are expected to be about 7% lower for the pipe-in-HDPE pipeline as compared to the Liberty pipeline construction.

(d) Alternative IV.C – Use Flexible Pipe System

The primary benefit of the flexible pipeline system is that it requires the least amount of trenching and, therefore, introduces the least amount of sediments into the water column. Also, because it is shipped on large spools, its installation process is very simple and can be completed more quickly then any of the other pipeline designs. The probability of a containment failure is, at best, no better than for a single-wall pipeline, and the system has the highest probability of a functional failure. Because the system is manufactured in long, continuous sections, it may be necessary to replace entire sections of the pipe, approximately 2,800 feet in length, depending on the location and nature of the damage. The flexible pipe system is constructed of multiple layers of metallic and nonmetallic materials—a design that makes pipeline monitoring more complex than the other systems.

For purposes of analysis in the EIS, we do not consider the annulus of the flexible pipe to have any containment capabilities, although the flexible pipe has many different layers in its design.

This pipe system would be constructed with an internal diameter of 12 inches of flexible pipe with a wall thickness of 1.47 inches. The flexible pipe is a nonbonded pipe made of thermoplastic layers and steel strips. The plastic layers provide very limited containment, and they transfer the pressure loads to the steel strips. The pipe has eight layers: an inner interlocked steel carcass; a pressure thermoplastic sheath; two layers of armor wires; fabric tape; and a polyethylene external sheath. The minimum burial depth for the flexible pipe system is 5 feet; the average minimum trench depth is 8.5 feet. The volume of material excavated and later used as backfill is 498,960 cubic yards (Table II.C-3).

The effects of disturbances from pipeline construction would decrease because of the shallower excavation depth and less of the seafloor surface area is affected. Disturbances from suspended sediments would decrease because of the smaller volume, about 31% less, of sediment excavated and used as backfill as compared to the single-wall pipeline.

This alternative, compared to Alternative I, would change the impacts to the following resources in the ways described:

Lower Trophic-Level Organisms: Shallower burial in the Alternative I pipeline route would permanently eliminate 2 fewer acres of very diffuse kelp, boulder, and suitable substrate than the Alternative I burial depth. The amount of turbidity generated by shallower burial would be only two-thirds of that for Alternative I, probably causing less reduction in annual kelp production during the construction phase.

Essential Fish Habitat: Water quality is expected to be improved, because the total amount of suspended-particulate matter would be less than under Alternative I.

Economy: Alternative IV.C could generate more jobs, greater wages, and greater capital expenditures than Alternative I. This alternative could result in increases of $0.9 million in wages for 7 months; 8 direct jobs in pipeline construction in Alaska for 7 months; 12 indirect jobs in Alaska for 7 months; and $5.1 million in capital expenditures. The increased cost of this alternative is based primarily on increased material cost.

Water Quality: The duration of turbidity from flexible pipe pipeline construction is expected to be 15 days shorter as compared to the Liberty pipeline (49 days). The overall effects of turbidity are expected to be about 31% lower for the flexible pipeline construction compared to Liberty pipeline construction.

(3) Effects of Alternative Upper Island Slope-Protection Systems

This component set of alternatives evaluates the effects for two options that provide upper slope protection to the gravel island.

- Alternative I - Use Gravel Bags, would use gravel bags similar to those used at the Endicott Island.
- Alternative V - Use Steel Sheetpile, would use steel sheetpile similar to the system installed at the Northstar Project.

The impacts to the following resources would be the same for both, because they are not impacted differently by the unique aspects of this alternative:

- Bowhead Whales
- Eiders
- Seals, Walruses, Beluga Whales, and Polar Bears
- Marine and Coastal Birds
- Terrestrial Mammals
- Lower Trophic-Level Organisms
- Fishes and Essential Fish Habitat
- Vegetation-Wetland Habitat
- Subsistence-Harvest Patterns
- Archaeological Resources
- Economy
- Water Quality
- Air Quality
- Environmental Justice

(a) Alternative I - Use Gravel Bags (Liberty Development and Production Plan)

Gravel bags would be used in the upper portion of the island slope starting at 7-8 feet above sea level and continuing to the top of the berm, which is 23 feet above sea level and 8 feet above the working surface of the island. The bags would be placed in an overlapping pattern. A gravel bench covered with concrete mats extending more than 40 feet from the base of the gravel bags to the sea surface would dampen wave energy approaching the island and induce natural formation of ice rubble. The gravel bags would be used only in the upper portion of the island to keep them from contact with direct forces from ice or wave action which would lessen potential damage and dislocation, and protect the surface of the island from the unlikely event of further ice rideup.

BPXA's proposed use of gravel bags for this project is quite different from previous exploration island construction. The bags proposed for use in Liberty Island construction are made from a polyester material that does not float. BPXA would monitor ice events at or near the island and repair or replace any torn or ripped bags as part of their ongoing maintenance program. With proposed BPXA maintenance, it is highly unlikely that a gravel bag would be ripped or torn during an ice event and not repaired before a wave event could wash the bag into the ocean. In the unlikely event a bag or part of a bag is washed into the marine environment, the bag would not float but sink to the bottom. BPXA would remove all of the gravel bags used in the upper slope-protection system at project abandonment.

Alternative I would have effects to the sociocultural systems described below.

Sociocultural Systems: Using gravel bags would contribute to ongoing concerns of local subsistence hunters about gravel bags from past gravel exploration islands contaminating the environment and creating navigation hazards for whaling boats. This increased stress of local Inupiat could be considered a slight increase in effects to sociocultural systems and could be construed as not taking into account local knowledge and concern for the local offshore environment and its resources.

(b) Alternative V - Use Steel Sheetpile

This alternative was developed to eliminate the potential of gravel bags entering the environment and becoming a hazard to local navigation, especially to bowhead whaling vessels.

Under this alternative, steel sheetpile would protect the upper part of Liberty Island; no gravel-filled bags would be on the island. The sheetpile would be similar to that used for Seal Island in the Northstar Development Project. This alternative would eliminate the need for gravel bags as upper slope protection, which would eliminate the possibility of damaged bags entering the environment as a result of a storm or ice event. The sheetpile would be designed to carry the surface loads. It would protect the island above the concrete blocks used for lower slope protection and would weather to a natural rust color. The steel sheetpile would be removed when the island is abandoned.

The specific components of using steel sheetpile for upper island slope protection, as described, would change the impacts only to sociocultural systems as described in the following:

Sociocultural Systems: Using steel sheetpile in island construction would relieve ongoing concerns of local subsistence hunters about gravel bags from past gravel exploration island developments contaminating the environment and creating navigation hazards for whaling boats. Using steel sheetpile would serve to reduce overall stress in the local Inupiat population, particularly Nuiqsut, over the development of Liberty Island in the Beaufort Sea offshore environment. This reduction in stress of local Inupiat could be considered a slight reduction in effects to sociocultural systems and could be construed as taking into account local knowledge and concern for the offshore environment and its resources.

(4) Effects of Alternative Gravel-Mine Sites

This set of component alternatives evaluates two different gravel mine sites.

- Alternative I - Use the Kadleroshilik River Mine Site (Liberty Development and Production Plan) evaluates the effects of creating a new mine site at the Kadleroshilik River.
- Alternative VI - Use Duck Island Mine Site evaluates the existing Duck Island Mine Site (see Map 1), which was used as a gravel source for the Endicott Project and other projects. Key components of these alternatives are summarized in Table II.A-1.

The differences in mine site locations for Alternatives I and VI do not provide measurable differences to the following resources:

- Bowhead Whales
- Subsistence-Harvest Patterns
- Sociocultural Systems
- Archaeological Resources
- Environmental Justice

(a) Alternative I – Use Kadleroshilik River Mine (Liberty Development and Production Plan)

The Kadleroshilik River mine site is approximately 1.4 miles south of Foggy Island Bay, with a ground surface elevation of 6-10 feet above mean sea level (BPXA, 2000a). The mine site is in a region of riverine barrens and alluvial floodplain. BPXA has estimated that the proposed site is about 40% dry dwarf shrub/lichen tundra, 10% dry barren/dwarf shrub and forb grass complex, and 50% river gravel. The development of this mine site would destroy about 24 acres of wetland habitat.

The development mine site is approximately 31 acres, with the primary excavation area developed in two cells. The first cell would be approximately 19 acres and developed in Year 2; it would support construction of the gravel island. The second cell is approximately 12 acres and would support pipeline construction activities in Year 3 (Noel and McKendrick, 2000).

Mining would not extend into the active river channel; a dike approximately 50 feet wide would be left in place between the mine site and the river channel while mining operations are under way. Gravel would be excavated by blasting, ripping, and removing material in two 20-foot lifts to a total depth of 40-plus feet below the ground surface. Some portion of the lower 20-foot lift may be left in place, if all gravel available from the site is not needed to meet island requirements.

After usable gravel has been removed from the mine, material unsuitable for construction (for example, unusable material stockpiled during mining) would be placed back into the mine excavation. This backfilled material would be used to create a shelf (at approximately mean water level) along one side of the mine to improve future habitat potential. The backfilled area would provide substrate and nutrients to support revegetation and improve future habitat potential of the constructed shelf along the mine wall.

Alternative I, would have effects to the following resources:

Spectacled Eiders: Although less than 1% of the proposed gravel island quarry site in the Kadleroshilik River would be characterized as good spectacled eider nesting habitat (presence of waterbodies lasting through the nesting period). The numbers of nesting eiders displaced from the Kadleroshilik site (Alternative I) is likely to be very low. Past surveys have located eiders in the vicinity of the Kadleroshilik area along the river corridor. However, significant effects to this species are not expected to occur from mining activities at the proposed Kadleroshilik River mine site.

Seals, Walruses, Beluga Whales, and Polar Bears: Using the Kadleroshilik River mine site rather than the Duck Island gravel mine site may increase potential noise and disturbance of denning polar bears in the Kadleroshilik River area during winter. However, the number of bears potentially displaced would be low and would not affect polar bear populations. Seals, walruses, and beluga whales are not expected to be exposed to onshore mining operations.

Marine and Coastal Birds: Bird nest density and average density of individuals for 14 bird species on tundra habitats in the general vicinity of the in 1994 at the Kadleroshilik River area there are 44.3 nests and 108.3 birds/square kilometer. The numbers of nesting birds displaced from the Kadleroshilik area (Alternative I) would be low. Species observed using the island for breeding or were frequently present during a recent survey include Canada goose, black-bellied plover, lesser golden-plover, ruddy turnstone, buff-breasted sandpiper, long-tailed jaeger, rock ptarmigan, and Lapland longspur. However, significant effects are not expected to occur as a result of such disturbance.

Terrestrial Mammals: Using the Kadleroshilik River mine could increase potential noise and disturbance to muskoxen from ice-road traffic and mining activities in the Kadleroshilik River area during winter. The highest levels would be during construction, but some activities would be expected during the 15-20 year life of the project. The disturbances would have short-term effects on individual animals and would not affect the population.

Lower Trophic-Level Organisms: Alternative I would disturb lower trophic-level organisms in three primary ways: (1) island construction would bury up to 23 acres of typical benthic organisms; (2) pipeline trenching would disturb additional benthos, burying up to 14 acres with very low (1%) coverage of kelp and marginal kelp substrate; and (3) sediment plumes from pipeline and island construction probably would reduce Boulder Patch kelp production by 2-4% per year. The buried 14 acres are estimated to equal less than 0.1% of the Boulder Patch kelp habitat. The 1% coverage of the kelp and marginal substrate in the pipeline corridor means that the lost kelp biomass and production probably would be less than 0.001% of the Boulder Patch total. However, the effect (burial of kelp substrate) probably would last forever.

Sediment plumes from pipeline trenching and island construction probably would drift over other parts of the Boulder Patch, reducing light penetration and kelp production. The production probably would be reduced slightly due to winter construction of the island, but the reduction is estimated to be within levels of natural variation. Pipeline-installation activities during kelp-growth Year 2 probably would reduce annual production by about 4%. In Year 3, the kelp production probably would be reduced by 2% during the summer growth season due to sediment dispersal from stockpile Zone 1. Therefore, the overall effect would extend over three consecutive kelp-growth years, and about one-third of the effect would be due to the proposed stockpile.

Kelp and other organisms that grow on hard substrates would colonize the island's concrete slope from 6-feet deep to the seafloor. This 3-acre portion of the concrete slope probably would become a kelp habitat within a decade. Upon abandonment, the concrete mats probably would become buried naturally or would be removed, cutting back on the new kelp habitat. BPXA also could mitigate some trenching effects, if excess quarry boulders were placed on the backfill in the outer portion of the trench. Boulder Patch studies showed that bare rocks were colonized by kelp within a decade, and quarry boulders probably would help to reduce the longevity of trenching effects from "permanent" to approximately "decade long."

Kelp growth within about 14 acres or 0.1% of the Boulder Patch probably would be decreased annually by thickened ice roads during the life of the project. BPXA could mitigate the effect by extending the proposed route about 5% around the southern part of the Boulder Patch.

Fishes: To our knowledge, the Kadleroshilik River does not support overwintering fish. However, if it did, the effects from mining at the Kadleroshilik mine site during the winter on most overwintering fish would be expected to be short term and sublethal, with no measurable effect on overwintering fish populations. After the mine site becomes accessible to fishes, it may benefit them by providing the first viable overwintering habitat in this region of the Kadleroshilik River. This assumes that the mine site depth is adequate (i.e., 20 feet or more), and that oxygen levels remain sufficient during winter to support the number of fishes under the ice. While the Kadleroshilik River mine site possibly could create overwintering habitat, the Duck Island mine site would eliminate any possibility of disturbing fish.

Essential Fish Habitat: The Kadleroshilik River mine site would create potential overwintering habitat on the Kadleroshilik River for fish that potentially would serve as prey for salmon.

Vegetation-Wetland Habitats: Gravel mining is likely to have a minimal effect on overall vegetation-wetland habitats in the project area. The development of this mine site would destroy about 24 acres of wetland habitat. The gravel mining operations on State land would be required to have Section 404/10 permit and approval by the Corps of Engineers, as stated in BPXA's Development and Production Plan (BPXA, 2000a). The permit and approval process is expected to minimize adverse effects on wetlands. We assume that all associated work would occur in winter, resulting in little or no dust on adjacent vegetation. Any moisture-regime changes resulting from snow drifting would be confined to fewer than 20 acres at the mine site. Conducting mining operations during winter would lessen impacts on vegetation and wetland habitats. Winter operations and the use of ice roads for transporting the gravel would avoid the need to build gravel roads that would increase effects on tundra vegetation along any onshore transportation routes. Rehabilitation of the mine site would include flooding of the mine pit by connecting it with a river channel. The pit also would be used as a source of water for the construction of ice roads during winter.

Economy: Alternative I could generate approximately $100 million in wages and 870 full-time equivalent construction jobs for 1 year in Alaska during 14-18 months of construction; 1,248 indirect full-time equivalent jobs during the 14-18 months of construction; and $480 million in capital expenditure.

Water Quality: The general effects of disturbances are analyzed in Section III.C.3.l(2)(a) in the EIS. The greatest effect on water quality from gravel island and pipeline construction would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality (Section III.C.3.l(2) in this EIS); exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction activities generally are temporary and expected to occur during the winter and end within a few days after construction stops. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. This material would be similar in composition to seafloor sediments in the trenching and disposal areas, and its contribution to the future turbidity from waves and currents is expected to be about the same as the sediments existing at the seafloor surface before pipeline construction. Available data from site-specific chemical studies indicate construction activities are not expected to introduce or add any chemical pollutants.

Air Quality: The proposed Liberty Project would affect air quality in several ways, but the overall effects would be very low. The general effects of a large spill and the effects of oil-spill-cleanup activities are analyzed in Section III.C.2.m(2) of the EIS. An oil spill could cause an increase in hydrocarbon air pollutants, as discussed in Section III.C.2.m and summarized in Section III.A.1.m of the EIS. The overall effects on air quality would be minimal.

The most noticeable effects on air quality would be caused by emissions from equipment. This is discussed in detail in Section III.D.1.m of the EIS. That section concludes that the Liberty Proposal would cause a small, local increase in the concentrations of criteria pollutants. Concentrations would be within the Prevention of Significant Deterioration Class II limits and National Ambient Air Quality Standards. Therefore, the effects would be low.

(b) Alternative VI - Use the Duck Island Gravel Mine

This alternative was developed to provide less onshore noise disturbance and habitat alteration from gravel mining.

Under Alternative VI, the existing Duck Island gravel mine would be mined to provide gravel for the project. To get the required gravel for the project from the Duck Island mine site, BPXA would need to deepen a portion of the gravel pit by 20-40 feet (6-12 meters). This site does not require any overburden to be removed, and it would reduce the cost of snow and ice removal by about half. Eventually, BPXA would need to rehabilitate the site, but the Liberty Project would share a portion of the total costs.

Under this alternative, BPXA also would need to remove water from the mine before extracting the gravel. At the current permitted rate, it would take more than 400 days to remove the estimated 600 million gallons of water from the mine site. This water could go to adjacent tundra or creeks under the current general National Pollutant Discharge Elimination System permit. However, BPXA's preferred construction method would be to obtain a modified permit to increase appreciably the discharge rate (5-6 million gallons per day) to avoid a delay in the construction schedule.

The Duck Island mine site is about 17.4 miles (28 kilometers, or about 2.7 times) farther from the Liberty Island construction sites than the proposed Kadleroshilik mine. For purposes of analysis, the EIS assumes the use of two different sizes of haul vehicles and the use of a temporary dumping site. The larger of the vehicles (B70's) would haul the gravel from the mine site to a temporary site near the base of the Endicott Causeway. The gravel would be reloaded at the temporary site into smaller trucks (Maxhauls), which would haul the gravel to the island location. This is similar to the process used in the construction of the Northstar gravel island. An ice road 7.9 miles (12.7 kilometers) long from the base of Endicott to the gravel island would need to be constructed and maintained. From there, the distance to any of the three island locations (Liberty, Southern, and Tern) is approximately the same.

This alternative could delay the planned rehabilitation of the Duck Island mine site by a year or more.

The effects of disturbances from noise would decrease at a different mine site and increase from different and longer haul routes. The effects of disturbances from habitat alteration would decrease at the mine site and increase along the haul route.

The specific components of the Alternative VI - Use Duck Island Mine Site as described would change the impacts to the following resources in the ways described:

Spectacled Eiders: Obtaining gravel from the Duck Island gravel mine site on the Sagavanirktok River Delta instead of the proposed Kadleroshilik River quarry site would avoid disturbing any potential nesting habitat at the latter site; thus, any spectacled eiders that nest in that area would not be displaced from disturbed habitat the following summer. Because the potential for eider use of the Duck Island quarry site likely is much lower than the Kadleroshilik site, this may be viewed as a modest benefit if this latter site potentially would be occupied by any spectacled eiders. The nesting density and average density of eiders on tundra habitats in the general vicinity of the two sites were similar (0.3-0.5 nests/square kilometer and 0.4 birds/square kilometer) in 1994. This comparison suggests that there is little difference in the density of eiders in the surrounding potential source areas from which eiders might be drawn to either site. The numbers of nesting eiders displaced from the Kadleroshilik area (Alternative I) is likely to be very low but potentially greater than from the Duck Island site (Alternative VI) as a result of habitat modification and the probable buffering effect of the surrounding berm at the latter site. Past surveys have located eiders in the vicinity of both sites; however, more importantly, several in the Kadleroshilik area have been located along the river corridor. Therefore, this alternative potentially could have a lesser adverse effect on the spectacled eider population than obtaining gravel from the Kadleroshilik River site mine. Significant adverse population effects are not expected to occur as a result of disturbance.

Seals, Walruses, Beluga Whales, and Polar Bears: Using the Duck Island gravel mine rather than the Kadleroshilik River mine site would avoid potential noise and disturbance of denning polar bears in the Kadleroshilik River area during winter. Using this gravel mine site probably would involve an increase in ice-road traffic to and from the Sagavanirktok River to Liberty Island, which could present a potential increase in disturbance of polar bears and seals in this area. The potential effect on polar bears from mining and other development activities could be reduced along the coast of the Kadleroshilik River. Seals, walruses, and beluga whales are not expected to be exposed to onshore mining operations.

Marine and Coastal Birds: Obtaining gravel from the Duck Island gravel mine site on the Sagavanirktok River Delta instead of the proposed Kadleroshilik River site would avoid disturbing any potential resting, foraging, or nesting habitat at the latter site, which is undisturbed and has greater vegetative cover and habitat diversity. Thus, any of several shorebird, waterfowl, and passerine species and associated predatory species that may occupy the Kadleroshilik area would not be displaced from habitats disturbed by quarrying. Species observed using the island for breeding or were frequently present during a recent survey included the Canada goose, black-bellied plover, lesser golden-plover, ruddy turnstone, buff-breasted sandpiper, long-tailed jaeger, rock ptarmigan, and Lapland longspur. This alternative, obtaining gravel from the Duck Island mine where principal species observed during a recent survey were few, including the semi-palmated plover, semi-palmated sandpiper, buff-breasted sandpiper, and Lapland longspur, potentially could have a lesser adverse effect on various bird populations than obtaining gravel from the Kadleroshilik River site. Although both sites are assumed to have much lower densities of fewer species than occurs on surrounding tundra areas due to lower habitat diversity, the potential for bird use of the Kadleroshilik site is considerably greater than for the Duck Island site because of its undisturbed character and presence of a variety of habitat types. Bird use of tundra habitats near the two sites is similar. Nest density and average density of 14 species (the Lapland longspur excluded) on tundra habitats in the general vicinity of the two sites were similar (Kadleroshilik River area = 44.3 nests and 108.2 birds per square kilometer; Duck Island area = 46.8 nests and 134.9 birds per square kilometer) in 1994. This comparison suggests that there is little difference in the surrounding potential source areas from which individuals might be drawn to either site. Because most species are not present in winter, activity associated with quarrying and vehicle traffic would not disturb these species at either site. Small numbers of rock ptarmigan could be disturbed at either site. No substantial population effects for any species are expected to occur as a result of using either of these sites. The effect of Alternative VI on marine and coastal birds potentially would be substantially lower than Alternative I.

Terrestrial Mammals: Using the Duck Island gravel mine site rather than the Kadleroshilik River mine site would avoid potential noise and disturbance to muskoxen from ice-road traffic and mining activities in the Kadleroshilik River area during winter. Using the Duck Island gravel mine site would involve a general increase in ice-road traffic to and from this mine site to Liberty Island, which could disturb some overwintering caribou in the area.

Lower Trophic-Level Organisms: For this alternative, the effects of island construction and pipeline trenching would be the same as analyzed for Alternative I, except that gravel probably would be hauled over the Endicott access road and across an ice road to the Liberty island site. A direct ice road would pass over 5 miles of Boulder Patch kelp habitat and could reduce the light transmission and growth of kelp during the spring.

Fishes: While the Duck Island mine site would eliminate any possibility of disturbing fish, it also would eliminate the possibility of creating overwintering habitat on the Kadleroshilik River, as discussed for Alternative I.

Essential Fish Habitat: The potential net effect of this alternative on essential fish habitat is expected to be similar to Alternative I. However, using the Duck Island mine site as a source for gravel would eliminate any possibility of disturbance of fish or algae from increased turbidity and sedimentation downstream of the mine site. It also would eliminate the potential countervailing effect of creating overwintering habitat on the Kadleroshilik River for fish that potentially would serve as prey for salmon.

Vegetation-Wetland Habitats: Using Duck Island-Sagavanirktok River gravel mines rather than the Kadleroshilik River mine site would avoid disturbance of the sparsely vegetated gravel bar on the Kadleroshilik River. Consequently, the disturbance effect on vegetation and wetlands from mining activities would be avoided. Disturbance of vegetation and wetlands from the Liberty Project still would occur at the pipeline landfall site and along the onshore pipeline route. Effects would be local and have very little overall effect on the vegetation and wetland habitats.

Economy: Alternative VI could generate more jobs, greater wages, and greater costs than Alternative I. This alternative could result in an increase of approximately $4.4 million in wages for 14 months, 20 direct jobs in Alaska for 14 months, 30 indirect jobs in Alaska for 14 months, approximately $15 million in costs for gravel island construction, and additional costs associated for gravel mining and hauling for pipeline construction. The increased costs are based on three factors: (1) the cost of dewatering the Duck Island site is about $2.4 million; (2) the distance from the Duck Island mine to the island is about 17.3 miles or about 2.7 times farther from the Kadleroshilik mine, causing increased costs of hauling; and (3) the Duck Island haul route includes preparation of a longer floating-ice segment than the route to the island in Alternative 1.

Water Quality: Increasing the mine dewatering rate from 1.5 to 5 million gallons per day most likely would have little if any measurable effect on the quality of the receiving waters.

Air Quality: The general effects from using this alternative gravel mine site on air quality are expected to be the same as those analyzed for Alternative I in Section IV.C.4.a(10) of the EIS.

If the Duck Island gravel mine is used as a source of gravel for Liberty Island, the gravel would need to be hauled about 17.4 miles (28 kilometers), or about 2.7 times, farther to the Liberty Island construction site than from the proposed Kadleroshilik mine. The potential effects of increasing this distance are analyzed in Section IV.C.4(b)(10) of the EIS.

The effect on air quality at the Liberty Island site from using gravel from the Duck Island mine site should be the same as for Alternative I, using gravel from the Kadleroshilik River mine site.

The differences in air-quality effects from hauling the gravel from the Duck Island mine site (a greater distance than from BPXA's proposed Kadleroshilik mine site) would be a slight increase in the fugitive dust from trucks traveling the greater distance and in the air emissions from truck engines operating for a longer period of time. These air emissions would remain at negligible levels and should have no substantial effect on regional air quality.

(5) Effects of Alternative Pipeline Burial Depths

For purposes of analysis for the EIS, burial depth is defined as the distance between the top of the installed pipeline and the original seafloor, and trench depth is defined as the depth of the trench in relation to the original seafloor. Burial depth always would be less than trench depth. In various locations in the EIS, and in some of the pipeline studies, the term "depth of cover" is used. This term has the same meaning as burial depth.

This set of component alternatives evaluates two different pipeline burial depths. Alternative I - Use a 7-Foot Burial Depth evaluates excavating a trench with a trench depth of 8-12 feet (10.5 foot average trench depth) and burying the pipeline with a minimum burial depth of 7 feet. Alternative VII - Use a 15-Foot Pipeline Trench Depth, evaluates excavating a trench to a maximum 15-foot trench depth, which would result in a minimum 11-foot burial depth. Key components of these alternatives are summarized in Table II.A-1.

The following resources are not affected differently by the unique aspects of this alternative:

- Bowhead Whales
- Eiders
- Marine and Coastal Birds
- Terrestrial Mammals
- Vegetation-Wetlands Habitat
- Subsistence-Harvest Patterns
- Sociocultural Systems
- Archaeological Resources
- Air Quality
- Environmental Justice

(a) Alternative I - Use a 7-Foot Burial Depth (Liberty Development and Production Plan)

For this alternative, the pipeline trench would be an average of 10.5 feet (3.2 meters) deep. The trench depth may vary between 8 and 12 feet (2.4 and 3.7 meters). The trench would be dug using conventional trenching equipment and constructed from the ice surface. The minimum burial depth, assuming a single-wall steel pipe, is 7 feet. The trench at the seafloor would be 61-132 feet wide (18.5-40 meters) for this alternative. This alternative would require excavating and backfilling approximately 724,000 cubic yards of soil (see Table II.A-2). Trenching is estimated to take about 58 days.

Alternative I would have effects to the following resources:

Seals, Walruses, Beluga Whales, and Polar Bears: Construction activity would displace some ringed seals within perhaps 1 kilometer of the production island and along the pipeline route in Foggy Island Bay. This disturbance of seals and polar bears would be local, within about 1 mile along the pipeline route, and would persist for one season. Walruses and beluga whales would not be affected by pipeline burial, because these species do not occur in the project area during the winter season when the pipeline would be buried.

Lower Trophic-Level Organisms: Alternative I would disturb lower trophic-level organisms in three primary ways: (1) island construction would bury about 23 acres of typical benthic organisms; (2) pipeline trenching would disturb additional benthos, burying up to 14 acres with very low (1%) coverage of kelp, boulders, and suitable substrate; and (3) sediment plumes would reduce Boulder Patch kelp production by up to 6% during 1 year. The buried 14 acres would equal less than 0.1% of the Boulder Patch kelp habitat. The density of the kelp, boulders, and suitable substrate in the pipeline corridor is very low, averaging about 1% coverage, so the lost kelp biomass and production probably would be less than 0.001% of the Boulder Patch totals, but the effect (kelp substrate burial) would last forever.

Some of the suspended sediment from pipeline trenching and island construction would drift over other parts of the Boulder Patch, reducing light penetration and kelp production during 1 year. This reduction is estimated to be less than 6%, about one-third of which would be due to the proximity between the Boulder Patch to the Zone 1 disposal area for excess sediments. However, in relation to the large range of natural variability, all of these effects from suspended sediments would be barely detectable.

From 6-feet deep to the seafloor, the island's concrete slope temporarily would benefit kelp and other organisms that need a hard substrate for settlement. This portion of the concrete slope would be a temporary home for colonies of species similar to those of the Boulder Patch area. Upon abandonment, the concrete mats probably would be removed or would become buried naturally, eliminating the additional kelp habitat.

Fishes: Noise and discharges from dredging, gravel mining, island construction, island reshaping, and pipeline trenching associated with Liberty are expected to have no measurable effect on fish populations. While a few fish could be harmed or killed, most in the immediate area would avoid these activities and would be otherwise unaffected. Effects on most overwintering fish are expected to be short term and sublethal, with no measurable effect on overwintering fish populations. Placement of the concrete mat would create additional food resources for fishes and would have a beneficial effect on nearshore fish populations in the Beaufort Sea.

Essential Fish Habitat: As a result of disturbances caused by Liberty Island construction and operation, fish and zooplankton might experience short-term, localized but unmeasurable effects. This would include potential adverse effects from noise during construction and operations and from increased turbidity and sedimentation as a result of dredging, gravel mining, island construction, and pipeline trenching (see Sections III.C.3.e and III.C.3.f of the EIS). Marine plants could be subjected to short-term, localized, negative effects due to mechanical removals of individuals and from sedimentation resulting from pipeline trenching and island construction. Pipeline construction is expected to bury up to 14 acres of kelp and solid substrate, and sediment plumes are expected to reduce kelp production by 6% during 1 year. The effect of disturbance on water quality is discussed in Section III.C.3.l in this EIS. Water quality primarily would be affected by increased turbidity that would result from gravel island and pipeline construction, Liberty Island abandonment, and gravel mine reclamation. Turbidity and salinity of seawater discharged from the Liberty Island production facility are expected to be slightly higher than water in surrounding Foggy Island Bay. All of these disturbances are expected to be fairly localized and short term.

Economy: Alternative I could generate approximately $100 million in wages and 870 full-time equivalent construction jobs for 1 year in Alaska during 14-18 months of construction; and 1,248 indirect full-time equivalent jobs during the 14-18 months of construction.

Water Quality: The greatest effect on water quality from gravel island and pipeline construction would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality; exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction activities generally are temporary and are expected to occur during the winter and end within a few days after construction stops. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. This material would be similar in composition to seafloor sediments in the trenching and disposal areas, and its contribution to the future turbidity from waves and currents is expected to be about the same as the sediments existing at the seafloor surface before pipeline construction. Available data from site-specific chemical studies indicate construction activities are not expected to introduce or add any chemical pollutants.

(b) Alternative VII – Use a 15-Foot Pipeline Trench Depth

This alternative was developed to reduce potential ice scouring and ice-gouging effects to the pipeline.

For this alternative, the pipeline trench depth would be 15-feet (4.6 meters) rather than the proposed 10.5 feet (3.2 meters). This alternative assumes the trench would be dug using the same equipment and constructed from the ice surface, the same as for the other alternatives. For purposes of analysis, we assume an 11-foot minimum burial depth, regardless of the pipeline route or pipeline design. The trench at the seafloor would be 120-200 feet (36.5-61 meters) wide. This greater width would be needed for the 6.1 miles (9.8 kilometers) of offshore pipeline. Table II.C-3 provides information about the trench excavation and backfill quantities for this alternative in combination with the three pipeline routes evaluated in this EIS.

This alternative would require excavating approximately 1,438,560 cubic yards of soil, which almost doubles (98%) the amount of soil excavated under Alternative I. The total area disturbed is greater, about 81 acres, compared to 59 acres for Alternative I. The additional excavation work would add an additional 30 days of trenching time. Increasing the number of days needed for trenching also increases the number of days required for ice maintenance. This alternative would add to the likelihood of not completing the installation of the pipeline in a single winter construction season because of increased handling of excavation and backfill.

The effects of disturbances from suspended sediments would increase because of the deeper pipeline excavation depth and increased trenching and backfilling times. Effects of disturbances from habitat alteration would increase because of the greater seafloor area disturbed and from noise increases associated with longer trenching and backfilling times.

The differences would change some of the impacts to the following resources in the ways described:

Seals, Walruses, Beluga Whales, and Polar Bears: Burying the offshore pipeline deeper would double the amount of benthic habitat altered by pipeline installation. This alternative would increase the amount of time that seals and polar bears would be exposed to noise and disturbance from pipeline dredging and burial activities in Foggy Island Bay. The disturbance of seals and polar bears would be local within about 1 mile along the pipeline route and would persist for one season. Walruses and beluga whales would not be affected by pipeline burial, because these species do not occur in the project area during the winter season when the pipeline would be buried.

Lower Trophic-Level Organisms: Deeper burial in the Alternative I pipeline route would permanently eliminate an additional 3 acres of very diffuse kelp, boulder, and suitable substrate. The amount of turbidity generated by deeper burial would be about two times greater than Alternative I, possibly causing additional reduction in annual kelp production during the construction phase.

Fishes: Alternative VII would be expected to have a slightly greater effect on fishes from temporary displacement than Alternative I, due to more trenching and disturbance.

Essential Fish Habitat: The potential adverse effects of this alternative on essential fish habitat could be slightly increased compared to Alternative I. The chance of oil spills to essential fish habitat would be unchanged. However, deeper burial in the proposed pipeline route would permanently eliminate an additional 3 acres of diffuse kelp and solid substrate. Moreover, the amount of suspended sediments from deeper burial would be about two times greater than Alternative I, possibly causing additional reduction in annual kelp production during the construction phase.

Economy: Alternative VII could generate more jobs and greater wages than Alternative I. Assuming labor costs for construction of the deeper pipeline would increase by as much as two times over those of Alternative I, this alternative could result in increases of $10.8 million in wages, 100 direct jobs in pipeline construction for 7 months in Alaska, and 150 indirect jobs in Alaska. This twofold factor is about in proportion to the volume of additional material to be handled in this alternative as compared to Alternative I. Higher pipeline construction costs result in higher pipeline tariffs. Higher pipeline tariffs reduce royalty revenue to the Federal Government from the project and likewise reduce Section 8(g) payments to the State.

Water Quality: The duration of turbidity from pipeline construction and trenching to a depth of 15 feet is expected to be longer than for the Liberty pipeline trenched to an average depth of 10.5 feet. The overall effects of turbidity are expected to be about 98% greater for the 15-foot trench compared to the 10-foot trench.

c. Comparison of Effects Among Combination Alternatives

As indicated in Section E.3 of the Executive Summary, the Liberty Interagency Team developed three combination alternatives to compare to the BPXA Proposal. A discussion of their relative features and merits follows. Table I-1 shows the relationship between the component alternatives and combination alternatives. Tables IV.D-1 and IV.D-2 compares selected features between the combination alternatives.

Combination Alternative A and the BPXA Proposal (Liberty Island Location - 22-foot water depth) are located at the optimal location for the producing the Liberty Prospect. Combination Alternative B (Southern Island Location - 18-foot water depth) and Combination Alternative C (Tern Island Location - 23-foot water depth) are both 1.5 miles away from the optimal location. Combination Alternatives B and C would require more directional drilling, which increases costs, the time required to develop the field, and the amount of muds and cuttings.

Combination Alternative A (Liberty Island Location with Steel Sheetpile) requires the most gravel: about 20% more gravel than Combination Alternative B (Southern Island Location with Gravel Bags); 7% more gravel than the BPXA Proposal (Liberty Island with Gravel Bags); and, 26% more gravel than Combination Alternative C. Although Combination Alternative C has the largest footprint on the seafloor (26.8 acres), it incorporates existing gravel from the Tern exploration island. Combination Alternative B has the smallest footprint (21.9 acres). The BPXA Proposal and Combination Alternative A have footprints of up to 22.4 and 25.8 acres, respectively. Combination Alternatives B and C use the least amount of gravel. The reduction in gravel is not likely to result in a lower level of effects to most resources.

Combination Alternative A and the BPXA Proposal (Liberty Island Location) are closest to the Boulder Patch area, about 1 mile away. Combination Alternative C (Tern Island) is about 1.5 miles away, and Combination Alternative B is the farthest at 2.5 miles away. Combination Alternative B reduces the impacts of construction (sediment effects) to water quality and the kelp biological community in the Boulder Patch.

Combination Alternative A and the BPXA Proposal use the Liberty Pipeline Route that is 6.1 miles long. It is longer than the routes for Combination Alternative B (Eastern pipeline route) and Combination Alternative C (Tern pipeline route), which are 4.2 and 5.5 miles long, respectively. However, the length of a pipeline in 8 feet or more of water is about the same for Combination Alternatives A and B and for the BPXA Proposal. Combination Alternative C (Tern Pipeline Route) has the greatest length in water depths over 8 feet. Combination Alternative A and the BPXA Proposal have the same 7-foot burial depth. One can argue that a longer offshore pipeline is less safe and would increase the potential for an oil spill, but MMS has found that the oil-spill rate per mile is very small and, for offshore pipelines between 6.1 and 4.2 miles in length, the calculated oil-spill rate essentially is the same. Furthermore, if ice gouging and length of pipe in water depths more than 10 feet beyond the bottomfast-ice zone are the concern, then Combination Alternative C (Tern Pipeline Route) has the greatest length of pipeline (about 5 miles) in water depths of 10 feet or more, compared with the other alternatives at 3 miles.

The longer offshore pipeline length for the Liberty pipeline route and the 7-foot burial depth would require 724,000 cubic yards of material to be excavated and backfilled. Combination Alternative B has a shorter offshore length and a shallower burial depth (6 feet), with a smaller volume of 466,190 cubic yards of material to be excavated and backfilled. Combination Alternative C requires the largest volume of material (1,298,100 cubic yards), which is related to the 15-foot burial depth. There would be some effects to the kelp community and water column during pipeline construction. The pipeline route (Liberty pipeline route) in Combination Alternative A and the BPXA Proposal goes through areas with less than 10% boulders and sediment. Effects to water quality would be less than those in Combination Alternative C, which has a deeper pipeline burial depth. Combination Alternative B has the least effects on water quality. The sediment effects to water quality are short term and local for all alternatives.

Combination Alternatives A, B, and C all offer potential secondary oil containment and have lower risks of containment failure than the single wall pipeline contained in the BPXA Proposal. The Fleet (2000) report estimates the probability of a containment failure that releases 1,000 barrels or more of oil to the environment for Combination Alternatives A and C (pipe-in-pipe) at 0.00234 (0.234%) (Fleet, 2000). The BPXA Proposal and Combination B probability is estimated at 0.0138 (1.38%) (Fleet, 2000). The Combination Alternatives A, B, and C are more likely to suffer a functional failure than the single-wall pipeline design in the BPXA Proposal. The secondary containment afforded by the pipeline designs in Combination Alternatives A, B, and C could provide some flexibility in scheduling a pipeline repair to minimize the impacts on the species that inhabit the area.

The pipe-in-HDPE pipeline design in Combination Alternative B eliminates the problems of corrosion to the outer pipe. However, the HDPE pipeline is not capable of handling the full operating pressure in the carrier pipeline; therefore, it may not provide secondary containment for some situations where it would be provided by a pipe-in-pipe system, which may make annular monitoring more critical.

Combination Alternative A and the BPXA Proposal use the Liberty Pipeline Route with an onshore pipeline length of 1.5 miles. Combination Alternatives B and C use the same pipeline route onshore (eastern pipeline route), which is 3.1 miles long.

Combination Alternative C (pipe-in-pipe and 15-foot burial depth) would be the most expensive pipeline to install. Combination Alternative A (Pipe-in-Pipe and 7-Foot Burial Depth) is next, followed by Combination Alternative B (Pipe-in-HPDE). The BPXA Proposal (Single-Wall Pipe System and 7-Foot Burial Depth) is the least expensive. Increased pipeline costs translate to increased pipeline tariffs, which decreases Federal and State revenue from the project.

In Appendix D-1 of the EIS, MMS estimates the cost of the BPXA Proposal at $384 million and a Net Present Value of $58 million. Combination Alternative A would increase costs by $51.5 million, an increase of 13%. Combination Alternative B would increase costs by $24.5 million, an increase of 6%. Combination Alternative C would increase costs by $59 million, an increase of 16%. In this last case, expected costs would exceed expected revenue. Higher pipeline construction costs also would result in higher pipeline tariffs. Higher pipeline tariffs reduce royalty revenue to the Federal Government from the project and, likewise, reduce Section 8(g) payments to the State.

Combination Alternative A and the BPXA Proposal (Liberty Island Location) would be farther offshore than any of the other island locations and closer to the bowhead whale migration route. It is more likely that noise from drilling and production operations from this island location would affect bowhead whales and the subsistence hunting of bowhead whales. However, our analysis indicates that all of the island locations, including Liberty Island, are located more than 9 kilometers from the bowhead migration route, farther than noise is likely to travel. Bowhead whales and subsistence whale hunting should not be adversely affected by noise from any of the island locations.

Combination Alternatives A and C use steel sheetpile for the upper slope-protection system, which eliminates the potential for gravel bags to enter the marine environment. Gravel bags that are part of Combination Alternative B and the BPXA Proposal would be placed as a berm beginning 7 feet above sea level at the inner edge of a horizontal 40-foot concrete-block buffer zone. Because gravel bags are not used at or below the water line, it is unlikely that gravel bag material would enter the marine environment. These gravel bags would not float in the water. The placement of the steel sheetpile would increase the amount of noise during the construction period. However, construction of the steel sheetpile should be completed before the fall bowhead whale migration.

Combination Alternative B and the BPXA Proposal would use the Kadleroshilik River mine site. The Kadleroshilik River mine site would destroy about 24 acres of wetland habitat, but there also would be the potential for a new fish-overwintering site in the Kadleroshilik River. The haul distance of the gravel from the mine site to the gravel island would be about 6 miles. Combination Alternatives A and C would use the Duck Island mine site. It eliminates all potential effects at the Kadleroshilik River mine site, both beneficial and adverse. There would be no surface disturbance at the Kadleroshilik River mine site, and the potential for a new fish-overwintering site in the Kadleroshilik River would be lost. The mine site would need to be dewatered. The haul distance of the gravel would be increased from 6 miles to about 20 miles. The amount of equipment needed to transport the gravel would be increased, which translates to increased costs.

d. Agency-Preferred Alternatives

The National Environmental Policy Act Council on Environmental Quality Regulations requires an agency-preferred alternative be identified in the final EIS. The U.S. Army Corps of Engineers is prohibited by their regulations from identifying any such alternative. The MMS and the Environmental Protection Agency have reviewed the information in the EIS, comments received on the draft EIS, and other pertinent information and developed the MMS and the Environmental Protection Agency's Agency-Preferred Alternatives.

The following information is provided to meet the requirements of the Council on Environmental Quality but should not be considered as the final decision or approval of the project. Each agency will develop its own Record of Decision following the distribution of this EIS. The final decision(s) and supporting rationale may be different than the preferred alternative described in the following. The MMS Agency-Preferred Alternative is identical to the BPXA Proposal (Alternative I) and the Environmental Protection Agency's Agency-Preferred Alternative is identical to combination Alternative A.

The following text identifies the reasons that MMS and the Environmental Protection Agency selected each component to comprise their respective agency-preferred alternative, followed by the summary of effects. These effects summaries follow the format used for the combination alternatives previously described.

(1) MMS Agency-Preferred Alternative

(a) Description of the MMS Agency-Preferred Alternative

1) Preferred Island Location: Liberty Island

The Liberty Island location is in the optimum site to maximize oil recovery from the primary reservoir in the Liberty Prospect. This is the best location to ensure all of the planned wells reach their targeted locations to achieve conservation of the oil and gas resources by developing them to the maximum extent possible. The extended-reach drilling that would be required at the other alternative island locations would have a higher likelihood of incurring drilling problems. If drilling problems cannot be solved and development wells cannot reach their planned reservoir targets, oil recovery from the reservoir will not be optimal. If the gas-injection wells, which would have the furthest reach from either Tern Island or the Southern Island location, cannot be completed as planned, the potential loss in oil recovery could amount to perhaps 20% (24 million barrels) of the original expected recovery.

For the Tern Island location, about one-third (7 of 22) of the production and injection wells would require advanced drilling technology (extended-reach drilling) to successfully reach reservoir targets up to 3 miles from the production island. We define extended-reach drilling to exist when the horizontal departure is more than 1.5 times the vertical depth; for the Liberty reservoir, this is about a 16,000-foot horizontal departure. For the Southern Island location, about one-seventh (3 of 22) of the production and injection wells would require extended-reach drilling. Although these long wells are technically feasible to drill, they cost more, take longer to drill, use more materials, and have a higher probability of experiencing problems while drilling. The Liberty Island location minimizes the length of all of the wells drilled, which reduces risk. The Liberty Island location is best in terms of well drilling safety and well control (the Liberty Island location includes no planned extended-reach drilled wells).

The total time to complete the planned well program from the alternative island locations easily could increase by one-third (from about 600 days to 850-900 days). Drilling wastes, industrial noise, and duration of activities also would be proportionally greater for drilling from the alternative locations.

At the other alternative Island locations, the potential for decreased oil recovery affects the economic viability of the Liberty Project and income for both BPXA and the Federal Government, which receives taxes and royalty payments from the operator. Using a price of $16 per barrel (the long-term North Slope price of oil as adjusted), failure to recover 24 million barrels of oil represents an income loss of $384 million over the life of the field. From the Government's perspective, the loss in oil recovery is contrary to "conservation of resources" principles stated in the OCS Lands Act.

This location requires the largest amount of gravel to build the island, but the additional gravel does not translate into significant differences in effects to resources.

2) Preferred Pipeline Route: Liberty Pipeline Route

The MMS concludes that the preferred pipeline route is the BPXA Proposal. The BPXA-proposed Liberty pipeline minimizes the exposure to strudel scour, which is concentrated near the mouths of the Sagavanirktok and Kadleroshilik rivers. The Liberty pipeline route has the shortest onshore route. The Liberty island and pipeline route are inside a group of offshore barrier islands. The entire route is more than 10 kilometers (about 6 miles) from the bowhead migration route. The bowhead whale migration occurs outside the barrier islands. The construction of the pipeline would occur during the winter, when whales and other migratory species are not present.

The applicant's proposed Liberty pipeline route would disturb about 14 acres of 1% boulders (the seafloor surface area has boulders that cover about 1% of the total area). This type of habitat is not unique; neither is the loss of kelp production (less than 0.6 % of the annual production in the Boulder Patch area) considered significant.

3) Preferred Pipeline Design: Single-Wall Pipe System

The MMS concludes that a single-wall pipeline is the best and safest technology for the Liberty development project. The single-wall pipeline design can be inspected and monitored by multiple and redundant methods over the life of the project. Thus, identified problems can be repaired before a leak occurs. BPXA's proposed single-wall pipeline is designed specifically for the arctic offshore environment. The pipe itself will be similar to the one used for the Northstar Project. All of the alternative pipeline designs have essentially the same environment effects. All of the designs have a low probability of failure. The pipe-in-pipe system would be a little less likely to release oil to the environment but more likely to require repair. The ability to monitor the integrity of the inner pipe by inline inspection tools is reduced because of interference from the outer pipe. The integrity of the outer pipe can be determined only on a pass/fail basis and does not give any indication as to how close to failure the outer pipe may be. The inability to monitor the outer pipe reduces MMS's confidence that it actually would provide secondary containment in the unlikely event of a leak from the inner pipe.

The MMS concludes that the inability to monitor the exterior pipe of a pipe-in-pipe system is contrary to the MMS and U.S. Department of Transportation regulations requiring monitoring to ensure pipeline integrity.

A program to manage the pipeline's integrity is very important to the overall operation of the pipeline and to the environmental protection offered by the pipeline. Proper training of pipeline operators and maintenance personnel is another important key to operation of a pipeline and overall environmental protection. The pipeline oversight by the Alaska State Pipeline Coordinator's Office, the U.S. Department of Transportation, and the MMS will ensure that a pipeline-integrity-management plan will be in place to maximize the opportunity of identifying and correcting integrity degradation to the pipeline long before a leak occurs. This oversight also will ensure that pipeline operation and maintenance personnel are properly trained.

The MMS concludes that while internal inspection and repair cannot eliminate all pipeline failures, they can reduce the frequency of these events. Unfortunately, none of pipeline designs can totally eliminate the chance of a spill, which is why MMS believes that integrity monitoring and personnel training are so important.

4) Preferred Upper Island Slope-Protection System: Gravel Bags

During scoping, the use of gravel bags in the upper slope-protection system was identified at meetings on the North Slope as being a key issue.

Past exploration islands typically used gravel bags to protect both the upper and lower parts of the gravel island. These gravel bags were in contact with both the ice and wave forces. Large concrete blocks will be used to protect the lower slope (from the seafloor to 5 feet above the water line). These bags were made of polyethylene and, if damaged, they would float in the water, creating a potential hazard to boats and boat motors. The gravel bags proposed at the Liberty Island would be used only on the upper slope of the island, about 5 feet above sea level and set back more than 40 feet from the island's edge. The bags are made from a polyester material that does not float in the water, which would eliminate the potential damage to boats and boat motors. The gravel bags protect the upper slope of the island from only 5 feet up to about 20 feet. While ice can ride up over the cement blocks and contact the gravel bag, it is unlikely that there would be an ice event where the bags would be ripped or opened immediately followed by a wave or storm event that would wash the bags into the water.

The use of steel sheetpile would require a larger island and, therefore, would have a larger footprint and require more gravel.

5) Preferred Gravel-Mine Site: Kadleroshilik River Mine Site

The Kadleroshilik River mine site, after rehabilitation, would provide fish-overwintering habitat to the Kadleroshilik River, where none exists now. It would minimize the amount of time and distance needed to meet the gravel needs of the project. Rehabilitation of the mine site also would provide shallow-water habitat for birds to feed on fish, rear young, and nest. The Duck Island mine site would increase the amount of time and travel distance needed to develop the gravel needs of the project.

The Kadleroshilik River mine site (Phases I and II) would eliminate about 35 acres of wetland habitat. The loss of this area is a very small portion of the wetlands in the project area.

A potential mitigating measure has been included in the EIS and, if included as a condition of the permit, would require BPXA to reclaim and restore current abandoned gravel sites back to wetland habitat. This could be used to minimize wetland loss but would not reduce the effects at the Kadleroshilik River mine site location, and the effects to the biological resources would be essentially the same.

6) Preferred Pipeline Burial Depth: BPXA's Proposed Burial Depth

The MMS concludes that the pipeline burial depth is best determined by the pipeline design. The minimum burial depth identified in the Development and Production Plan for the single-wall steel pipe design is 7 feet of cover. The MMS and the State Pipeline Coordinator's Office will verify the burial depth through the joint technical review.

(b) Effects of MMS Agency-Preferred Alternative

The MMS Agency-Preferred Alternative is identical to the BPXA Proposal. The reasons and rationale that MMS used to select these component parts are presented in Section II.E. The following narrative compares the MMS Agency Preferred Alternative to the other Combination Alternatives in Section II.D.

The MMS Agency-Preferred Alternative uses Liberty Island and has the longest offshore pipeline at 6.1 miles. The MMS Agency-Preferred Alternative costs the least of all the combinations and is in the optimal location for recovering oil from the reservoir. It is farther offshore than Combination B but about the same distance from shore as Combination C. The single-wall pipeline design does not provide secondary containment, but it has a lower functional failure rate than the other pipeline designs; MMS believes it offers the best design for long-term monitoring of the pipeline operation and integrity using smart pigs. The two pipes in the double-wall pipeline designs in Combinations B and C will result in no pigging information about the condition of the outer pipe and can result in misleading information about portions of the inner pipe.

The MMS Agency-Preferred Alternative would occupy 22.4 acres of the ocean floor for construction of the island. It also would cause the temporary disturbance of 59 acres of ocean-floor habitat due to trenching the pipeline. As with Combination A, the island in the MMS Agency-Preferred Alternative is the closest to the Boulder Patch, increasing the potential for minor impacts to that sensitive biological community.

The MMS Agency-Preferred Alternative would use gravel bags for upper slope protection on the island, which possibly could result in broken bags entering the marine environment. However, this design uses interlocking cement blocks at the water/ice edge, and the proposed polyester gravel bags will not float. They are the same as those used at the Endicott Island.

The MMS Agency-Preferred Alternative uses the Kadleroshilik River gravel mine and would create a new gravel pit that would destroy 24-41 acres of wetland habitat in the Kadleroshilik River floodplain. After rehabilitation, the mine site could provide fish-overwintering habitat, which presently is absent in the area. As with Combination B, the MMS Agency-Preferred Alternative would haul gravel 6 miles from the mine to the construction site. This distance is considerably shorter than the other two combinations that use the Duck Island mine and would result in less air emission and require the use of less fuel. The MMS Agency-Preferred Alternative would increase cumulative impacts of oil and gas development to the local geographic area by increasing the number of gravel pits by one, but it would not require the loss of a major source of freshwater as would use of the Duck Island mine.

Effects on Inupiat Natives could occur because of their reliance on subsistence foods, and Liberty development may affect subsistence resources and harvest practices. The Inupiat community of Nuiqsut, and possibly Kaktovik, within the North Slope Borough, potentially would experience effects. In the unlikely event that a large oil spill occurred and contaminated essential whaling territory, we believe that major effects would occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. However, when we consider the low likelihood of a spill event and the little effect from routine activities, disproportionately high adverse effects would not be expected on Alaskan Natives from Liberty development under the Proposal. Any potential effects to subsistence resources and subsistence harvests are expected to be mitigated substantially, though not eliminated.

The MMS does not expect any significant impacts to result from any of the planned activities associated with the MMS Agency-Preferred Alternative. Significant adverse impacts to spectacled eiders, king eiders, common eiders, long-tailed ducks, and to local water quality could occur in the unlikely event of a large oil spill. However, the very low probability of such an event occurring (a less than 1% chance of oil entering the environment over the life of the project), combined with the seasonal nature of the resources inhabiting the area, make it highly unlikely that an oil spill would occur and contact eider and sea duck resources. This alternative includes mitigation, such as an extra-thick-walled pipeline, a pipeline burial depth that is more than twice the maximum 100-year ice-gouging event, and an advanced leak-detection system (LEOS). Together, they reduce the likelihood of an oil spill, detect very small volumes of oil, and limit the size of potential small chronic leaks to about 100 barrels of oil.

(2) The Environmental Protection Agency's Agency-Preferred Alternative

(a) Description of the Environmental Protection Agency's Agency-Preferred Alternative

1) Preferred Island Location: Liberty Island

The Environmental Protection Agency believes that the proposed Liberty Island location, when considered with the other components of their Agency-Preferred Alternative, best meets the purpose and need for the project. The Liberty Island location represents the site that is likely to maximize recovery of oil from the Liberty Prospect, thereby meeting a primary objective of developing the prospect. The Liberty Island location would minimize the length of the wells drilled. In addition, location is within the range of current engineering understanding and practices and, consequently, can be constructed safely and provide a stable base on which to build production facilities.

While the Liberty Island location is closer to the bowhead whale migration route and the Boulder Patch than other alternative island locations analyzed in the EIS, analyses in the EIS suggest that the difference in effects from these alternatives on bowhead whales would not be significantly different. Sedimentation impacts to the Boulder Patch from the construction of the Liberty gravel island and the excavation of the trench along the Liberty pipeline route are predicted to be greater than those expected from the other alternatives; they are not expected to significantly reduce biological productivity of the Boulder Patch.

2) Preferred Pipeline Route: Liberty Pipeline Route

The Environmental Protection Agency believes that the proposed Liberty pipeline route, when considered with the other components of their Agency-Preferred Alternative, best meets the purpose and need for the project. Based on the location of the production island, the Liberty pipeline route appears to minimize overall hazards to the pipeline and is the route BPXA proposed. The safety of the pipeline is an issue, especially the elimination or reduction of risk of oil entering the environment. BPXA's proposed route is the shortest, most direct, straight path to shore and the existing Badami pipeline, which can be used to transport oil to Pump Station 1 and the Trans-Alaska Pipeline System.

3) Preferred Pipeline Design: Pipe-in- Pipe System

The Environmental Protection Agency believes that the use of the pipe-in-pipe system minimizes the risk when compared to the proposed single-wall system. The Environmental Protection Agency believes the pipe-in-pipe system offers improved protection from external forces, such as ice gouges and strudel scour, and provides oil-containment capacity in the event of a failure of the internal, carrier pipe. The studies conducted as part of this EIS find the pipe-in-pipe alternative reduces the risk of a potential oil spill entering the environment.

The use of the pipe-in-pipe design would result in a 7% increase in overall project costs when compared with the proposed single-wall pipeline system. The Environmental Protection Agency believe the additional costs are reasonable when weighed against the need for the Federal Government to meet its tribal trust responsibilities, foster environmental justice in Federal decisionmaking, and minimize risks to the environment.

4) Preferred Upper Island Slope-Protection System: Steel Sheetpile

The Environmental Protection Agency believes the use of steel sheetpile would provide reliable island protection and containment without significant environmental effects or shortcomings. The use of sheetpile project systems has been shown to be reliable in other applications (Northstar) in the Beaufort Sea. The use of gravel bags for protecting the upper portion of the island provides no apparent advantages over steel sheetpile from the perspective of island protection and has the attendant negative aspect of the potential for the bags to enter the environment. Although the proposed gravel bags are different and do not float in the water, the use of gravel bags in the past have resulted in the release of torn bags into the Beaufort Sea. While it is unlikely for the bags to be washed into the Beaufort Sea, the use of steel sheetpile entirely eliminates the chances of this happening. The recent and unexpected movement and destruction of large sections of the articulated concrete mats used for the lower island slope protection employed at the Northstar Project demonstrates that offshore island construction and oil development is in its infancy. There is not a long history of development islands to draw on, and it appears from the Northstar experience that ice forces on the island are different than what was expected. It is not clear how a gravel system, as proposed for Liberty, would have fared in the ice forces of this past winter; however, none of the steel sheetpile system at Northstar was damaged. The Environmental Protection Agency believes the steel-sheetpile system is the most protective system available. In addition, the use of the steel sheetpile system is responsive to concerns raised by the North Slope Native residents who do not support the use of gravel bags because of past experiences with other torn gravel bags becoming entangled with their boat motors. While the proposed gravel bags sink and would not pose a problem to the Inupiat's (and others') vessels, the potential ecological effects from bags deposited on the seafloor are not understood. The Environmental Protection Agency believes that the use of steel sheetpile represents a reasonable solution that minimizes or eliminates the risks of gravel bags entering the marine environment.

Overall project cost would increase by 2%, and the maximum size of the island footprint would increase by 1%, relative to the project proposed by BPXA. The Environmental Protection Agency believes these differences are reasonable when weighed against the benefits of improved island stability/integrity and the elimination of any potential release of torn gravel bags to the environment.

5) Preferred Gravel-Mine Site: Duck Island Mine Site

The existing Duck Island gravel-mine site would provide the gravel needed to construction the project without the effects associated with creating a new gravel-mine site. The Duck Island mine site would increase the amount of time and travel distance needed to develop the gravel needs of the project.

This mine site would require the removal of about 600 million gallons of water. The gravel would need to be hauled about 2.7 times as far as the BPXA-proposed Kadleroshilik River mine site. This alternative also would eliminate the Duck Island mine site as a potential source of freshwater for building ice roads on the North Slope for several years.

The Environmental Protection Agency also believes that gravel reclaimed from abandoned, unused gravel pads, roads, and/or airstrips should be used to augment the extraction of gravel from the Duck Island mine site. A potential mitigating measure has been included in the EIS and, if included as a condition of the permit, would require BPXA to reclaim and restore current abandoned gravel sites back to wetland habitat. This could be used to minimize wetland loss but would not reduce the effects of dewatering the Duck Island mine site.

6) Preferred Pipeline Burial Depth: BPXA's Proposed Burial Depth

Pipeline-design considerations include the goal of minimizing the risk of oil entering the environment. Meeting this goal requires pipeline design be optimized for various parameters, including pipeline burial depth. To that end, the choice of a particular burial depth is driven by the considerations undertaken during pipeline design and optimization. The burial depth would be that determined by the pipeline design and pipeline-verification process. Because the pipeline-verification process has not been completed, we assume a 7-foot minimum burial depth.

(b) Effects of the Environmental Protection Agency's Agency-Preferred Alternative

The Environmental Protection Agency's Agency-Preferred Alternative is identical to the Combination A Alternative. The reasons and rationale that they used to select these component parts are stated previously and presented in Section II.E. The following narrative compares the Environmental Protection Agency's Agency-Preferred Alternative to the other Combination Alternatives in Section II.D.

The Environmental Protection Agency's Agency-Preferred Alternative uses Liberty Island and has the longest offshore pipeline at 6.1 miles. The Environmental Protection Agency's Agency-Preferred Alternative is the second highest in costs ($51.5 million more than the BPXA Proposal) This would increase costs to about $415.5 million and reduce the net present value of potential profits to about $6.5 million. The potential rate of return would be reduced to below 2%. Liberty Island is in the optimal location for recovering oil from the reservoir. It is farther offshore than Combination B but about the same distance from shore as Combination C. The double-wall pipeline design provides secondary containment, but it has a higher functional failure rate than the other pipeline designs. The pipe-in-pipe system will result in no pigging information about the condition of the outer pipe and can result in misleading information about portions of the inner pipe. The outer pipeline can be monitored only by using a pass/fail pressure test.

The Environmental Protection Agency's Agency-Preferred Alternative would occupy 25.5 acres of the ocean floor for construction of the island, which is 1% larger than the BPXA-proposed island size. It also would cause the temporary disturbance of 59 acres of ocean-floor habitat due to trenching the pipeline. As with the BPXA Proposal and the MMS Agency-Preferred Alternative, the Liberty Island location is the closest to the Boulder Patch, increasing the potential for minor impacts to that sensitive biological community.

The Environmental Protection Agency's Agency-Preferred Alternative would use steel sheetpile for upper slope protection on the island, which eliminates the potential for broken gravel bags to enter the marine environment. However, the proposed polyester gravel bags will not float. This alternative would increase the amount noise generated during the construction of the island, because the steel sheetpile is verberated into the ground. It would also lengthen the time required to construct the island. However, construction of the island should be completed before the bowhead whale migration period, and the additional noise effects are short term and do not reach the significant threshold.

The Environmental Protection Agency's Agency Preferred Alternative uses the existing Duck Island gravel mine. This mine site would require the removal of about 600 million gallons of water, and the gravel would need to be hauled about 2.7 times as far as the BPXA-proposed Kadleroshilik River mine site. This would increase the amount of air emission as well as fuel and hauling costs. Using gravel from the Duck Island mine would keep the number of mine sites on the North Slope the same. It would prevent the destruction of 24-41 acres of wetland habitat in Kadleroshilik River Floodplain; it also would eliminate the potential for fish-overwintering habitat that could be created after the Kadleroshilik River mine site were rehabilitated. This alternative also would eliminate the Duck Island mine site as a potential source of freshwater for building ice roads on the North Slope for several years.

Effects on Inupiat Natives could occur because of their reliance on subsistence foods, and Liberty development may affect subsistence resources and harvest practices. The Inupiat community of Nuiqsut, and possibly Kaktovik, within the North Slope Borough, potentially would experience effects. In the unlikely event that a large oil spill occurred and contaminated essential whaling territory, major effects would occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. The pipe-in-pipe system may provide containment from some types of oil spills, but it also may hinder monitoring of the integrity of the inner pipe. However, when we consider the low likelihood of a spill event and the little effect from routine activities, disproportionately high adverse effects would not be expected on Alaskan Natives from Liberty development under the Proposal. Any potential effects to subsistence resources and subsistence harvests are expected to be mitigated substantially, though not eliminated.

Significant adverse impacts to spectacled eiders, king eiders, common eiders, long-tailed ducks, and to local water quality could occur in the unlikely event of a large oil spill. However, the very low probability of such an event occurring (a less than 1% chance of oil entering the environment over the life of the project), combined with the seasonal nature of the resources inhabiting the area, make it highly unlikely that an oil spill would occur and contact eider and sea duck resources. This alternative includes mitigation, such as a pipe-in-pipe pipeline, a pipeline burial depth that is more than twice the maximum 100-year ice-gouging event, and an advanced leak-detection system (LEOS).

4. Mitigation

a. BPXA's Mitigating Actions

In planning for construction and design, BPXA has attempted to minimize impacts and to incorporate mitigating measures into the Liberty Project design. They are listed in Table I-3.

b. Mitigation Required by the MMS

The project also includes stipulations that are part of the lease OCS-Y-01650. This mitigation reflects the efforts of the people of the North Slope and their tribal and local governments working with MMS and other Federal and State agencies. The full text for these stipulations is found in Appendix B, Part B of the EIS. BPXA is required to comply with these stipulations.

Stipulation No. 1, Protection of Biological Resources. The Liberty Prospect is located near the Stefansson Sound Boulder Patch, a special biological resource. The drilling and production island locations and pipeline routes have been selected to avoid significant adverse impacts to the Boulder Patch.

Stipulation No. 2, Orientation Program. Site personnel would receive training on at least an annual basis, and full training records would be maintained for at least 5 years.

Stipulation No. 3, Transportation of Hydrocarbons. Pipelines are the preferred mode of transportation hydrocarbons.

Stipulation No. 4, Industry Site-Specific Bowhead Whale Monitoring Program. Not applicable, because this stipulation applies to exploratory operations.

Stipulation No. 5, Subsistence Whaling and Other Subsistence Activities. BPXA proposes measures that include ongoing community liaison, development of a Cooperation and Avoidance Agreement with the Alaska Eskimo Whaling Commission, planning major construction activities for the winter season, and limiting vessel transit to the island to routes inside the barrier islands. An ongoing consultation process would be used to identify any concerns not addressed by BPXA's proposed mitigation and potential measures to be considered.

c. Mitigation and Traditional Knowledge

The above mitigating measures incorporate traditional knowledge and the cooperative efforts between the MMS, the State, and the people of the North Slope and their tribal and local governments to develop effective mitigating measures for our leasing program. The concerns of North Slope residents to protect their subsistence and cultural heritage are incorporated in the Orientation Program and the Subsistence Whaling and other Subsistence Activities stipulations. The Transportation of Hydrocarbons stipulation reflects the concerns of the North Slope residents to require that the transportation of oil and gas is done in a safe manner. The subsistence and sociocultural sections of this EIS highlight and note the information, concerns, and traditional knowledge that North Slope residents have provided.

d. Potential Mitigation

Mitigation was developed through public planning, scoping, public hearings, and comments to the draft EIS. This mitigation reflects the efforts of people of the North Slope and their tribal and local governments working with MMS and other Federal and State agencies.

Seasonal Drilling Restriction: The purpose of this mitigation is to provide protection to resources by eliminating the potential for a blowout during periods of broken ice during the development phase of the project. This mitigating measure is similar to the measure required by the State of Alaska for the Northstar Project. BPXA is prohibited from drilling the first development well into targeted hydrocarbon formations during the defined broken ice periods for the site location; drilling subsequent development wells into previously untested hydrocarbon formations during defined broken ice periods; and subject to the imposition of additional restrictions on a case-by-case basis.

This mitigating measure would reduce the chance of a large blowout type oil spill during the development of the Liberty Prospect and further reduce the already low chance of a large oil spill. It could increase the length of time (a few weeks) needed to develop the field.

Recovery and Reuse of Gravel: The purpose of this mitigation is to offset the reduction in wetlands that would result from onshore mining activities and gravel pad construction (for example, shore-crossing pad and pipeline tie-in pad). This mitigation would recover gravel from abandoned gravel facilities and rehabilitate those sites to useable wetland habitats in an amount equal to or greater than the area lost from gravel mining and pad construction. The permittee would be required to recover and reuse available gravel from abandoned pads, roads, and airstrips within the immediate project area and/or within the Prudhoe Bay oil field complex and to rehabilitate the site.

This mitigation would require the permittee to assess abandoned onshore gravel sites near the Liberty Prospect and/or within the Prudhoe Bay oil field and develop gravel recovery and rehabilitation plans for abandoned site(s). These plans would need to include: the location, amount, and type of gravel; the aerial extent of the gravel site (size); the current owner and any ownership issues; any potential gravel contamination concerns and a proposal to deal with those concerns; the proposed timing for obtaining applicable local, State, and Federal permits; and a rehabilitation plan, including timetable. If potential gravel contamination or travel costs prohibit the use of the recovered gravel for this offshore project, the gravel could be stockpiled in nonwetland or currently filled areas and used in other ongoing or future projects by the permittee.

This mitigation is based on recently permitted on- and offshore oil and gas developments (for example, Northwest Eileen and Northstar). The effectiveness of this mitigation is evaluated in Section III.D.2.o of the EIS.

LEOS Verification. BPXA will conduct a test to verify that the LEOS system is functional and capable of detecting liquid hydrocarbons within 1 year of installation of the system. A test protocol will be submitted to the MMS for approval.

Through-Ice Oil-Spill-Monitoring Program. In the event the LEOS system becomes inoperable, BPXA must initiate a through-the-ice monitoring program for potential oil spills from a pipeline leak. Within 6 months following first production, BPXA must analyze the Liberty oil properties, model the under-ice spreading characteristics, and develop a protocol to detect a leak that is below the detection limit of the pressure-point analysis and mass-balance line-pack compensation systems with a monthly through-ice testing program at a 95% confidence level. The protocol must be submitted to the MMS for approval.

Prior to production, BPXA must provide the MMS with an operations and management plan for monitoring and evaluating the functionality of the LEOS system. The plan must outline the conditions under which BPXA would determine that the LEOS system is not functioning or capable of detecting oil leaks from the pipeline and would initiate the through-the-ice spill-monitoring program.

Surge Tank Installation: BPXA must submit an assessment on the benefits of the installation of a surge tank to enhance stable flow conditions and inline leak-detection thresholds. The assessment should address the technical merits, practicability of installation and maintenance, and economic impacts. This assessment should be submitted to the MMS within 6 months of approval of the Development and Production Plan. The MMS will use this assessment to determine if surge tanks will be required in the final Liberty facility design.

Protection of Cross Island from an Oil Spill. Cross Island is a priority protection site for subsistence use, and measures must be in place to limit impacts of an oil spill on the island. BPXA must develop a strategy to ensure that protective booming can be deployed quickly around Cross Island to prevent shoreline contact from an oil spill during the open-water season to facilitate an uncontaminated site for landing whales. A strategy must be submitted to the MMS within 2 months of approval of the Development and Production Plan.

The effectiveness of the LEOS Verification, Through-Ice Oil-Spill Monitoring Program, Surge Tank Installation, Protection of Cross Island from an Oil Spill measures lies in early detection of an oil spill and ensures that measures are taken promptly to reduce the amount of oil that might enter the marine environment or affect a critical subsistence area. In general, such a reduction lessens the potential effects on water quality and on the biological resources that might be present at the time of the spill or shortly thereafter; these resources might include bowhead whales, seals, polar bears, fishes, and marine and coastal birds. Reducing the amount of oil entering the environment also might reduce the cleanup effort and the disturbance effects associated with these activities in the marine and coastal environments

Gravel Bag Maintenance. BPXA must provide the MMS with a plan for monitoring, replacing, and repairing damaged gravel bags used in the construction of the gravel island to minimize the potential for damaged bags and bag remnants to enter the open water. The plan also must describe the mechanism by which gravel bags will be marked with a unique identifier, so that damaged bag material that is introduced into the open water can be traced back to the Liberty island. The plan must be developed and included as part of the platform verification process under 30 CFR 250 Subpart I.

The effectiveness of this measure lies in the potential for reducing the amount of polyester material entering the marine environment. Such a reduction could lessen the potential effects on biological resources that might be affected by the material and on-the-water subsistence activities, where the material could interfere with the operation of boat engines.

Archaeological Resource Report. BPXA must submit an updated Archaeological Resource Report for the final pipeline right-of-way selected for the project. The effectiveness of this measure lies in the potential for reducing the possible disturbance of any archaeological sites that presently are unknown.

F. CUMULATIVE ANALYSIS

For the cumulative analysis, MMS found that all of the alternatives were very similar to those of BPXA's Proposal. That is, the differences in alternatives would result in very small differences in cumulative effects. These small differences are greatly overshadowed by the inherent uncertainty in making estimates of past, present, and reasonably foreseeable cumulative effects. Therefore, we present just one analysis for all the alternatives.

1. Scope of Analysis

Based on our past experience, we base our cumulative-effects analysis for this EIS on a five-step process:

Step 1: We identify the potential effects of the Liberty Development and Production Plan that may occur on the natural resources and human environment

- in the Beaufort Sea,
- on the North Slope, and
- along the oil transportation route.

Step 2: We analyze other past, present, and reasonably foreseeable future oil-development activity on the North Slope/Beaufort Sea for effects on the natural resources and human environment that we found were potentially affected by the Liberty Development and Production Plan.

Step 3: We consider effects from other actions (sport harvest, commercial fishing, subsistence hunting, and loss of overwintering range, etc.) on these same natural resources and human environments.

Step 4: We attempt to quantify effects by estimating the extent of the effects (number of animals and habitat affected) and how long the effects would last (population-recovery time).

Step 5: To keep the cumulative-effects analysis useful, manageable, and concentrated on the effects that are meaningful, we weigh more heavily other activities that are more certain and geographically close to Liberty, and we analyze more intensively effects that are of greatest concern. We also focus our effort by using guiding principles from existing standards (see the following), criteria, and policies that control management of the natural resources of concern. Where existing standards, criteria, and policies are not available, our experts use their best judgment on where and how to focus the analysis.

Oil and gas activities occur on the Outer Continental Shelf in Alaska, the Gulf of Mexico, and California and are cited in the most recent 5-year Oil and Gas Program EIS (USDOI, MMS, Herndon, 1996a). To be consistent with the 5-Year Program EIS, the Liberty cumulative analysis also evaluates the effects for transporting oil through the Trans-Alaska Pipeline System and tankering from Valdez to ports on the U.S. west coast. Activities other than those associated with oil and gas also are considered. We also include by reference certain cumulative effects that are more national in scope, for example, global warming and alternative energy development.

Oil and gas activities considered in the analysis include past development and production, present development, reasonably foreseeable future development, and speculative development. Some activities beyond the 15-20 year life of the Liberty Project are considered too speculative to include at this time, while other such activities are included in this analysis. Furthermore, we exclude future actions from the cumulative effects analysis, if those actions are outside the geographic boundaries or timeframes established for the cumulative-effects analysis. We address uncertainty through monitoring and note that monitoring is the last step in determining the cumulative effects that may ultimately result from an action.

For this analysis, we used the Endangered Species Act of 1973 and the Liberty scoping process as appropriate vehicles to identify species that are potentially at risk from incremental cumulative effects from the Liberty Project. Effects on listed species identified for the Liberty Project by the National Marine Fisheries Service and the Fish and Wildlife Service under Section 7 of the Endangered Species Act are covered in this cumulative-effects analysis. The management of seals by the National Marine Fisheries Service and polar bears by the Fish and Wildlife Service under the Marine Mammal Protection Act of 1972 provides for monitoring these species' populations and managing/mitigating potential effects of development on these species. The State of Alaska, Department of Fish and Game monitors caribou, including the Central Arctic Herd.

Water quality on the North Slope is regulated and/or monitored through various permitting and regulatory programs administered by the Environmental Protection Agency; the Alaska Departments of Natural Resources, Environmental Conservation, and Fish and Game; and the North Slope Borough. These programs have been established to protect against the significant degradation of water quality associated with specific human/development activities. In evaluating the cumulative effects to water quality, we consider the collective impacts associated with permitted/regulated activities as well as other nonregulated activities and/or naturally occurring events.

Air quality is regulated under the Clean Air Act. The major stationary sources of air pollutants are regulated under the Prevention of Significant Deterioration permitting process. For sources located on the outer continental shelf (such as the proposed Liberty Project), the Prevention of Significant Deterioration program is administered by the Environmental Protection Agency, and for sources located in State waters and onshore, the program is administered by the Alaska Department of Environmental Conservation. Minor sources of air pollutants are not subject to Prevention of Significant Deterioration permitting requirements. The analysis of cumulative effects to air quality in this EIS is based on five monitoring sites, three of which were deemed subject to maximum air-pollutant concentrations and two of which were deemed more representative of the air quality of the general Prudhoe Bay area.

Impacts to wetlands are regulated under Section 404 of the Clean Water Act and administered by the U.S. Army Corps of Engineers. In addition, the Administration has a No-Net-Loss goal for wetland functions and values. Under the National Memorandum of Agreement regarding "The Determination of Mitigation Under the Clean Water Act Section 404(b)(1) Guidelines" between the Corps of Engineers and the Environmental Protection Agency, it is recognized in Footnote Number 7 of the Memorandum of Agreement that in areas such as the North Slope of Alaska (where there is a high proportion of wetlands), minimizing wetland losses would be the primary method of mitigation. However, compensatory mitigation could be required for unavoidable losses to high-use wetlands.

For the human environment (subsistence activities, sociocultural systems, and the economy), we focus our evaluation of cumulative effects associated with oil-development activities on the North Slope local environment, because this is where the most significant cumulative effects are expected to be concentrated. We have met with local tribal governments to discuss subsistence issues relating to the Liberty Project and have established a dialogue on environmental justice with these communities. Mitigation in place for the Liberty Project (measures developed for MMS's Beaufort Sea Lease Sale 144) evolved through negotiations with local, borough, and agency representatives, and Inupiat traditional knowledge had a large part in developing mitigation and the timing of project activities. Local Inupiat government representatives have been members of our Outer Continental Shelf Advisory Committee that have met to discuss and resolve issues that arise from the 5-Year Plan and recent lease sales. Conflict avoidance agreements between the oil industry and Inupiat whalers are an important mechanism for overcoming conflicts.

The cumulative effects on archaeological resources can be minimized through required surveys, consultations with the State Historical Preservation Officer to identify potential archaeological sites, and requirements to plan and schedule activities to avoid these locations. We analyze the potential for disturbance to archaeological resources on the North Slope and in the Beaufort Sea as well as the potential effects from the cleanup of oil spills along the transportation route.

2. Cumulative Effects

a. Significant Effects Conclusion

The MMS does not expect any significant cumulative impacts to result from any of the planned activities associated with the Proposal (Alternative I, Liberty Development and Production Plan) or any of the alternatives. Significant resource thresholds are identified in Section III.A.1.a of the EIS and Section C.7 of the Executive Summary. In the unlikely event of a large offshore oil spill, some significant cumulative impacts could occur, such as adverse effects to spectacled eiders, long-tailed ducks, king eiders, common eiders, subsistence resources, sociocultural systems and local water quality. However, the probability of such an event combined with the seasonal nature of the resources inhabiting the area make it highly unlikely that an oil spill would occur and contact these resources. Spectacled eiders, long-tailed ducks, and king and common eiders are present on the North Slope for only 3-5 months out of the year. A resource may be present in the area but may not necessarily be contacted by the oil. An oil spill could affect the availability of bowhead whales, or the resource might be considered tainted and unusable as a food source. The potential for adverse effects to some key resources (bowhead whales, subsistence, the Boulder Patch, polar bears, and caribou) is of primary concern and warrants continued close attention. Effective mitigation practices (winter construction, an advanced leak-detection system, thick-walled pipeline designs, etc.) also should be considered in future projects.

b. General Conclusions

The MMS found the following general conclusions were applicable and informative:

- The incremental contribution of the Liberty Project to cumulative effects is likely to be quite small. Construction and operations related to the Liberty Project would be confined to a relatively small geographic area, and oil output would be a small percentage (approximately 1%) of the total estimated North Slope/Beaufort Sea production.
- The Liberty Project would contribute a small percentage of risk (about 4%) to resources in State and Federal waters in the Beaufort Sea from potential large offshore oil spills. Any subsequent spills are not expected to contact the same resources or to occur before those resources recover from the first spill. We recognize the importance of readily available abiotic standards to determine environmental quality. Abiotic measurements for air and water quality, for example, often provide a good indication of the quality of biological and cultural resources. We also recognize that as we move from the abiotic and the biotic to the human environment, the variables increase, making it more difficult to determine cumulative effects on the quality of life. Similarly, as we move from the terrestrial environment to the offshore environment, the variables of environmental quality increase. Migratory species present additional variables that reflect habitat and species condition outside the primary study areas. Humans introduce even more variables with their mobility and behavioral diversity. Hence, as we progress from abiotic to biotic, or from freshwater to marine, or from terrestrial and marine to sociocultural effects our analysis, by necessity, becomes more difficult and less conclusive.

c. Keeping Cumulative Effects in Perspective

Concern about the potential for cumulative effects should be weighed with the following information:

- Expected oil and gas activities are likely to have fewer impacts on the environment than those activities conducted in the early years of the region's development.
- Current industry practices and the environmental state of the North Slope/Beaufort Sea region frequently are observed and assessed, and much of this information is available to the public.
- A key element of the transportation system for development of North Slope/Beaufort Sea oil is the Trans-Alaska Pipeline System pipeline. The pipeline is 800 miles long, stretching from Pump Station 1 at Prudhoe Bay to the Valdez Marine Terminal with a corridor width of about 100 feet, representing an area of about 16 square miles.
- Following the *Exxon Valdez* oil spill, substantive improvements have been made in tanker safety to reduce the potential for oil spills from tanker accidents.
- If a major oil spill occurred, there likely would be a great slowdown in new development during which additional safeguards certainly would be put in place and new concepts for pipeline placement and design would be researched.
- The actual sizes and locations of future oil and gas developments on the North Slope and in the Beaufort Sea are uncertain.

d. Cumulative Effects by Resource

Endangered Species (Bowhead Whales, Eiders, Other Species): Some bowhead whales temporarily may avoid noise-producing activities or change their breathing, surfacing, or calling rates. Contact with spilled oil could cause temporary, nonlethal effects, and a few could die from prolonged exposure to freshly spilled oil. The Liberty Project's contribution to cumulative effects is expected to be limited to temporary avoidance behavior by a few bowhead whales in response to vessel traffic. Significant effects to spectacled eiders would occur if substantial numbers were contacted by an oil spill in offshore or nearshore areas adjacent to the eastern Arctic Coastal Plain. Disturbance may cause short-term energy loss if spectacled eiders are displaced from preferred habitat. Liberty would be additive to effects from all projects in this cumulative analysis, but only in the case of a large offshore oil spill would Liberty be expected to increase adverse cumulative effects to potentially significant population levels. Oil transportation from Liberty to ports along the U.S. west coast likely would contribute little to cumulative effects on species occurring along transportation routes.

Seals, Walruses, Beluga Whales, and Polar Bears: Ongoing activities that may affect polar bears seals, walruses, and beluga whales include disturbance, habitat alteration, and spilled oil. Overall effects (mainly from oil) should last no more than one generation (about 5-6 years) for ringed and bearded seals, walruses, and beluga whales and about 7-10 years for polar bears. Liberty should only briefly and locally disturb or displace a few seals, polar bears, possibly a few walruses, and beluga whales. A few polar bears could be temporarily attracted to the production island with no substantial effects on the population's distribution and abundance.

Marine and Coastal Birds: Substantial numbers of birds potentially could be exposed to a large oil spill during the molt period (long-tailed ducks), or during the migration period (long-tailed ducks, king and common eiders) as they pass through offshore staging areas, lagoons, or beaches in the petroleum development area. It is unknown what percentage actually uses it as a stopover or staging area. Migrating birds also might collide with production islands or structures under poor visibility conditions. Collision losses are expected to be relatively low, unless greater numbers of offshore production structures are constructed in the foreseeable future. Disturbance from support activities could cause displacement to less favorable foraging areas. Effects of Liberty would be additive to effects observed or anticipated for cumulative projects and, in the case of a large oil spill, could substantially increase adverse effects at the population level in several loon, waterfowl, shorebird, and seabird species. Mortality resulting from an oil spill could cause significant effects in long-tailed duck and king and common eider populations.

Terrestrial Mammals: About half the Central Arctic Caribou Herd uses coastal habitat adjacent to the Liberty area during summer. Oil development in the Prudhoe Bay area is likely to continue to displace some caribou during the calving season within about 4 kilometers of roads with vehicle traffic. Liberty is expected to contribute less than 1% of the local short-term disturbance of caribou. Liberty should only briefly and locally disturb or displace a few muskoxen and grizzly bears.

Lower Trophic-Level Organisms: Effects of additional drilling discharges, construction-related activities, and oil spills are not expected to substantially affect organisms near Liberty island or elsewhere. Liberty is not expected to make a measurable contribution to the cumulative effects on these organisms.

Fishes and Essential Fish Habitat: Small numbers of fish in the immediate area of an offshore or onshore oil spill may be killed or harmed, but this would not have a measurable effect on fish populations. Marine and migratory fishes are widely distributed in the Beaufort Sea and are not likely to be affected by the Liberty Project. Oil is not expected to contact overwintering areas during winter. Hence, the Liberty Project is not expected to contribute measurably to the overall cumulative effect on fishes.

Vegetation-Wetland Habitats: Construction causes more than 99% of the effects, with spills having a very minor role. Rehabilitation of gravel pads can result in the growth of grasses-sedges within 2 years after the pads are abandoned. Natural growth of plant cover would be very slow. Liberty would contribute less than 1% of the cumulative disturbance effects on 9,000 acres now affected by oil development.

Subsistence-Harvest Patterns: Subsistence harvests in Nuiqsut and Kaktovik could be affected by Liberty development and other past, present, and future projects with one or more important subsistence resources becoming unavailable or undesirable for use for 1-2 years, a significant effect. Liberty is expected to have periodic effects on subsistence resources. Because one offshore oil spill (although not from the Liberty Project) is assumed in the cumulative case, many harvest areas and some subsistence resources would be unavailable for use. Some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. Tainting concerns in communities nearest the spill event could seriously curtail traditional practices for harvesting, sharing, and processing bowheads and threaten a pivotal underpinning of Inupiat culture. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree these resources were contaminated.

Sociocultural Systems: Liberty development, other past, present and future projects, and one assumed offshore oil spill (although not from the Liberty Project) in the cumulative case could disturb sociocultural systems for at least an entire season (1 year) and could seriously curtail traditional practices for harvesting, sharing, and processing of bowhead whales; such displacement could extend to the harvesting, sharing and processing of other subsistence resources. If disruption to major subsistence resources extended for up to 2 years, impacts on sociocultural systems would be considered to be significant. Liberty would contribute periodic disturbance effects on communities near the Liberty Project but would not displace any social systems, community activities or traditional practices. For a summary of Environmental Justice effects, see the Environmental Justice summary that follows at the end of this section.

Archaeological Resources: Existing laws and regulation protect archaeological resources, and known sites are avoided or mitigated. Liberty's contribution to cumulative effects and the cumulative effects overall are expected to be minimal for archaeological resources, because any surface-disturbing activities that could damage archaeological sites would be mitigated by current State and Federal procedures.

Economy: The cumulative analysis projects employment could increase as follows: 2,400 direct oil industry jobs at peak, declining to 1,300; about 3,400 indirect jobs at peak, declining to 2,000; about 150 jobs for North Slope Borough residents at peak, declining to 50; about 5-125 jobs for 6 months for cleanup of an oil spill in the Beaufort Sea; and about 10,000 jobs and 25% price inflation for 6 months for cleanup of a tanker oil spill in the Gulf of Alaska. This cumulative analysis projects annual revenues could be as follows: $125 million Federal, $77 million State, and $28 million State and North Slope Borough. Liberty's contribution to the cumulative effects could range from 1% to, at peak level, 36%.

Water Quality: Oil spills would degrade the marine environment and result in a greater than 1.5 parts per million acute criterion for about 3 or more days in an area of 15-20 square kilometers. A large crude or refined oil spill (greater than or equal to 500 barrels) would have a significant effect on water quality by increasing the concentration of hydrocarbons in the water column to levels that greatly exceed background concentrations; however, the chance of a large spill occurring is low. Also, regional (more than 1,000 square kilometers [386 square miles]), long-term (more than 1 year) degradation of water quality to levels above State and Federal criteria because of hydrocarbon contamination is very unlikely.

Resuspended sediments from construction activities are not expected to exceed acute water-quality criteria, and permitted discharges would be designed to ensure rapid mixing and dilution of the discharge. The effects from the Liberty Project from 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.

Air Quality: Projects in the past and present have caused essentially no deterioration in air quality and have not contributed measurably to global climate change. Air emissions from the Liberty Project essentially would have no effects on air quality.

Environmental Justice: Alaska Inupiat Natives, a recognized minority, are the predominant residents of the North Slope Borough, the area potentially most affected by Liberty development. Effects on Inupiat Natives could occur because of their reliance on subsistence foods, and Liberty development may affect subsistence resources and harvest practices. The Inupiat community of Nuiqsut, and possibly Kaktovik, within the North Slope Borough, could experience potential effects. However, effects are not expected from routine activities and operations. If the one large spill assumed in the cumulative case (although not from the Liberty Project) occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Such impacts would be considered disproportionately high adverse effects on Alaskan Natives. When we consider the little effect from routine activities and the low likelihood of a large spill event from Liberty development under the Proposal, disproportionately high adverse effects would not be expected on Alaskan Natives. Any potential effects to subsistence resources and subsistence harvests are expected to be mitigated substantially, though not eliminated.

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TABLES

Table I-1 The Relationship Between the Component Alternatives and Combination Alternatives

Component Alternative	Combination Alternative A	Combination Alternative B	Combination Alternative C	Liberty DPP
Alternative Drilling Island Location and Pipeline Route				
Alt. I – Use Liberty Island Location and Pipeline Route (Liberty DPP)	✔	–	–	✔
Alt. III.A – Use Southern Island Location and Eastern Pipeline Route	–	✔	–	–
Alt. III.B – Use Tern Island Location and Pipeline Route	–	–	✔	–
Alternative Pipeline Design				
Alt. I – Use Single-Wall Pipe System (Liberty DPP)	–	–	–	✔
Alt. IV.A – Use Pipe-in-Pipe System	✔	–	✔	–
Alt. IV.B – Use Pipe-in-HDPE System	–	✔	–	–
Alt. IV.C – Use Flexible Pipe System	–	–	–	–
Alternative Upper Island Slope Protection System				
Alt. I – Use Gravel Bags (Liberty DPP)	–	✔	–	✔
Alt. V – Use Steel Sheetpile	✔	–	✔	–
Alternative Gravel Mine Sites				
Alt. I – Use Kadleroshilik River Mine (Liberty DPP)	–	✔	–	✔
Alt. VI – Use Duck Island Gravel Mine	✔	–	–	–
Alternative Pipeline Burial Depths				
Alt. I – Use a 7-Foot Burial Depth (Liberty DPP)	✔	*	–	✔
Alt. VII – Use a 15-Foot Pipeline Trench Depth	–	*	✔	–

* The burial depth for the HDPE system is a 6-foot minimal depth as designed by INTEC (2000)

Note: Each of the above component and combination alternatives is a complete project; each has all of the project elements needed to develop the Liberty Prospect and can be compared to each other on an equal footing.

Table I-3 Measures BPXA Incorporated into Their Liberty Development and Production Plan (Alternative I–BPXA's Proposal) to Avoid or Minimize Potential Impacts to the Biological, Physical, and Sociocultural Resources Within the Study Area

Action	Benefit
Mitigation by Design	
Smaller facility size; reduced wellhead spacing to 9 feet; directional drilling.	Minimize impacts associated with size of the offshore island.
Designed facility for zero discharge of drilling wastes; no reserve pits.	Reduce island size and impacts to benthos; eliminate potential for contaminant release from reserve pits; avoid water-quality impacts; avoid impacts to fish and essential fish habitat.
Locate island as close to shore as possible.	Reduce length of pipeline necessary to reach shore, thereby minimizing disturbance to the marine environment and essential fish habitat.
Use filter fabric to reduce leaching of fine particulates downstream onto sensitive marine habitat.	Minimize redistribution of fine sediments from the gravel island following construction.
Process design incorporated measures to minimize carbon dioxide emissions by using natural gas and electrical power for drilling (long term).	Reduce emissions of greenhouse gases.
Mine gravel and construct island and pipeline during winter from ice roads.	Eliminate impacts to wildlife; reduce sediment input effects; eliminate dust effects; eliminate impacts to tundra wetlands from a permanent access road; minimize impacts to essential fish habita and subsistence; facilitate abandonment and reclamation of mine site.
Dispose of solid wastes onshore.	Minimize waste storage on the island. Reduce fox and polar bear encounters.
Impose restrictions to spring helicopter overflights of Howe Island.	Avoid disturbance to breeding and nesting snow geese and brant.
Route helicopter traffic to minimize effects to wildlife. Route vessel traffic inside the barrier islands.	Minimize disturbance to seals, bowhead whales, polar bear dens, and subsistence-whaling activities.
Consult with Alaska Eskimo Whaling Commission if bowhead whales are observed inside the Midway Islands barrier island group.	Minimize disturbance to migrating bowhead whales or subsistence-whaling activities.
Prohibit hunting by project personnel, and restrict public access.	Protect wildlife and cultural resources.
Train personnel in interactions with wildlife. Establish an environmental awareness program.	Reduce potential for disturbance to wildlife and essential fish habitat. Increase awareness of risks and means to reduce impacts on wildlife.
Train personnel to recognize and avoid cultural resources.	Ensure that cultural resources are preserved.
Develop Conflict and Avoidance Agreement with local subsistence users.	Avoid unreasonable conflicts to subsistence activities.
Use ice roads to access Liberty Project and resources.	Minimize impacts to the tundra.
Use sea ice to support island construction and pipeline placement. Install pipeline during winter, when water currents are low.	Avoid barge traffic in summer for gravel transport, reducing air emissions. Reduce sedimentation of disturbed materials from the pipeline trench on adjacent benthic environments and essential fish habitat. Reduce noise disturbance to marine mammals.
Minimize Island size.	Reduce footprint of island and impacts on benthic environment.
Coordinate with the Alaska Department of Fish and Game on studies of fish and brown bears within project area. Identify and avoid den locations.	Minimize interactions with bears. Identify important fish resources in project area.
Coordinate with the Fish and Wildlife Service on historic and recent locations of polar bear den sites.	Avoid actions that would disturb denning polar bears.
Archaeology surveys.	Avoid disturbance of potential archaeology sites.

Source: BPXA (2000a)

Table II.A-1 Key Project Component Summary for All Alternatives[1]

	I Proposal	III.A Southern Island	III.B Tern Island	IV.A Pipe-in- Pipe	IV.B Pipe-in-HDPE	IV.C Flexible Pipe	V Steel Sheetpile	VI Duck Island Gravel Mine	VII Bury Pipe Deeper
GRAVEL ISLAND									
a. Location	Liberty Island	Southern Island	Tern Island	Liberty Island	Liberty Island	Liberty Island	Liberty Island	Liberty Island	Liberty Island
b. Upper Slope Protection	Gravel Bags	Gravel Bags	Gravel Bags	Gravel Bags	Gravel Bags	Gravel Bags	Steel Sheetpile	Gravel Bags	Gravel Bags
c. Lower Slope Protection	17,000 Cement Mats	16,000 Cement Mats	18,000 Cement Mats	17,000 Cement Mats	17,000 Cement Mats	17,000 Cement Mats	22,500 Cement Mats	17,000 Cement Mats	17,000 Cement Mats
d. Amount of Gravel	797,600 cu yd	684,800 cu yd	599,500 cu yd	797,600 cu yd	797,600 cu yd	797,600 cu yd	855,000 cu yd	797,600 cu yd	797,600 cu yd
e. Maximum Footprint	835' * 1,170'	825' * 1,155'	850' * 1190'	835' * 1,170'	835' * 1,170'	835' * 1,170'	905' * 1,240'	835' * 1,170'	835' * 1,170'
f. Maximum Footprint Area	22.4 acres	21.9 acres	23.3 acres	22.4 acres	22.4 acres	22.4 acres	25.8 acres	22.4 acres	22.4 acres
g. Working Surface	345' * 680'	345' * 680'	345' * 680'	345' * 680'	345' * 680'	345' * 680'	345' * 680'	345' * 680'	345' * 680'
h. Water Depth at Island	22 feet	18 feet	23 feet	22 feet	22 feet	22 feet	22 feet	22 feet	22 feet
PIPELINE									
a. Pipe Design	1 Steel Pipe	1Steel Pipe	1 Steel Pipe	1 Steel Pipe in a Steel Pipe	1 Steel Pipe in an HDPE Pipe.	1 Flexible Pipe	1 Steel Pipe	1 Steel Pipe	1 Steel Pipe
b. Route	Liberty Route	Eastern Route	Tern Route	Liberty Route	Liberty Route	Liberty Route	Liberty Route	Liberty Route	Liberty Route
c. Average Trench Depth /Range in (Feet)	10.5 / (8 -12)	10.5 / (8-12)	10.5 / (8-12)	9 / (6.5-10.5)	10 / (7.5-11.5)	8.5 / (6-10)	10.5 / (8 -12)	10.5 / (8 -12)	15 feet
d. Quantity of Trench Dredge/ Excavation Material *	724,000 cu yds	499,025 cu yd	652,800 cu yd	557,300 cu yd	673,920 cu yd	498,960 cu yd	724,000 cu yd	724,000 cu yd	1,438,560 cu yd
e. Quantity of Trench Backfill Material *	724,000 cu yds	499,025 cu yd	652,800 cu yd	557,300 cu yd	673,920 cu yd	498,960 cu yd	724,000 cu yd	724,000 cu yd	1,438,560 cu yd
f. Minimum Burial Depth	7 feet	7 feet	7 feet	5 feet	6 feet	5 feet	7 feet	7 feet	11 feet
g. Surface Area Disturbed by Trench	59 acres	37 acres	59 acres	52 acres	57 acres	49 acres	59 acres	59 acres	81 acres
h. Offshore Length	6.1 miles	4.2 miles	5.5 miles	6.1 miles	6.1 miles	6.1 miles	6.1 miles	6.1 miles	6.1 miles
i. Onshore Length	1.5 miles	3.1 miles	3.1 miles	1.5 miles	1.5 miles	1.5 miles	1.5 miles	1.5 miles	1.5 miles
j. Construction Seasons	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Winter
k. Leak-Detection System	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.
l. Engineering Calculation of Pipeline Failure Rate but no oil released	3.1%	3.1%	3.1%	2.1%	3.2%	4.6%	3.1%	3.1%	2.2%
m. Engineering Calculation of Pipeline Failure Rate with oil released (any size spill)	0.001%	0.001%	0.001%	0.01%	0.01%	0.1%	0.001%	0.001%	0.0003%
n. Engineering Calculation of Probability of a Spill Larger than 1,000 bbls during project life[2]	1.38%	1.38%	1.38%	0.234%	1.38%	1.38%	1.38%	1.38%	1.38%
GRAVEL MINE SITE									
a. Location	Kadleroshilik River	Kadleroshilik River	Kadleroshilik River	Kadleroshilik River	Kadleroshilik River	Kadleroshilik River	Kadleroshilik River	Duck Island Mine	Kadleroshilik River
b. Number of Haul Days	45-60	40-57	30-45	45-60	45-60	45-60	45-60	90-120 or use more equipment	45-60
c. Distance from Island	6 miles	5 miles	6 miles	6 miles	6 miles	6 miles	6 miles	20 miles	6 miles

1 Unless otherwise noted all information in this table is from INTEC (2000)
2 Information from Fleet (2000)

Shading indicates components or quantities that are different from Alternative I-Proposal

Table II.A-2 Pipeline Trench Excavation and Backfill Quantities for Alternatives I, III, IV, and VII

	I Proposal-Liberty Island and Single-Wall Pipe	III.A Southern Island	III.B Tern Island	IV.A Steel Pipe in Steel Pipe	IV.B Steel Pipe in HDPE	IV.C Flexible Pipe	VII Bury Pipe Deeper
PIPELINE TRENCH							
a. Length							
Island to 3-mile limit	8,000 feet	2,376 feet	11,616 feet	8,000 feet	8,000 feet	8,000 feet	8,000 feet
3-mile limit to shoreline	24,400 feet	19,900 feet	17,524 feet	24,400 feet	24,400 feet	24,400 feet	24,400 feet
Total	32,400 feet	22,276 feet	29,140 feet	32,400 feet	32,400 feet	32,400 feet	32,400 feet
b. Width	61-132 feet	61-132 feet	61-132 feet	53-115 feet	53-115 feet	50-110 feet	120-152 feet
c. Fill Area							
Island to 3-mile limit	18.2 acres	5.3 acres	25.8 acres	15.4 acres	17.0 acres	14.7 acres	24.9 acres
3-mile limit to shoreline	55.4 acres	44.1 acres	38.9 acres	47.1 acres	51.8 acres	44.9 acres	76.1 acres
Total	73.6 acres	49.4 acres	64.7 acres	62.5 acres	68.8 acres	59.6 acres	101.0 acres
d. Onshore Transition Zone							
Length and width	150 x 25 feet	205 x 25 feet	205 x 25 feet	150 x 25 feet	150 x 25 feet	150 x 25 feet	150 x 25 feet
Area	0.3 acres	0.41 acres	0.41 acres	0.3 acres	0.3 acres	0.24 acres	0.4 acres
e. Quantity of Dredged/ Excavated Material							
Island to 3-mile limit	(179,000 cu yd)	(53,225 cu yd)	(260,200 cu yd)	(137,600 cu yd)	(166,400 cu yd)	(123,200 cu yd)	(355,200 cu yd)
3-mile limit to shoreline	(545,000 cu yd)	(445,800 cu yd)	(392,600 cu yd)	(419,700 cu yd)	(507,520 cu yd)	(375,760 cu yd)	(1,083,360 cu yd)
Total	(724,000 cu yd)	(499,025 cu yd)	(652,800 cu yd)	(557,300 cu yd)	(673,920 cu yd)	(498,960 cu yd)	(1,438,560 cu yd)
f. Quantity of Backfill							
Select backfill							
Island to 3-mile limit	17,000 cu yd	5,800 cu yd	24,250 cu yd	None	17,000 cu yd	17,000 cu yd	17,000 cu yd
3-mile limit to shoreline	50,000 cu yd	40,800 cu yd	36,050 cu yd	None	50,000 cu yd	50,000 cu yd	50,000 cu yd
Total select backfill	67,000 cu yd	46,600 cu yd	60,300 cu yd	None	67,000 cu yd	67,000 cu yd	67,000 cu yd
Native backfill							
Island to 3-mile limit	162,000 cu yd	47,425 cu yd	235,950 cu yd	137,600 cu yd	149,400 cu yd	106,200 cu yd	338,200 cu yd
3-mile limit to shoreline	495,000 cu yd	405,000 cu yd	356,550 cu yd	419,700 cu yd	457,520 cu yd	325,760 cu yd	1,033,360 cu yd
Total native backfill	757,000 cu yd	452,425 cu yd	592,500 cu yd	557,300 cu yd	606,920 cu yd	431,960 cu yd	1,371,560 cu yd
Total native and select backfill	724,000 cu yd	499,025 cu yd	652,800 cu yd	557,300 cu yd	673,920 cu yd	498,960 cu yd	1,438,560 cu yd

Source: BPXA (2000a)

Table II.C-3 Comparison of Trench Excavation and Backfill for Different Pipeline Designs and Routes

Pipeline Design	Trench Characteristic	Island Location and Pipeline Route								
		Alternative I Liberty Island/Liberty Pipeline			Alternative III.A Southern Island/Eastern Pipeline Route			Alternative III.B Tern Island/Tern Pipeline Route		
		Gravel Island to 3-Mile Limit	**3-Mile Limit to Shoreline**	**Onshore Transition Pipeline**	**Gravel Island to 3-Mile Limit**	**3-Mile Limit to Shoreline**	**Onshore Transition Pipeline**	**Gravel Island to 3-Mile Limit**	**3-Mile Limit to Shoreline**	**Onshore Transition Pipeline**
Alternative 1 Single-Wall Pipe	**a.** Trench Length (ft)	8,000	24,400	150	2,376	19,900	205	11,616	17,524	205
	b Trench Width (ft)	61'-132'	61'-132'	25	61'-132'	61'-132'	25	61'-132'	61'-132'	25
	c. Trench Excavation (yd^3)	(179,000)	(545,000)	(2,200)	(53,225)	(445,800)	(3,000)	(260,200)	(392,600)	(3,000)
	d. Select Backfill (yd^3)	17,000	50,000	2,500	5,800	40,800	3,450	24,250	36,050	3,450
	e. Native Backfill (yd^3)	162,000	495,000	400	47,425	405,000	550	235,950	356,550	550
	f. Total Trench Backfill (yd^3)	179,000	545,000	2,900	53,225	445,800	4,000	260,200	392,600	4,000
	g. Trench Fill Area (acres)	18.2	55.4	0.3	5.3	44.1	0.41	25.8	38.9	0.41
	h. Trench Depth (ft)	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Alternative III.A Pipe-in-Pipe	**a.** Trench Length (ft)	8,000	24,400	150	2,376	19,900	205	11,616	17,524	205
	b. Trench Width (ft)	53'-115'	53'-115'	25	53'-115'	53'-115'	25	53'-115'	53'-115'	25
	c. Trench Excavation (yd^3)	(137,600)	(419,700)	(1,875)	(40,900)	(342,300)	(2,570)	(200,000)	(301,500)	(2,570)
	d. Select Backfill (yd^3)	none	none	2,160	none	none	2,950	none	none	2,950
	e. Native Backfill (yd^3)	137,600	419,700	345	40,900	342,300	470	200,000	301,500	470
	f. Total Trench Backfill (yd^3)	137,600	419,700	2,505	40,900	342,300	3,420	200,000	301,500	3,420
	g. Trench Fill Area (acres)	15.4	47.1	0.3	4.6	38.4	0.36	22.4	33.8	0.36
	h. Trench Depth (ft)	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Alternative III.B Pipe-in-HDPE	**a.** Trench Length (ft)	8,000	24,400	150	2,376	19,900	205	11,616	17,524	205
	b. Trench Width (ft)	59'-126'	59'-126'	25	59'-126'	59'-126'	25	59'-126'	59'-126'	25
	c. Trench Excavation yd^3	(166,400)	(507,520)	(2,090)	(49,420)	(413,920)	(2,850)	(241,615)	(364,500)	(2,850)
	d. Select Backfill (yd^3)	17,000	50,000	2,400	5,800	40,800	3,275	24,250	36,050	3,275
	e. Native Backfill (yd^3)	149,400	457,520	385	43,620	373,120	525	217,365	328,450	525
	f. Total Trench Backfill (yd^3)	166,400	507,520	2,785	49,420	413,920	3,800	241,615	364,500	3,800
	g. Trench Fill Area (acres)	17.0	51.8	0.3	5.1	42.3	0.39	24.7	37.2	0.39
	h. Trench Depth (ft)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Alternative III.C Flexible Pipe	**a.** Trench Length (ft)	8,000	24,400	150	2,376	19,900	205	11,616	17,524	205
	b. Trench Width (ft)	50'-110'	50'-110'	25	50'-110'	50'-110'	25	50'-110'	50'-110'	25
	c. Trench Excavation (yd^3)	(123,200)	(375,760)	(1,770)	(36,590)	(306,460)	(2,425)	(178,890)	(269,870)	(2,425)
	d. Select Backfill (yd^3)	17,000	50,000	2,035	5,800	40,800	2,790	24,250	36,050	2,790
	e. Native Backfill (yd^3)	106,200	325,760	325	30,790	265,660	445	154,640	233,820	445
	f. Total Trench Backfill (yd^3)	123,200	375,760	2,360	36,590	306,460	3,235	178,890	269,890	3,235
	g. Trench Fill Area (acres)	14.7	44.9	0.24	4.4	36.6	0.33	21.4	32.3	0.33
	h. Trench Depth (ft)	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Alternative VII Bury the Pipe Deeper	**a.** Trench Length (ft)	8,000	24,400	150	2,376	19,900	205	11,616	17,524	205
	b. Trench Width (ft)	120'-152'	120'-152'	25	120'-152'	120'-152'	25	120'-152'	120'-152'	25
	c. Trench Excavation (yd^3)	(355,200)	(1,083,360)	(3,125)	(105,500)	(883,560)	(4,275)	(515,750)	(778,070)	(4,275)
	d. Select Backfill (yd^3)	17,000	50,000	3,590	5,800	40,800	4,920	24,250	36,050	4,920
	e. Native Backfill (yd^3)	338,200	1,033,360	575	99,700	842,760	785	491,500	742,020	785
	f. Total Trench Backfill (yd^3)	355,200	1,083,360	4,165	105,500	883,560	5,705	515,750	778,070	5,705
	g. Trench Fill Area (acres)	24.9	76.1	0.4	60.6	62.0	0.59	36.2	54.6	0.59
	h. Trench Depth (ft)	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0

Source: BPXA (2000a)

Table II.C-5 Pipeline Failure Rate and Expected Spill Volume

	Alternative I Single-Wall Pipe	Alternative IV.A Pipe-In-Pipe System	Alternative IV.B Pipe-In-HDPE System	Alternative IV.C Flexible Pipe	INTEC's 7-Foot Burial Depth Pipe-In-Pipe System
Damage Category	**Pipeline Failure Probability by Pipeline Design [1]**				
1–Pipeline displacement but no leak	0.031	0.02	0.03	0.04	0.022
2–Pipeline buckle but no leak	0.0012	0.001	0.002	0.006	0.00012
3–Small/medium leak into the environment	0.000013	0.0001	0.0001	0.001	0.00000028
3–Oil leaks into the annulus	NA	0.0001	0.001	NA	0.0001
3–Water leaks into the annulus	NA	0.0001	NA	NA	0.0001
4–Large leak/rupture	0.0000003	0.0001	0.000001	0.00001	0.00000021
	"Expected" Spill Volume—Life of the Pipeline [1]				
	0.0021 bbl (0.088 gal)	0.028 bbl (1.18 gal)	0.014 bbl (0.59 gal)	0.14 bbl (5.88 gal)	0.00034 bbl (0.014 gal)
	"Expected" Spill Volume—Life of the Pipeline [2]				
	28 bbl (1176 gal)	8 bbl (336 gal)	24 bbl (1008 gal)	29 bbl (1218 gal)	13 bbl (546 gal)
	Probability of Spill Larger Than 1000 barrels Occurring During Project Life [2]				
	0.0138	0.00158	0.0138	0.0138	0.00234

[1] Summary information from INTEC pipeline alternatives report (INTEC, 2000).
[2] Summary information from Fleet risk evaluation report (Fleet, 2000).

Table III.C-4 Large and Small Spill Sizes We Assume for Analysis in this EIS by Alternative

	ASSUMED SPILL SIZE IN BARRELS									
	LARGE								SMALL	
	CRUDE OIL							DIESEL OIL	CRUDE OR DIESEL	REFINED OIL
	GRAVEL ISLAND[1]	OFFSHORE PIPELINE					ONSHORE PIPELINE	GRAVEL ISLAND (Diesel Tank)	OPERATION SPILLS OFFSHORE AND ONSHORE	OPERATION SPILLS OFFSHORE AND ONSHORE
		Leak-Detection and Location System		Pressure-Point Analysis And Mass-Balance Line-Pack Compensation						
		Leak	Rupture	Summer Leak	Winter Leak	Rupture				
Alternative I BPXA Proposal	925	125	1,580	715	2,956	1,580	720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative II, No Action	Spills occur elsewhere from oil reserves produced at another location									
Alternative III, Use Alternative Island Locations and Pipeline Routes	925	125	1,580	715	2,956	1,580	720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative IV, Use Different Pipeline Designs										
Assumption 1, Neither Outer nor Inner Pipe Leaks										
Alternative IV.A Use Pipe-in-Pipe System	925	0		0			720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative IV.B Use Pipe-in-HDPE System	925	0		0			720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative IV.C Use Flexible Pipe System	925	0		0			720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative I Single Wall (for comparison)	925	0		0			720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Assumption 2, Both Outer and Inner Pipes Leak										
Alternative IV.A Use Steel Pipe-in-Pipe System	925	125	1,580	715	2,956	1,580	720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative IV.B Use Pipe-in-HDPE System	925	125	1,580	715	2,956	1,580	720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative IV.C Use Flexible Pipe System	925	125	1,580	715	2,956	1,580	720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative I Single Wall (for comparison)	925	125	1,580	715	2,956	1,580	720–1,142	1,283	17<1 bbl, 6 ≥1 and < 25 bbl	53 of 0.7 bbl
Assumption 3, Only the Inner Pipe Leaks										
Alternative IV.A Use Pipe-in-Pipe System	925	0		0			720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative IV.B Use Pipe-in-HDPE System	925	0		0			720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative IV.C Use Flexible Pipe System	925	125	1,580	715	2,956	1,580	720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative I Single Wall (for comparison)	925	125	1,580	715	2,956	1,580	720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Assumption 4, Only the Outer Pipe Leaks										
Alternative IV.A Use Pipe-in-Pipe System	925	0		0			720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative IV.B Use Pipe-in-HDPE System	925	0		0			720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative IV.C Use Flexible Pipe System	925	Na	Na	Na	Na	Na	720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative I Single Wall (for comparison)	925	Na	Na	Na	Na	Na	720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative V, Use Steel Sheetpile	925	125	1,580	715	2,956	1,580	720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative VI, Use Duck Island Mine	925	125	1,580	715	2,956	1,580	720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl
Alternative VII, Use a 15-Foot Trench Depth	925	125	1,580	715	2,956	1,580	720–1,142	1,283	17<1 bbl, 6 ≥1 and <25 bbl	53 of 0.7 bbl

Source: USDOI, MMS Alaska OCS Region

[1] The revised Oil Discharge Prevention and Contingency Plan prohibits the drilling of new wells or sidetracks from existing wells into major liquid-hydrocarbon zones at its drill sites during the defined period of broken ice and open water (BPXA, 2001; Section 2.1.7). This period begins on June 13 of each year and ends with the presence of 18 inches of continuous ice cover for one-half mile in all directions from the Liberty island. This drilling moratorium eliminates the environmental effects associated with a well blowout during drilling operations in the Beaufort Sea during broken-ice or open-water conditions.

Table III.D-6 Kadleroshilik River Mine Site Land Areal Coverage by Land Cover Type (Class)

Class	Land Cover Description	Wetland	Phase 1 Mine Cell		Phase 2 Mine Cell		Reserve Area		Total Mine Site	
			Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area
Ia	Water	No	0.15	0.8%	0.01	0.1%	0.06	0.3%	0.21	0.4%
IIIa	Wet Sedge Tundra	Yes	0.15	0.8%	0.00	0.0%	0.00	0.0%	0.15	0.3%
Va	Moist Sedge, Dwarf Shrub Tundra	Yes	0.02	0.1%	1.02	8.2%	0.22	1.0%	1.26	2.4%
Vc	Dry Dwarf Shrub, Crustose Lichen	Yes	7.26	38.1%	4.83	38.8%	3.23	15.1%	15.32	29.0%
IXb	Dry Barren/Dwarf Shrub, Forb Grass Complex	Yes	2.00	10.5%	3.41	27.4%	3.85	18.0%	9.26	17.5%
IXc	Dry Barren/Forb Complex	Yes	1.44	7.6%	2.11	17.0%	9.47	44.2%	13.02	24.6%
IXf	Dry Barren/Dwarf Shrub, Grass Complex	Yes	1.90	10.0%	0.16	1.3%	0.00	0.0%	2.06	3.9%
Xa	River Gravel	No	6.12	32.2%	0.89	7.1%	4.59	21.4%	11.6	21.9%
	Total Land Cover Area		19.03	100.0%	12.43	100.0%	21.42	100.0%	52.87	100.0%
	Total Wetland Area		12.77	67.1%	11.53	92.7%	16.77	78.3%	41.06	77.6%

Source: Noel and McKendrick (2000).
Total Wetland Area is defined by the U.S. Army Corp of Engineers as Land Cover Types (Class) III.a, Va,Vc, IXb, IXc, and IXf.

Table IV.D-1 Key Project Element Summary for the Combination Alternatives

	Combination Alternative A	Combination Alternative B	Combination Alternative C	BPXA Proposal (Liberty DPP)
GRAVEL ISLAND				
a. Location	Liberty Island	Southern Island	Tern Island	Liberty Island
b. Upper Slope Protection	Steel Sheetpile	Gravel Bags	Gravel Bags	Gravel Bags
c. Lower Slope Protection – Cement Mats	22,500	16,000	23,500	17,000
d. Amount of Gravel	855,000 cu yd	684,800 cu yd	659,000 cu yd	797,600 cu yd
e. Maximum Footprint Dimension	905' * 1240'	800' * 1110'	925' * 1,260'	835' * 1170'
f. Maximum Footprint Size	25,8 acres	21.9 acres	26.8 acres	22.4 acres
g. Working Surface	345' * 680'	345' * 680'	345' * 680'	345' * 680'
h. Water Depth at Island	22 feet	18 feet	23 feet	22 feet
PIPELINE				
a. Pipe Design	1 Steel pipe in a steel Pipe	1Steel pipe in HDPE	1 Steel pipe in a steel Pipe	1 Steel pipe
b. Route	Liberty Route	Eastern Route	Tern Route	Liberty Route
c. Engineering Calculation of Probability of a Spill Larger than 1,000 bbl during project life	0.234%	1.38%	0.234%	1.38%
d. Average Trench Depth/Range in (Feet)	10.5 / (8 -12)	10 / (7.5 - 11.5)	15 feet	10.5 / (8 -12)
e. Quantity of Trench Dredge/Excavation Material	724,000 cu yd	466,190 cu yd	1,298,095 cu yd	724,000 cu yd
f. Quantity of Trench Backfill Material	724,000 cu yd	466,190 cu yd	1,298,100 cu yd	724,000 cu yd
g. Minimum Burial Depth	7 feet	6 feet	11 feet	7 feet
h. Trench Width	61' X 132'	59' X 126'	120'-152'	61' X 132'
i. Surface Area Disturbed by Trench	59 acres	49 acres	91 acres	59 acres
j. Offshore Length	6.1 miles	4.2 miles	5.5 miles	6.1 miles
k. Onshore Length	1.5 miles	3.1 miles	3.1 miles	1.5 miles
GRAVEL MINE SITE				
a. Location	Duck Island	Kadleroshilik River	Duck Island	Kadleroshilik River
b. Number of Haul Days	90-120 or use more equipment	40-57	60-90 or use more equipment	45-60
c. Distance from Island	20 miles	5 miles	21 miles	6 miles

Source: USDOI, MMS, Alaska OCS Region (2000)

Table IV.D-2 Comparison of Selected Features of the Combination Alternatives

Selected Alternative Attributes	**Combination A** Liberty Island Route Pipe in Pipe Steel sheetpile Duck Island Gravel 7-Foot burial Depth	**Combination B** South Island/Eastern Route Pipe in HDPE Gravel Bags Kadleroshilik River Gravel 6-Foot burial depth	**Combination C** Tern Island/Tern Route Pipe in Pipe Steel Sheetpile Duck Is Gravel 11-Foot Burial Depth	**BPXA Proposal** Liberty Island Route Singled walled pipe Gravel Bags Kadleroshilik River Mine 7-Foot burial depth
Distance from bowhead migration	**nearest**	**farthest**	**second farthest**	**nearst**
Likelihood of disturbance of bowhead whales and subsistence hunting	**low**	**lowest**	**lower**	**low**
Gravel requirement	**855,000 cu yd** (most)	**684,800 cu yd** (thirdmost)	**659,000 cu yd** (least)	**797,600 cu yd** (secondmost)
Gravel haul distance	**20 miles** (secondmost)	**5 miles** (least)	**21 miles** (most)	**6 miles** (thirdmost)
Use of existing offshore gravel	**None**	**none**	**most**	**none**
Mine wetland habitat destroyed	**Least**	**most**	**least**	**most**
Impacts from gravel bags	**None**	**low**	**none**	**low**
Newly buried ocean bottom (island)	**25.8 acres** (most)	**21.9 acres** (thirdmost)	(least)	**22.4 acres** (secondmost)
Temporarily disturbed habitat from pipeline trench	**59 acres** (secondmost)	**49 acres** (least)	**91 acres** (most)	**59 acres** (secondmost)
Length of offshore pipeline deeper than 8-foot water depth	**Least**	**least**	**most**	**least**
Average depth of pipeline trench	**10.5 ft**	**10 ft**	**15 ft**	**10.5 ft**
Distance from Boulder Patch	**1 mile** (nearst)	**2.5 miles** (farthest)	**1.5 miles** (second farthest)	**1 mile** (nearest)
Likelihood of impacts to the Boulder Patch	**Low**	**lowest**	**Lower**	**low**
Length offshore pipeline	**6.1 miles** (most)	**4.2 miles** (least)	**5.5 miles** (secondmost)	**6.1 miles** (most)
Length onshore pipeline	**1.5 miles** (least)	**3.1 miles** (most)	**3.1 miles** (most)	**1.5 miles** (least)
Secondary pipeline spill containment	**Yes**	**yes**	**Yes**	**no**
Likelihood of pipeline leak offshore	**Lower**	**lowest**	**Lowest**	**low**
Likelihood of pipeline leak onshore	**Lower**	**low**	**Low**	**lower**
Directional drilling	**Least**	**most**	**Most**	**least**
Risk to maximum recovery of oil	**Least**	**most**	**Most**	**least**
Costs over the BPXA Proposal	**$51.5 million** (thirdmost)	**$24.5 million** (secondmost)	**$59 million** (most)	same
Economic return to BPXA	**Second highest**	**third highest**	**Least**	**highest**
Economic benefits to Federal and State government	**Second highest**	**third highest**	**Least**	**highest**

Source: USDOI, MMS, Alaska OCS Region (2000)

MAP

Map 1 Liberty Project Area.

Sources: BPXA 1998a; Ban et al, 1999.

The Department of the Interior Mission
As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission
As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.

20 Years of Service to America

MMS

Minerals Management Service

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