SECTION 4F.0
EFFECTS OF THE CUMULATIVE CASE

4F.1 Introduction

NEPA and its implementing guidelines require an assessment of the proposed project and other projects that have or are likely to occur and which together may have cumulative impacts that go beyond the impacts of the proposed project itself. The lead agency is to be made aware of and consider such cumulative impacts when making decisions. NEPA defines cumulative impacts as follows:

> "Cumulative Impact" is the impact on the environment which results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. (40 CFR 1508.7 and 1508.25[a][2])

Further,

> To determine the scope of environmental impact statements, agencies shall consider...Cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement.

The key to the assessment of cumulative impacts is the identification of other past, present, and reasonably foreseeable projects or actions that will impact the environment of the region in the same time span as the proposed action. This section also considers cumulative impacts to resources that migrate into or through the region (such as birds and whales), whether those impacts occur in the region or are encountered in other parts of their range.

4F.2 Structure of the Cumulative Impacts Assessment

4F.2.1 Components of the Cumulative Assessment

The cumulative impacts assessment has four components:

Assessment of the Impacts of the Proposed Project to the Environment – Project-specific impacts (applicant's proposed project and full-field development [FFD]) are first assessed. These have been reported in earlier parts of Section 4.0 by specific resource.

Identification of Cumulative Impact Issues – Issues related to cumulative impacts have been identified from the scoping analysis. Issues associated with past and present actions have also been identified. The cumulative impact assessment addresses these issues.

Identification of Past, Present and Reasonably Foreseeable Future Actions – Other activities that could contribute to cumulative impacts in the geographic area and time frame are identified. The projects and actions considered are listed and described in Section 4F.2.

Assessment of Cumulative Impact – Cumulative impact is determined by adding the impacts of the proposed project to the impacts of past, present, and reasonably foreseeable future projects. The sum

of all impacts is the "cumulative impact." Impacts are evaluated in the context of the cumulative issues that have been identified.

Protective standards and guiding principles from existing regulatory programs and policies that control management of natural resources are used as guidelines in the cumulative analysis. Where existing standards, criteria, and policies are not available, the resource experts use their best judgment on where and how to focus the analysis.

4F.2.2 Cumulative Impact Issues

Cumulative Impact issues were identified by obtaining input from members of communities who live in the project area and region, governmental and non-governmental agencies with jurisdiction or interest, and previous environmental reviews through the scoping process. During the scoping process, interested parties voiced a number of concerns. Many concerns were interrelated or were sub-issues of a larger issue. Following completion of the scoping process, the BLM reviewed, sorted, and categorized publicly expressed concerns and formulated a set of integrated issues, which may be addressed at both the project-specific impact assessment and cumulative impacts assessment levels. Six general issue areas were identified in the scoping process:

Adherence to Stipulations Identified in the Northeast NPR-A Integrated Activity Plan/Environmental Impact Statement (IAP/EIS)

Expanded North Slope Oil and Gas Development to include the NPR-A

Impacts to Local Residents and Traditional Subsistence-Use Areas

Potential Impacts to Colville River Delta Resources

Longer-term Development to include Full-Field Development with the Plan Area

Potential Impacts to Environmental Quality

Within each of the general issues listed above are a number of sub-issues. For example, the issue that addresses traditional subsistence includes the evaluation of cumulative impacts to species that are relied upon for subsistence and access to subsistence hunting and fishing areas. The last issue encompasses a large array of concerns with impacts to resources and the residents of the North Slope that use these lands and resources**.** The general issue areas identified were expanded by resource specialists as the basis for each resource area evaluation.

Coincident with the BLM's scoping process for the Alpine Satellite Development Plan (ASDP), the National Research Council (NRC) of the National Academies issued its report on Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (NRC 2003). This report also included a series of issues, which formed the basis for its cumulative impact evaluation methodology. Table 4F.2.2-1 presents these issues and a cross-reference to the sections in this cumulative impact assessment where the same or similar issues were evaluated.

TABLE 4F.2.2-1 ISSUES FROM NRC–CUMULATIVE EFFECTS OF OIL AND GAS ACTIVITIES ON ALASKA'S NORTH SLOPE

No.	NRC Report Issue	Reference to ASDP DEIS
1	Roads	Impacts discussed under nearly all parts of Sec. 4
2	Damage to Tundra from Off-Road Travel	4A – D.3.1, 4F.6.1
3	Effects on Animal Populations	4A – D.3.2, 3.3, 3.4, 4F.6
4	Interactions of Climate Change and Oil Development	4A – D.2.3.1, 4F.5.8
5	Interference with Subsistence Activities	4A – D.4.3, 4F.7.3
6	Social Changes in North Slope Communities	4A – D.4.1, 4F.7
7	Cumulative Aesthetic, Cultural, and Spiritual Consequences	4A – D.4.5, 4.8, 4F.7
8	Response of North Slope Communities to Declining Revenues	4A – D.4.2, 4F.7.2
9	Legacy of Abandoned Infrastructure and Unrestored Landscapes	2.3.2, 2.3.3, 2.3.4
10	Expansion into New Areas	Impacts discussed under nearly all parts of Sec. 4

4F.2.3 Region and Time Frame of Consideration

The geographic boundaries set for the analysis of project-specific impacts are generally the immediate vicinity of specific project actions (the Alpine field and its local environs), with some exceptions, such as air quality. Since the cumulative analysis evaluates a broader set of projects and actions, the geographic boundary of the cumulative analysis is necessarily larger. The appropriate geographic region of consideration for the cumulative analysis was determined to be generally the North Slope region of Alaska as defined by the drainage basin north of the Brooks Range (approximately 68 degrees north latitude). For the marine environment, the coastal and near coastal portions of the adjacent Chukchi Sea and Beaufort Sea are included. Figure 4F.2.3-1 shows the North Slope region considered for the cumulative impact analysis.

The time frame for consideration is the present to approximately 20 years in the future. Estimates of recoverable reserves and expected production from existing developed areas and known fields for which development is occurring or planned are reasonably well defined.

4F.2.4 Elements Included by Reference in the Cumulative Analysis

4F.2.4.1 Projections of North Slope Oil Production

Projections of North Slope production were included in the recent Northwest NPR-A Draft EIS (DEIS) (BLM 2003b) for three different crude oil price futures. These projections included low (5 billion barrels [Bbbl]), mid (11 Bbbl) and high (15 Bbbl) estimate ranges (see Table iv-15 of the Northwest NPR-A Draft EIS, vol. 2). These forecasts are incorporated by reference in this DEIS.

The purpose of these estimates is to provide a bounding estimate on total oil production for impacts related to operations including oil spills, traffic, and other production activities.

4F.2.4.2 Transportation of Crude Oil

Production of any North Slope reserves would not occur without a means of exporting the production to market by a transportation system. The transportation infrastructure system for this project includes four components: pipelines from the production pads to the Alpine Processing Facility, pipeline from

the Alpine Processing Facility to trans-Alaska pipeline, the trans-Alaska pipeline from Prudhoe Bay to Valdez, and seagoing tankers that travel from Valdez to ports on the west coast of the Untied States and in Asia.

Given the decline of production in existing Prudhoe Bay fields, the existing oil transportation system (including the Trans-Alaska Pipeline System [TAPS]) is expected to be able to transport oil produced by development of new reserves in the areas surrounding the Prudhoe Bay fields, as well as additional enhanced recovery from the Prudhoe Bay fields during the 20-year cumulative analysis period. New fields would use infrastructure at the edge of the core area to transport processed crude oil to the TAPS pipeline. This existing infrastructure at the edge of the core area includes the western sector, or Alpine Group (including existing Alpine and Kuparuk field infrastructure), which would accommodate the NPR-A; the central or Northstar Group; and the eastern sector or Badami Group.

Currently, the TAPS terminal at Valdez handles about 999,202 barrels (bbls) of crude daily. At peak production, the ASDP would contribute up to 145,000 thousand barrels per day of crude oil (Alternative A – CPAI Development Plan) to the total amount transported by TAPS. Assuming future production on the North Slope (including offshore) grows to the high end of projections, oil tankers still could be moving on the order of 1.0 MMbbl daily from Valdez in 2009.

All of the elements of the TAPS system are currently in place, are operational, and have sufficient capacity to support the ASDP and the associated FFD. Transport of production from this area to the TAPS would be accomplished by a connector pipeline from the ASDP area to the existing Alpine Processing Facility, and from there the oil would be transported in existing pipelines from the Alpine Field to the Kuparuk Field and on to the TAPS system. The cumulative impacts of operating the TAPS transportation system were evaluated in the recent Final Environmental Impact Statement for Renewal of the Federal Grant for the Trans-Alaska Pipeline System Right-of-Way (TAPS Renewal FEIS). These impacts included consideration of continuing use of the crude oil transportation system to transport current and future production. It also considered the probability and consequence of spills from various elements of the system. Because the proposed ASDP, including FFD, will not add to or change operations of this transportation system downstream of the Alpine Processing Facility, the conclusions about the cumulative impacts associated with transportation of crude oil from the North Slope presented in the TAPS Renewal FEIS are equally applicable to the ASDP and are incorporated into this cumulative analysis. A copy of the TAPS Renewal EIS can be reviewed on-line at http://tapseis.anl.gov/, and the findings are summarized below.

The conclusions of the TAPS Renewal FEIS on impacts from continued operation of the pipeline and tanker transportation system were the following:

Paleontology, Air Quality, Transportation, Waste Management, Terrestrial Vegetation and Wetlands, and Cultural Resources – TAPS would have no or very minor impact.

Soils and Permafrost – Increased throughput could expand thaw bulbs and ground settlement near TAPS. Reduction in throughput could cause frost heaves. TAPS would be a minor contributor to cumulative effects related to soils and permafrost.

Sand, Gravel, and Quarry Resources – TAPS would be a minor contributor to requirements for these resources.

Surface Water Resources – Impacts to surface waters would be localized unless an oil spill occurs, in which case impacts could be substantial. TAPS operation would have a very small effect on surface water quality.

Groundwater – An oil spill from the TAPS or oil development activities could impact groundwater quality to a small or large extent, depending on the spill's size, location, and the effectiveness of response activities.

Physical Marine Environment – The marine environment could be affected by spills from tanker and other forms of marine transportation in Prince William Sound or along Pacific transportation routes. Reasonably foreseeable spills would be small and rapidly cleaned up and of local consequence. Larger, less probable spills might take longer to clean up and result in widespread contamination of the marine environment.

Noise – All activities would have the potential to produce local impacts on noise.

Human Health and Safety – No adverse health impacts would be expected from the inhalation of industrial air emissions in the Valdez area. Valdez Marine Terminal operations contribute to, but are not the sole source of, organic air pollution emissions in the Valdez area. The general public would be exposed to more vehicle emissions over the next 30 years unless additional controls are placed on such emissions. Accidental releases of hazardous materials and spills into the marine environmental also could have small impacts on public health.

Fish – Risks of large spills with large consequences would be low; however, a major spill into a waterway could be severe and possibly long-term.

Birds and Terrestrial Mammals – Impacts from many activities could be large in local areas but would be minor on the population level.

Threatened, Endangered, and Protected Species – Impacts are anticipated to be negligible to minor and are not anticipated to threaten population viability, unless a low-probability, high-volume spill from oil transportation occurred in Prince William Sound or along Pacific Transportation routes. Such a spill might cause impacts that would be high on a local level.

Economics – Continued production of North Slope petroleum reserves, including transportation, would make a substantial, though declining contribution to domestic oil production and would continue to reduce the need for foreign oil imports, thus improving national energy security and the overall balance of trade. Significant federal tax revenue would be generated with continued TAPS operation, together with marine and shipbuilding employment and employment in the economy as a whole.

Subsistence – There would be low impacts on subsistence, except on the North Slope where impacts would be moderate. Contributions from TAPS to these [subsistence] cumulative impacts are expected to be relatively small.

Socio-cultural Systems – In socio-cultural systems founded on cooperation and subsistence, cumulative impacts might accompany their continued interaction with modern American society and the continued growth in the importance of a cash economy. However, these changes occurring throughout Alaska are not attributable solely to cumulative actions considered in [the Renewal EIS]. The contribution of TAPS to these cumulative impacts would be relatively small.

Land Use and Coastal Zone Management – The contribution of the TAPS operation to these cumulative impacts is expected to be relatively small. However, an oil spill to marine waters from marine transportation or from oil production could impact implementation of CMPs.

Recreation, Wilderness, and Aesthetics – Oil or gas spills associated with TAPS operations could impact recreation, aesthetic, and wilderness values. Because spills could result in long-term impacts, aesthetic impacts along the TAPS may be major.

4F.2.4.3 Size and Frequency of Oil Spills

Opportunity for spillage of oil and other hazardous material is present during exploration, development, and production. No large spills (greater than 100,000 bbl) have occurred on the North Slope during the time of modern oil production. However, small localized spills in a range of sizes have occurred with measurable frequency. An analysis of the expected frequency of spills by size class has been developed and incorporated into EISs prepared for the Northeast NPR-A (which contains a portion of the Alpine planning area), Northwest NPR-A, and the TAPS Right-of-way. The most recent, the EIS for the Northwest NPR-A Integrated Initial Activity Plan, represents a refinement of previous

spill analyses. Since no materially new information is available on the size or frequency of oil spills, the spill analysis included in the Northwest NPR-A EIS is incorporated by reference. Further discussion of the conclusions of that analysis may be found in Section 4.3 of this EIS.

4F.3 Guiding Principles for Cumulative Impact Assessment

4F.3.1 Reliance on Federal and State Programs for Resource Protection

A number of federal and state programs have been established to protect environmental resources and, in cases where there is existing environmental impairment, to effect restoration. The assessment of cumulative impacts must recognize the existence of these programs and assume that the mandate under which each program was established will continue. The practical effect of these programs is that they are assumed to require the avoidance or mitigation of the environmental impacts that they are designed to address. The programs assumed to continue for the cumulative impact assessment are described by the resource that they manage or protect as follows:

Threatened, Endangered, and Protected Species – The ESA of 1973 is intended to protect listed species from harassment and harm that could be detrimental to the continued existence of the species. This protection considers direct project effects, and cumulative effects of multiple actions. Consultation on listed species identified in the Plan Area by the NMFS (now known as NOAA Fisheries) and the USFWS under Section 7.0 of the ESA are incorporated by reference in this cumulative analysis. The potential effects on each of the other species identified through scoping were also reviewed and included, as appropriate in this EIS. Cumulative effects were also analyzed for those species listed as "endangered," "threatened," "proposed," or "candidate" on the North Slope, in the Beaufort Sea, and in the Chukchi Sea and which the NMFS and USFWS indicated that this EIS should assess.

Marine Mammals – The management of seals by the NMFS and polar bears by the USFWS under the MMPA of 1972 provides for monitoring these species' populations and managing or mitigating potential effects of development on these species. For example, the USFWS implements measures to protect polar bear den sites through a Letter of Authorization under the MMPA.

Essential Fish Habitat (EFH)— The amended Magnuson-Stevens Act requires Federal agencies that authorize, fund, or conduct activities that "may adversely affect" EFH to work with NMFS to develop measures that minimize damage to EFH. By providing EFH Conservation Recommendations before an activity begins, NMFS may help to prevent habitat damage before it occurs rather than restoring it after the fact, which is less efficient, unpredictable, and often more costly.

Caribou – The ADF&G monitors caribou by a census of caribou calving and caribou distribution. These monitoring efforts provide a means of determining whether significant cumulative effects on caribou have occurred or are occurring on the North Slope and help in developing measures to minimize effects.

Water Quality – Water quality on the North Slope is regulated and/or monitored through various permitting and regulatory programs administered by the U.S. EPA; ADNR, ADEC and Fish and Game; and NSB. These programs have been established to protect against the significant degradation of water quality associated with specific human and development activities. In evaluating the cumulative effects to water quality, collective impacts associated with both permitted/regulated activities and non-regulated activities and/or naturally occurring events are considered.

Air Quality – The Clean Air Act and its PSD regulations establish controls on major point sources of air emissions to maintain specific ambient air quality standards. This regulatory program addresses individual project emissions in a cumulative regional context. For sources located in the OCS, the PSD program is administered by the EPA. For sources in state waters and onshore, the PSD program is administered by the ADEC. The analysis of cumulative effects to air quality considers the contribution of both major and minor sources of air pollution on the North Slope.

Wetlands and Floodplains– Conversion of wetlands and floodplains is protected in two ways. Impacts to wetlands and floodplains are mitigated through the stipulations in the 1998 Northeast NPR-A IAP/EIS and the terms and conditions of permits and approvals issued by the BLM at the exploration and development stage on BLM managed lands in the NPR-A. These require protection and mitigation of impacts to wetlands. In addition, Section 404 of the Clean Water Act, administered by the USACE, controls any modifications to wetlands to minimize the net loss of wetlands. A Memorandum of Agreement between EPA and USACE recognizes that in areas such as the North Slope of Alaska (with its high proportion of wetlands) minimizing wetland losses is preferable to compensatory mitigation.

Environmental Justice – Executive Order 12898 *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* and an accompanying presidential memorandum require each federal agency to make the consideration of environmental justice part of its mission. The existing demographics (race and income) and subsistence consumption of fish and game are discussed, disproportionate environmental and health effects on Alaska Natives are evaluated, and mitigating measures and their effects are presented.

Native Consultation – Executive Order 13084 *Consultation and Coordination with Indian Tribal Governments* requires consultation with Native tribal governments on "Federal matters that significantly or uniquely affect their communities," so that an effective process is established that "permits elected officials and other representatives of Indian tribal governments to provide meaningful and timely input." Representatives of the BLM and the cooperating agencies have met with local tribal governments to discuss subsistence issues relating to the ASDP EIS and have established a dialogue on environmental justice with these communities. Mitigation measures included in this EIS include measures advocated by tribal groups. Inupiat Traditional Knowledge had a part in developing mitigation.

4F.3.2 Types of Cumulative Impacts Considered

The purpose of the cumulative impact analysis is to identify impacts of a proposed action or its alternatives that may not be of consequence when considered alone, but when combined with the impacts of other actions may become consequential. Three types of cumulative effects are considered (Council on Environmental Quality, *Considering Cumulative Effects Under the National Environmental Policy Act, January 1997)*:

Additive – Accumulated effects to a resource from more than one action such that the operation of independent nearby projects all impact the same resource.

Countervailing – Adverse effects that are offset by beneficial effects to the same resource.

Synergistic – Accumulated effects to a resource that are more than additive. Synergistic impacts occur when additive effects escalate beyond the normal incremental increase in impacts expected to occur from individual projects or actions.

Cumulative impacts to each resource were evaluated for each of the three types of impacts listed. It should be noted that if one of the types of impacts did not occur, it is not listed.

4F.4 Methodology/Scope of Cumulative Impact Analysis

4F.4.1 Background

The North Slope Region of Alaska is a very sparsely populated region of extreme climate but which has abundant energy and other natural resources. This region is a treeless tundra where low temperatures and ice conditions dominate all natural processes. Native cultures are known to have subsisted on the North Slope for many thousands of years. Exploration and industrial development for extraction of the mineral resources of the region (principally oil and gas) has been active over the past 80 years, and this development is the most significant man-induced change to the North Slope. Oil discoveries first occurred from early exploration in northern Canada that resulted in the oil discovery in

1920 at Norman Wells, a site that has been intermittently productive. The USGS explored for oil in the early 1920s in lands set aside by the federal government as a naval petroleum reserve. The Umiat oilfield, in the southeastern NPR-A, was discovered during exploration by the U.S. Navy in 1946 but remains undeveloped. The South Barrow gas field began production in 1950. More extensive exploration in the 1960s resulted in numerous oil and gas discoveries in northern Alaska and the adjacent Mackenzie Delta in Canada. The largest of these, Prudhoe Bay, was discovered in 1968 to have nearly 13 Bbbl of recoverable oil. An extensive exploration program in the NPR-A was conducted first by the Navy and later by the U.S. Geological Survey during the 1970s and early 1980s when test wells were drilled and seismic data were collected. After completion in 1977 of the TAPS, which provided a means of transportation for produced crude oil out of the region, a number of North Slope oil discoveries were brought into production. The most recent of those discoveries was the Alpine field in the Colville River Delta. The first oil production from the Alpine field occurred in November 2001.

During the 80-year oil and gas industrialization period, the most intense development activity occurred during the 1970s and early 1980s. It was then that the Prudhoe Bay fields were developed, TAPS and the haul road were constructed, and a large portion of the roads, drilling pads, gravel sources, collector pipelines, and production facilities were built. Since then, additional development has occurred, but incremental physical disturbance to the environment has been reduced. More recent fields were generally developed in areas adjacent to existing producing areas, reducing the amount of additional support infrastructure (roads, pipelines, and processing facilities) needed to support additional production. At the same time, changes and improvements in technology have generally lessened the physical disturbance caused by more recent exploration, development, and production activities.

Until development of the Alpine field in the eastern part of the NPR-A Plan Area and Badami to the east of Prudhoe Bay, most development was in and adjacent to Prudhoe Bay. This encompasses an area approximately 120 to 130 miles east to west and ranging from 10 to 20 miles inland from the Beaufort Sea coastline. Development of the Alpine field, including the proposed ASDP and the extended FFD, would extend the primary area of oil production to the west approximately 40 miles and in from the coastline up to 40 miles. To form a context for the proportional size of the development area, the North Slope (including the general area north of the Brooks Range) is a regional area of approximately 55,000 square miles (including the Arctic National Wildlife Refuge), with 650 miles of coastline. The oil development area (not including the TAPS corridor) is an area of approximately 3,000 square miles, with a coastline of approximately 230 miles. Thus, oil development (including the proposed development) affects approximately 5.4 percent of the land area and 35 percent of the coastline of the North Slope. It should be noted that a description of the proportional area of development does not impute a specific level of cumulative impact to resources.

The Native population of the North Slope has established settlements from Kaktovik in the east to Point Hope in the west. From these settlements, hunting and fishing areas (traditional subsistence use areas) extend across the landscape and coastal waters of the Chukchi and Beaufort seas. Of the four communities in proximity to the ASDP, only Nuiqsut is close to the primary oil development area. Barrow, the next closest, is approximately 130 miles from Prudhoe Bay. The area of current and proposed oil development is within the subsistence use areas of Barrow and Nuiqsut (BLM 1998a, Section III.C) Until leasing in the NPR-A and development of the Alpine field, Nuiqsut was to the west of the development area, although the development area occurred within Nuiqsut's subsistence use area. With development of the Alpine field, including the proposed project, Nuiqsut will have oilfield development extending to the north and west of the village site and further extending into its subsistence use area. As overall oilfield development is pursued in the NPR-A, the other North Slope communities will have oilfield development closer to their village sites and increased overlap between the development and their subsistence use areas.

To assess cumulative impacts, an evaluation is made of the historical development, the proposed development (CPAI's proposed five-pad development and FFD), and other projects and activities likely to occur. The purpose of the cumulative impact analysis is to identify any project impacts that when

combined with other impacts to resources or the region will cumulatively form impacts to be considered for mitigation. It should be noted that the analysis of project-specific impacts (documented earlier in Section 4.A through 4.E) presents project impacts in the context of the existing conditions, which also includes the operations and related impacts of current oil development, subsistence living by local residents, and other existing activities. The primary focus of the cumulative impact assessment is to incorporate the consideration of past, present, and reasonably foreseeable future projects and to evaluate impacts within a broader geographic area (see discussion in Section 4F.2.3, Region and Timeframe of Consideration).

4F.4.2 Alternatives Evaluated in Cumulative Analysis

The ASDP has been evaluated in four alternative configurations and the "No-Action Project Alternative". Alternative A is the applicant's proposal; Alternatives B, C, and D represent different means of achieving the same or similar objectives. The No-Action Alternative is Alternative "E". The FFD scenarios for each alternative are included as part of the reasonably foreseeable future development in the analysis of cumulative impacts. The following analysis initially describes the cumulative impacts associated with Alternative A. The cumulative impacts of the other alternatives are then assessed**.**

4F.4.3 Defining Reasonably Foreseeable Future Actions for Cumulative Analysis

The cumulative analysis evaluates the proposed project together with other reasonably foreseeable future actions and combines the effects of these actions with the effects of past and present actions. These actions include projects or activities that may occur in a broader geographic area than the impact area considered in Sections 4A through 4E and projects that may be in any one of a number of stages of development. To identify and select projects for inclusion, the BLM considered the following:

Past Development/Production*:* Activities that were associated with past actions and may involve present operations. This involves infrastructure development and non-oil related actions, as well as the development of the oil industry facilities.

Present Development/Production*:* This includes exploration, development, or production operations and related activities that may be currently under way or planned for the near future. This may also include other non-oil-related development.

Reasonably Foreseeable Future Development*:* Oil and gas discoveries or other projects that are clearly identified and are expected to initiate development-related activities (site surveys, permitting, appraisal drilling, or construction) within the next 15 to 20 years. In addition to oil and gas development, other reasonably foreseeable future actions were identified. They include the Dalton Highway to Nuiqsut road project and continued human activities such as sport and subsistence hunting and fishing, commercial fishing, sport harvest, tourism, and recreational activities**.**

Speculative Development*:* Additional new discoveries could be made and developed beyond 20 years. The chance for development is too uncertain for detailed analysis at this time. However, additional exploration activities (wells and seismic surveys) are likely to occur and have been factored into the analysis.

4F.4.4 Oil and Gas Development

Recent Environmental Impact Statements prepared by the BLM (Northeast NPR-A, Northwest NPR-A, TAPS) and the NRC report have projected oil and gas development on the North Slope and described the types of impacting activities that would occur. These forecasts and descriptions have been reviewed by the BLM and updated as necessary.

4F.4.4.1 Future Oil Development

Past, present, and future oil and gas production for Alaska's North Slope is given in Table 4F.4.4-1. This table includes the following:

TABLE 4F.4.4-1 PAST OIL AND GAS DEVELOPMENT ON THE NORTH SLOPE

Past Production and Development			
Field/Unit	**Field/Satellite**	**Began/2001 Production**	**Reserves**
Onshore			
Duck Island	Sag Delta	89 / Included above	-
	Ivishak	- / 0.14	-
Prudhoe Bay (PB)	Prudhoe Bay	77 / 194.24	2,454
	P.B. Satellites	- / Included above	1441
	Lisburne	81 / 3.68	33
	West Beach	94 / 7.02	5
	North P.B.	93 / 18.69	1
	Midnight Sun	99 / 1.35	11
	Aurora	01 / 0.42	38
	Borealis	01 / 1.31	63
	Polaris	01 / 0.07	49
Kuparuk River	Kuparuk River	81 / 68.27	814
	Tabasco	98 / 1.32	24
	Tarn	98 / 8.05	46
	West Sak	98 / 2.0	100
	Meltwater	01 / 0.15	52
	Palm	02 / -	35
Milne Point	Milne Point	85 / 15.27	260
	Cascade	96 / -	
	Schrader Bluff	91 / 3.82	99
	Sag River	94 / 0.25	7
Colville River	Alpine	00 / 28.69	398
	Nanuq	01 / .02	40
NPR-A	East Barrow	81 / - (gas only)	-
	South Barrow	50 / -(gas only)	-
	Walakpa	93 / -(gas only)	-
Offshore			
Duck Island	Endicott	87 / 10.96	177

TABLE 4F.4.4-1 PAST OIL AND GAS DEVELOPMENT ON THE NORTH SLOPE

Past Production and Development			
Field/Unit	**Field/Satellite**	**Began/2001 Production**	**Reserves**
	Sag Delta North	89 / Included above	-
	Eider	98 / 0.66	4
Prudhoe Bay	Niakuk	94 / 3.68	49
	Pt. McIntyre	93 / 1.74	208
Badami	Badami	98 / 0.67	8
Northstar	Northstar	01 / 1.27	175

Source: NPR-A Northwest, 2002, Vol. 2; State of Alaska, AOGCC (2002); MMS,OCS Alaska

Past Development / Production

Past Development/Production includes producing fields on the North Slope and nearshore areas of the Beaufort Sea. Infrastructure, cumulative production, and remaining reserves are well defined. Individual oil pools have been developed together as fields that share common wells, production pads, and pipelines. Fields have been grouped into production units with common infrastructure, such as processing facilities. Impacts associated with development have occurred over the past three decades, and there are data from monitoring that accurately reflect some of the long-term effects. Future activity may include installation of additional wells at existing locations and rework of existing wells. Addition to other infrastructure is unlikely.

This category contains 33 discoveries that are currently producing oil. Table 4F.4.4-1 lists the discoveries, date of initial production, and 2002 production and reserves. Table 4F.4.4-2 provides information on the existing infrastructure**.** A map showing the location of these developments and the general infrastructure interconnecting them is shown in Figure 4F.4.4-1. All of these fields, with the exception of Northstar, Endicott, Sag Delta North, and Eider, are onshore on state leases**.** The Niakuk, Point McIntyre, and Badami oilfields are mainly offshore but are produced from onshore sites. If the Point Thomson field, which is included in the list of future projects, is developed, it is expected that the proposed Point Thomson pipeline would tie into Badami's common-carrier pipeline.

The most recent additions to this category are in the Alpine field. During 1996, ARCO announced that the Alpine Prospect in the Colville River Delta was producible and contained an estimated 365 MMbbl of oil. More recent estimates of Alpine are over 429 MMbbl. The most recent additions to this category are in the Alpine field, which came on line in November 2000 and is currently producing approximately 80,000 barrels of oil per day. Alpine resources are extracted from two production pads known as CD-1 and CD-2 and are connected by a 3-mile-long road. An oil processing facility has also been constructed at CD-1. Oil is transported through a 34-mile pipeline to the Kuparuk processing facility, where Alpine production is commingled with Kuparuk output and transported via TAPS. The Alpine pipeline to Kuparuk crosses under the Colville River channel. Ice roads and bridges provide access during the winter. There are no gravel roads connecting the Kuparuk infrastructure to Alpine. Alpine's 40,000-acre field was developed on 94 surface acres.

TABLE 4F.4.4-2 NORTH SLOPE OIL INFRASTRUCTURE, 1968-2001

	1968	1973	1977	1983	1988	1994	2001
Gravel roads							
oil field (mi.)	0	100	139	294	358	370	400
oil field (ac.)	0	677	1,002	2,029	2,448	2,536	2745
Dalton Highway (mi.)*	0	170	170	170	170	170	170
Dalton Highway (ac.)*	0	332	332	332	332	332	332
Gravel pads							
Production, Processing, Support, Exploration (no.)	4	100	158	277	325	341	353
Production, Processing, Support, Exploration (ac.)	14	901	1,981	4,570	5,552	5,692	5817
Airstrips (no.)	1	15	19	20	20	20	20
Airstrips (ac.)	6	136	252	287	313	313	287
Offshore islands (no.)	0	0	2	12	15	16	17
Offshore islands (ac.)	0	0	5	54	133	149	155
Gravel Mines							
In rivers (ac.)	25	4,732	4,996	5,011	5,063	5,061	5,082
In tundra (ac.)	0	34	151	745	1,179	1,186	1,283
Pipeline corridors							
Oil field (mi.)**							450
Trans-Alaska Pipeline***	0	166	166	166	166	166	166
Tundra impacted areas (ac.)							
Gravel footprint areas****	352	2,045	3,620	7,354	9,013	9,252	9,557
Other impacted areas*****	308	1,388	1,552	1,694	1,698	1,753	1,765
Gravel mines	25	4,766	5,146	5,756	6,241	6,246	6,364
Total Disturbed area (ac.)	685	8,200	10,319	14,804	16,952	17,251	17,686

Source: Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope, 3-03; *Environmental Atlas of the Trans Alaska Pipeline System*.

Notes:

* does not include portions of the highway south of the North Slope.

** multiple pipelines are included in some corridors, e.g., 366 miles have 1-5 pipelines and 73 miles have 66-11 pipelines.

*** a buried gas pipeline roughly parallels the oil pipeline for 144 miles south to pump station 4; mileage only includes those on the North Slope.

**** includes gravel roads, gravel or paved airstrips, offshore and onshore gravel pads/islands

*****includes exploration site-disturbed area around gravel pad, exploration airstrip, peat roads, tractor trail, exploration roads, and gravel pad removed

Present Development/Production (Within the Next Few Years)
Present Development/Production (within the next few years) includes fields that are in planning stages for development or in development but have not yet begun production. Infrastructure components, scheduling, and reserve estimates are fairly well defined, although reserve volumes could be revised. Because new developments are commonly tied into existing infrastructure, continued development depends on the continued operation of this infrastructure.

CPAI's current proposal to develop CD-3 through CD-7 is at this stage of development. The ADR estimates the five pads could produce a total of 330 million barrels of oil in the next two decades **(**ADR, Tax Division. Unpublished files from Spring 2003 Revenue Sources Book**).** Orion, within the Prudhoe Bay unit, is also at this stage and is estimated to have reserves of 50 million barrels**.**

Reasonably Foreseeable Future Development/Production (Within the Next 15 to 20 Years)
Reasonably Foreseeable Future Development includes projects that are reasonably foreseeable to begin development within the next 15 to 20 years. Known discoveries outside of the ASDP are listed in Table 4F.4.4.-3, which shows the date of discovery and general location of each. accurate oil volumes for individual fields are generally unavailable, though for cumulative impacts analysis purposes, it is assumed that the pools listed in the table contain approximately 1,500 million barrels, two-thirds of which is off-shore. Figure 4F.4.4-1 shows the locations of these areas.

Development in addition to that which ConocoPhillips is currently proposing may also occur in areas only recently made available for oil and gas leasing in NPR-A. This development, which would include as yet undiscovered reserves, could occur both within the ASDP Plan Area and west of the ASDP area, though the amount, nature, and location of such development is unknown. For purposes of analysis, however, this EIS assumes that the FFD scenario represents the reasonably foreseeable future development within the ASDP.

TABLE 4F.4.4-3 PAST, PRESENT, AND REASONABLY FORESEEABLE FUTURE OIL AND GAS DEVELOPMENT

Reasonable Foreseeable Future Oil ands Gas Development		
	Pool	**Discovery / Location**
Western Group	Kalubik	1992/Offshore
	Thetis Island	1993/Offshore
Central Group (Northstar)	Gwydyr Bay	1969 / Offshore
	Pete's Wicked	1997 / Onshore
	Sandpiper	1986 / Offshore
Eastern Group	Mikkelson	1978 / Onshore
	Sourdough	1994 / Onshore
	Liberty	1983 / Offshore
	Yukon Gold	1994 / Onshore
	Point Thomson	1977 / Onshore
	Flaxman Island	1975 / Offshore
	Stinson	1990 / Offshore
	Hammerhead	1985 / Offshore
	Kuvlum	1987 / Offshore
		Offshore Total
		Onshore Total
		Total

Source: NPR-A Northwest, 2002, Vol. 2; State of Alaska, AOGCC (2002); MMS,OCS Alaska

Many of the listed discoveries were made decades ago and have remained non-commercial to this day. Development in these cases will depend largely on technology advancements and higher petroleum prices. These developments would most likely occur near existing (past and present) fields to share infrastructure systems.

Additional amounts of oil could be produced by enhanced recovery technology[1] from existing fields and from undeveloped (or undiscovered) satellite pools adjacent to existing production areas. Some of this production would replace declining production at existing fields. Although the extent of both of these new resources (reserve growth and satellites) is as yet undetermined, it is reasonable to assume that a portion would be brought into production in the next 20 years. Assuming, for analysis, that half of the 4 Bbbl estimated for enhanced recovery and satellite fields would be brought into production in the foreseeable future gives approximately 2 Bbbl. Because enhanced recovery and satellite fields would be developed largely from existing infrastructure, the incremental addition of new infrastructure and related land disturbance is expected to minimal. The oil infrastructure assumptions for the reasonably foreseeable development scenario include the following**:**

Future ASDP area development: the respective FFD assumptions for each alternative

Other reasonably foreseeable oil development: 450 acres footprint, 180 miles of pipeline

Speculative Development (Beyond 20 years)
Speculative resources include both discovered (though uneconomic) and undiscovered (purely speculative) resources that may be developed more than 20 years from now. Speculative Development includes those small discoveries and undiscovered resources that are very unlikely to be developed in the next 20 years including undiscovered oil resources that may be found as a result of future state and federal lease sales. Among the speculative developments are fields discovered 50 years ago and remain noncommercial today because of their very remote locations, low production rates, and the lack of a gas-transportation system. Because they are currently noncommercial and are not planned for development, they are speculative and were not included in the Cumulative Impacts analysis. Similarly, the cumulative effects of undiscovered resources also cannot be included in the Cumulative Impacts analysis because a reasonable estimate of the location, magnitude, schedule, and type of development cannot be made.

4F.4.4.2 Future Gas Development

Development of gas resources on the North Slope is considered speculative; gas has been uneconomical to produce for several decades, is currently uneconomical, and is expected to continue to be uneconomical in the future. The largest known gas accumulation on the North Slope is in the Prudhoe Bay field with 46 trillion cubic feet [Tcf] originally in place with approximately 25 Tcf available now for sale. Gas reserves from the Prudhoe Bay field are sufficient to supply a large-scale gas export project for at least 20 years. Surrounding oilfields also have available gas resources that could feed into a North Slope gas transportation system. However, no means of transporting this gas to North American or Asian markets is available.

Plans to construct methods of transportation have been formulated but have not been able to overcome high project development costs or marketing hurdles even though proven gas reserves have already been developed adequate to supply such a transportation project. There are three transportation projects in various stages of development, although none is currently active. A fourth project to use the existing TAPS is in the feasibility evaluation phase. These projects are listed below:

[1] Enhanced recovery adds production from known reservoirs, effectively creating "reserve growth." For example, the Prudhoe Bay field was originally estimated to hold 9.6 Bbbl of reserves, and today it has reserves approaching 13 Bbbl. More than 3 Bbbl were added by factoring in enhanced recovery technologies.

TAGS – A natural gas pipeline constructed parallel to the TAPS crude oil pipeline from Prudhoe Bay and terminating at a LNG at Valdez. The project has been designed and permitted since 1988. It is not actively under development.

ANGTS – A natural gas pipeline that parallels the TAPS pipeline to Delta Junction then is routed across the Yukon Territory to connect with gas pipeline systems in Canada. This project has been permitted since 1980. It is not actively under development.

Arctic Resources, Northern Gas Pipeline Project – A pipeline constructed offshore from Prudhoe Bay to the Mackenzie River Delta then south to connect with the gas pipeline system in Canada. This project has not received regulatory approvals and has no commitments from shippers.

Natural Gas to Liquids Conversion – This project would convert natural gas to liquid that could be shipped through the TAPS and exported from Valdez. An experimental conversion facility to determine the feasibility of this approach is currently under development.

Because the export of known gas resources is uneconomical today, it is difficult to predict the viability, timing, or scale of future gas production projects. If a gas transportation system were constructed in the future, current gas reserves associated with existing oil production would be used before the industry is likely to invest in new gas exploration. The development of remote, undiscovered, and more expensive gas resources is considered to be unlikely while there are adequate supplies of known, readily available reserves.

4F.4.4.3 Impacting Oil and Gas Activities

To assess cumulative impacts, the activities of present and future oil development and production that cause impacts must be described. Section 2.0 includes a description of the activities to be undertaken, including the construction sequence for construction and operation of CPAI's proposed development project. These same types of activities would be undertaken for expansions of existing fields and development of new fields on the North Slope.

Surveys – Seismic and other surveys to estimate potential for presence of reserves. For onshore surveys, includes overland transportation of survey crews using low-pressure tire type vehicles, initiation of micro-scale seismic inputs, and temporary installation of recording equipment to collect data. Seismic input and data collection are generally one-time temporary activities causing small, localized disturbance. Seismic input generates temporary noise events.

Leasing Activity – Auctions of lease rights to explore and develop mineral resources, conducted by Native Corporations and state and federal governments. Most leases are preceded by an environmental review that may include field collection of data to verify the presence and extent of natural resources. Such surveys may include the use of Rolligons, helicopters, and other wheeled vehicles for access. Survey activity is minimally to non-impacting.

Exploration Drilling – Typically conducted in the winter. Requires construction of a temporary ice access road and ice drilling pad. Drilling muds and cuttings are typically injected in the annular space of the well or transported to an EPA-approved disposal site. Includes installation of some temporary structures for workspace and personnel. Has the potential for inadvertent spill of petrochemicals (diesel fuel), drilling muds, and other material, although any spills would be of limited quantity and localized to the exploration site.

Production Drilling – Typically requires construction of a permanent access road or local airstrip and may include expansion of the permanent production pad. Requires transportation of equipment and materials to the site, operation of fossil-fuel-fired equipment, a water supply, and disposal of drilling muds and cuttings. Includes installation of buildings and materials handling and storage facilities, including containment for storage of liquids required for operation. Similar to exploration, drilling has the potential for inadvertent spill of petrochemicals (diesel fuel), drilling muds, and other material, although a spill would be of limited quantity and localized to the site. Drilling multiple wells extends the period of intense site activity to 12 to 24 months, during which traffic (road or air) to the site

would be frequent. Offshore production drilling is similar to onshore except that a gravel island is constructed that would have a larger footprint than the onshore production pad.

Infrastructure Installation – Each production site is interconnected by pipeline to a centralized processing facility which in turn interconnects to the TAPS pipeline for exporting of crude oil. Pipeline installation requires construction of a temporary ice road to provide access and construction laydown area during pipeline construction. Pipelines are installed above ground on pilings or VSMs placed into the permafrost. Permanent ground disturbance is limited to the piling location. The installed aboveground pipeline becomes a linear landscape feature. In some circumstances the pipeline may be installed adjacent to the production site access road to facilitate routine pipeline inspection and maintenance. Pipeline construction includes the use of fossil-fuel-fired equipment, noise from construction activities, and a need for a water supply. After completion, the pipeline is cleaned and hydrostatically tested. Cleaning wastes and hydrostatic test water require disposal. During construction, small spills of diesel fuel and lubricants may occur during equipment fueling and maintenance operations. Oil spills of any magnitude during operation are unlikely based on operating experience.

The current Integrated Activity Plan for the Northeast NPR-A prohibits permanent roads connecting Northeast NPR-A facilities to outside infrastructure. Stipulation 48 for the Northeast NPR-A states, "Permanent roads (that is gravel, sand) connecting to a road system or docks outside the planning area are prohibited, and no exceptions may be granted" (BLM 1998b, p. 38). Similarly, ongoing and planned oil-development projects such as Badami, Alpine, Northstar, and the other satellite production pads currently proposed by CPAI in the ASDP Plan Area are not expected to have permanent gravel roads connecting to Prudhoe Bay. Transportation to these fields is assumed to be by aircraft and/or marine vessels; in winter, temporary ice roads also will be used. However, permanent roads may be constructed within the planning area that interconnect production facilities.

Production – Operation of the wells during production requires the use of diesel-fired equipment and the transportation of recovered oil, diesel, and injection water through the pipeline system. Limited onsite personnel are required during operations, minimizing the number of trips by vehicle or aircraft to the site. During operations of the collector pipeline system, inadvertent spills of seawater, diesel fuel, or recovered oil may occur. If spills were to occur, they may not be confined except to the extent that existing topography limits the extent of a spreading. Spills may occur at locations that may lead to the introduction of spill fluids directly or indirectly into watercourses, surface water bodies, or wetlands. Aircraft operations serving production sites served by an airstrip (a roadless development) will intermittently produce local noise.

Processing – Production also includes processing of the recovered product at a centralized processing facility to separate the crude oil from other constituents including natural gas, water, and solids. The recovered natural gas and water is transported back to the production site and re-injected into the producing structure to maintain reservoir pressure. Since a single processing facility serves multiple production sites, few new processing facilities will be constructed.

Transportation – Crude oil exported from the processing facility is transported via TAPS to the Valdez, Alaska, marine terminal, where it is loaded aboard seagoing tankers and transshipped to markets on the west coast of the United States and Asia. Because no other export means are available, all North Slope production is expected to be transported by this system.

Gravel Resources – Road, production pad, and gravel island construction requires the extraction and transportation of gravel resources. While gravel is reasonably abundant on the North Slope, gravel extraction has historically occurred at two types of locations: in river or stream channels or in upland areas. In upland areas, gravel extraction requires removal and stockpiling of overburden. Construction activities requiring gravel mining and transportation typically occur in the winter. Blasting to excavate gravel material would likely be required and would produce noise effects. Because gravel resources must be transported by truck, the location of gravel mine sites is optimized to reduce transportation distance.

Water Resources – Water resources are required for construction of ice roads and bridges and other needs during construction. Construction water needs are typically high-volume but short-term. A minimum but continuous quantity of water is required during operation.

Waste Management – Current and expected future development and production methods allow for zero-discharge waste operations. All waste material is recycled, reused, or disposed of onsite.

All of the activities considered under present and future oil development would include the above activities.

4F.4.5 Dalton Highway to NPR-A/Nuiqsut Road

The Alaska Department of Transportation and Public Facilities proposes to construct an access road from the Dalton Highway to the NPR-A and the village of Nuiqsut. The route for the proposed 102-mile-long road would begin at Pump Station 2 (Dalton Highway Milepost 357, 57 miles south of Deadhorse), cross the foothills of the Brooks Range, then turn north toward Nuiqsut. The road would cross the Colville River before its destination at Nuiqsut. Several alternative river crossing locations have been considered. For analysis purposes, this EIS assumes that the road will have a footprint of about 610 acres and produce impacts from gravel mining on 130 acres**.** The route of this proposed road is shown in Figure 4F4.5-1.

This road would provide year-round access for residents of Nuiqsut to Fairbanks and other populated areas of Alaska. It would also provide access to the NPR-A for industry. The State of Alaska is evaluating public access policies that would include limiting public use of this road. However, for the purpose of this cumulative analysis, it was assumed that this road would eventually be opened to public access. The road would be constructed of gravel and create an overall constructed footprint of approximately 611 acres. At stream crossings culverts would be installed to maintain stream flow**.** The Colville River crossing is planned to be a bridge structure.

4F.4.6 Amendment to the Northeast NPR-A IAP/EIS

On June 23, 2003, BLM announced that it would undertake an amendment to the Northeast NPR-A IAP/EIS. The BLM is conducting an EIS to amend the plan, which it anticipates completing in late 2004. Following this full NEPA review, the BLM may approve changes to the stipulations and other requirements of the original Northeast NPR-A IAP/EIS. Stipulations developed through the amendment will apply to tracts BLM leases in the future on lands it manages in the Northeast NPR-A IAP/EIS plan area, including some lands within the ASDP area. The stipulations developed in the original Northeast NPR-A IAP/EIS are attached to all current federal leases within the ASDP area, including those that CPAI seeks to develop from CD-6 AND CD-7.

Any proposed changes to the Northeast NPR-A IAP/EIS will undergo a full NEPA review, including analysis of any cumulative impacts of the proposed action. Furthermore, no changes to the stipulations attached to the existing leases will occur until after consideration in the full NEPA review for the Northeast NPR-A Amended IAP/EIS and renegotiations with the leaseholders. Although lease stipulations may be revised to include more performance, rather than prescriptive, stipulations as a result of that NEPA process, it is not anticipated that these revisions will create different impacts from what might occur given current stipulations. Making additional lands available for leasing, as the amendment also will consider, may ultimately lead to greater development. However, no decision has been made to provide more lands for leasing and it is speculative to estimate or analyze the impacts of leasing that has not yet been authorized.

4F.5 Analysis of Cumulative Impacts to the Physical Environment

4F.5.1 Physiography

4F.5.1.1 Evaluation

Cumulative impacts to the physiography of the North Slope would likely result from changes to landforms caused by continued development and construction of roads, pads, airstrips, and gravel mines. Impacts would be localized to the immediate footprint of the facilities and the immediate surroundings. Breaking the vegetated surface layer, however, is not an acceptable construction practice; thus, the existing physiographic terrain features on the North Slope generally would not be directly altered to construct the facilities.

The exception would be the gravel mine sites. In order to meet the gravel needs under the Proposed Plan and to accommodate continued development on the North Slope, additional gravel mining sites are necessary for pad, road, and airstrip construction and maintenance. New gravel mine sites would affect the existing tundra surface by complete removal and extraction of the underlying gravels. A large disturbance such as this could cause melting of the permafrost soils around the mine site perimeter, which would create additional landform changes. If ponds are created in the mine area, they would likely be much deeper than the typical North Slope lake and, as typical under a water body that does not freeze completely during winter, thaw bulb formation would likely follow. However, when gravel extraction is completed, the mine site would be re-contoured, approximating natural terrain features thus decreasing the likelihood for long-term adverse cumulative impacts.

To date North Slope oil development has resulted in approximately 1,280 acres of gravel mines on the tundra and 9,640 acres of gravel footprint in roads, airstrips, and pads (Table 4F.5.1-1). Construction of CPAI's proposed project, reasonably foreseeable future oil development, and a road between the Dalton Highway and Nuiqsut may result in over 500 hundred acres of additional gravel mines (based on the past ratio of gravel mine to gravel footprint) and 2,700 or more additional acres of gravel footprint. This total impact to the physiography is only a fraction of a percent of the approximately 56.8 -million-acre arctic coastal plain. Of the cumulative impact of past, present, and reasonably foreseeable development to the physiography of the area, CPAI's proposed action would result in direct physiographic effects from gravel mines of 65 acres and from 270 acres of additional roads, airstrips, and pads. This constitutes 4 percent and 2 percent, respectively, of the past, present, and reasonably foreseeable impacts from gravel mines and gravel footprint**.**

TABLE 4F.5.1-1 PAST, PRESENT, AND REASONABLY FORESEEABLE FUTURE DEVELOPMENT INFRASTRUCTURE (ACRES)

	2002	With CPAI's Proposed 5 pads Alt. A)	With Reasonably Foreseeable Development [a]
Gravel footprint	9,640	9,910	12,370
Gravel mines (in tundra) (in rivers)	 1,283 5,082	 1,348 5,082	 1,822 (unknown additions)
Total Disturbed area (ac.) [b]	17,769	18,104 [c]	20,910 [c]

Source: Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope, 3-03 for data to 2001; 2002 data represents addition of Meltwater and Palm gravel footprint to NAS 2001 data.

Notes:

[a] Represents Alternative A FFD scenario plus estimates for the road between the Dalton Highway and Nuiqsut under consideration by the State and other reasonably foreseeable oil field development. For the last, no estimate is provided for gravel mine impacts. No estimate is provided for other reasonably foreseeable but as yet undiscovered fields.

[b] Disturbed areas also include 1,765 acres affected by a variety of activities, including disturbance around exploratory gravel pads and tundra scarring from thin gravel roads and airstrips and from tractor trails.

[c] Assumes only gravel footprint and mine increases.

4F.5.1.2 Conclusion

Impacts to the physiography are similar to the impacts to soil, permafrost, sand, and gravel and are associated with the development and construction of gravel pads, roads, air strips, pipelines, and pump stations. The largest cumulative impacts on phyisography are anticipated from gravel mining and it associated activities. The duration of the impacts range from short-term to long- term and are dependent upon the success of re-contouring of the terrain back to its original features. Of the alternatives considered in this EIS, Alternative C (whether considered as only CPAI's proposal or the FFD) would contribute the most to cumulative impacts and would consequently have the largest cumulative impact. Alternative D would have the least cumulative impact of the action alternatives and Alternative B the second least impact**.** While physiographical impacts, especially those resulting from gravel mining, are additive, the total incremental amount of disturbed area is small compared to the total resources within the North Slope region and is not considered to be cumulatively significant.

4F.5.2 Geology

4F.5.2.1 Evaluation

The following discussion of cumulative impacts of the proposed action to geologic resources is limited to lithified, inorganic materials and their associated petroleum resources. Cumulative impacts to unconsolidated material are discussed in Sections 4G.5.3, Soils and Permafrost, and 4G.5.4, Sand and Gravel.

The primary impact to North Slope geology of past, present, and reasonably foreseeable development on the North Slope has been the extraction of oil reserves. Through 2001 approximately 13.6 billion barrels of oil has been extracted from Prudhoe Bay and other existing fields, more than 70 percent of the estimated original reserves of the past and presently developed fields. In the next twenty year CPAI's proposal would remove approximately 330 million barrels, according to Alaska Department of Revenue projections (BLM Northwest NPR-A Draft IAP/EIS, Tables iv-14 and iv-16**).**

4F.5.2.2 Conclusion

Cumulative geological impacts are mainly additive, and**,** given the project objectives**,** cause effects to the geologic environment that are unavoidable. The proposed action would likely remove a significant percent of total economically recoverable petroleum resources available within the Plan Area on both the proposed Alternatives and FFD scales**,** just as past, present, and reasonably foreseeable development has and will continue to remove oil from other known and perhaps as yet unknown fields. All the action alternatives will have similar cumulative effects, though Alternative B, by reducing recovery from CD-6 and eliminating some pads in the FFD scenario, would have somewhat less cumulative impact.

4F.5.3 Soils and Permafrost

4F.5.3.1 Evaluation

Cumulative changes to soils on the North Slope would occur from natural processes (weathering and the annual freeze/thaw cycle) and disturbance by man. Human-induced impacts have primarily occurred as a result of disturbance from industrial activities related to both oil and gas (exploration and transportation). Other disturbance has occurred from human settlements and subsistence living, archaeological excavation, cleanup of contaminated sites, overland moves, and the small amount of tourism and recreation that has occurred on the North Slope. The analysis for cumulative impacts to soils is similar to the analysis for vegetation and is measured by accounting for the acreage of roads, pads for facilities (drilling, production facilities, and airstrips), and gravel extraction sites. In addition,

oil spills can affect soils. The mechanism for impacts is the placement of gravel overburden to provide foundations for roads and pads. The overburden covers and eliminates tundra vegetation but insulates and protects permafrost. Impacts to soils and permafrost are additive.

The total impact to soils and permafrost from all past and present oil industry-related activity projects on the North Slope**,** including the Dalton Highway**,** is approximately 17,800 acres. Impacts for foreseeable future projects are estimated to occur on approximately 2,800 acres; total impacts including foreseeable future and Alternative A – FFD will affect approximately 20,900 acres (see Table 4F5.1-1). Of the cumulative impacts, CPAI's proposal represents less than 4 percent of tundra gravel mines (approximately 1 percent of all gravel mines) and approximately 2 percent of the gravel footprint**.**

Oil spills may also affect soils, leading to alteration of vegetation. The oil alone would decrease vegetation growth, but oil spills probably would leave the surface organic mat intact. Spill cleanup, however, is more likely to damage soils. Cleanups are not always well controlled; heavy traffic and digging are common, resulting in damaged soils. Oil-spill cleanup mitigates impacts on soils only if cleanup methods and operations are very carefully controlled to minimize surface disturbance. The area affected is limited to that area immediately adjacent to and covered by the spill.

4F.5.3.2 Conclusion

Impacts to soils are similar to the impacts to vegetation and occur from activities associated with development, which include construction of gravel pads, roads, airstrips, pipelines, and pump stations and the excavation of material sites. The duration of the impacts ranges from short-term (one to several years) if the vegetation is disturbed and up to several decades if the soils are destroyed. Incremental impacts of the proposed project would be small (on the order of 2 percent when compared to past, present, and future development. With the exception of Alternative C, the cumulative impacts of the other alternatives would be less than those for Alternative A. While soils and permafrost impacts are additive, the total and incremental amount of disturbed area is small compared to the total resource within the North Slope region and is not considered to be cumulatively significant.

4F.5.4 Sand and Gravel

4F.5.4.1 Evaluation

Sand and gravel resources are a primary building material used for construction of temporary and permanent roads, pads, processing facility foundations, and airstrips throughout the North Slope. Sand and gravel are extracted from quarry areas after removal of overburden and from watercourses and rivers. Sand and gravel resources are common in the river delta areas throughout the coastal plain. The past, present, and foreseeable future impacts to sand and gravel as measured in acres disturbed are those attributable to gravel mines in Table 4F.5.1-1**.**

4F.5.4.2 Conclusion

Impacts to sand and gravel are similar to those of permafrost and soils; thus, the contribution of both Alternative A – CPAI Development Plan and Alternative A – FFD to additive cumulative gravel and sand impacts is significantly less than the total past, present, and future development. Alternative B, D, and E would have less cumulative impacts than Alternative A; C would result in more**.** However, once used, sand and gravel resources for construction of roads, pads, or airstrips may only be available for reuse upon abandonment.

4F.5.5 Paleontology

4F.5.5.1 Evaluation

Oil and gas exploration and development activities on the North Slope have been and are expected to continue to be the primary source of disturbance and cumulative effects on North Slope paleontological resources in terms of the geographical extent of impact. However, activities such as non-oil- and

gas-related overland moves, scientific data gathering, recreational use by the public, and activities ancillary to the management of the area may have a slight impact at localized areas.

Excavation of gravel for the production pads, roads, facility foundations, and airstrips poses the greatest potential for impact to paleontological resources. Most mammalian fossils are found in Quaternary age deposits that are also the primary source of most North Slope sand and gravel resources. Therefore, the more gravel deposits that are excavated for development construction activities, the more chances that significant impacts to paleontological resources would occur.

Most paleontological deposits are revealed as the result of natural erosional activities such as the action of flowing water or wind, seasonal freezing and thawing (cryoturbation), thermokarsting, and solifluction. To the extent that erosional activities are modified or increased by future development, incrementally additive impacts are likely to occur. However, in most cases the exposure of resources as a result of erosional processes is regarded as revealing rather than as negatively impacting the resource.

The effects of a large terrestrial oil spill on a paleontological deposit would be directly related to the time of year (frozen versus unfrozen) and the context of the resource. In an unfrozen context, surface or near-surface paleontological resources could be easily impacted—primarily from contamination that would render radiocarbon and biomolecular assays valueless, leading to more significant impacts to the resource. Impacts could occur as the result of the cleanup rather than the actual spill. During the frozen months, both a spill and the resulting cleanup would cause considerably less impact.

4F.5.5.2 Conclusion

While the nature of paleontological deposits (specifically, their unpredictable location and context on surface, near-surface, or deeply buried) make impacts difficult to assess, the continued use of current procedures for survey and inventory before exploration and development are expected to minimize the potential for impacts to occur. Effects across the North Slope of Alaska are expected to be additive and minor. Because the probability that a large oil spill would occur is extremely low (see discussion in Section 4.3), the potential for any cumulative oil spill impacts to paleontological resources is considered to be minimal.

4F.5.6 Water Resources

Existing and future North Slope development has the potential to cumulatively affect water resources in two ways: by altering the physiographic features of the landscape and by withdrawal of water for construction and operations use. Further alteration of physiographic features can occur as a direct result of either development or thermokarst action.

Construction of roads, production pads, pipelines, processing facilities**,** and bridges has the potential to alter surface water hydrology. This alteration occurs when the construction of facilities or removal of gravel from riverine pools or construction of facilities disturbs watercourses or lake shorelines by diverting, impeding, or blocking flow in stream channels, lake currents, or shallow-water tracts. Ice conditions and break-up conditions, especially in the Colville River Delta floodplain, can exacerbate flow constrictions at bridge sites and road culverts. Unless properly designed, water flow, especially under ice conditions and in floodplains, can be adversely affected by oil field infrastructure**.** Such alterations may also lead to subsequent melting of permafrost (thermokarst) and additional changes in stream morphology. Development of roads because they are linear features, as differentiated from the compact footprint of production pads and processing facilities, has a greater potential to alter surface water drainage patterns and flows in watercourses. Because economically exploitable sand and gravel resources are only available in limited areas, water resource impacts related to sand and gravel extraction are likely to be additive and concentrated (Refer to discussion of Sand and Gravel Resources above). Subsidence of the ice-rich permafrost along the streambanks and lakeshores may occur from the long-term effects of thermokarst, especially in areas where the wave action of the water will accel-

erate the removal of the degrading protective cover. Fine-grained sediments melting out of the ice-rich permafrost result in increased sediment erosion and suspended sediment, and changes to the morphology of stream channels and beds.

Both construction and operation of North Slope oil production and transportation facilities require freshwater resources. Ice roads typically require 1 million gallons (approximately 3.1 acre-feet [ac-ft]) per square mile to construct. When use of the road is completed, the road is allowed to melt, so water use for road construction is not consumptive in the same way that it would be if the water were used for an industrial process. Recent water use for all North Slope oil- and gas-related activities has ranged from 776 million gallons (approximately 2,381 ac-ft) in 1996 to 1,458 million gallons (approximately 4,474 ac-ft) in 2000. These quantities change from year to year depending on the amount of construction occurring, because construction is a more water-intensive activity than operations. Water requirements for the proposed project range from 26 to 91 million gallons during the years of project development (2005 to 2009), then drop to 5 million gallons per year during operating years (Alternative A). Under FFD (Alternative A – FFD), construction water requirements would range from 6 to 30 million gallons per year, and between 5 to 7 million gallons per year during operation. The cumulative change in annual freshwater use is expected to be as follows:

	Total in 2000 (millions of gallons)	Total Future	Construction* (millions of gallons)	% of Total	Operation* (millions of gallons	% of Total
Alternative A	1,458	2,020	96	4.5	5	0.25
Alternative A FFD	1,458	2,020	30	1.5	7	0.35

*Numbers provided are worst case scenario and are the greatest amounts utilized over the entire life of proposed project.

4F.5.6.2 Conclusion

Developments of oilfield facilities and associated transportation systems have and will continue to affect water resources. These impacts are most likely to be related to road development**,** of which there are currently approximately 570 miles (including the Dalton Highway) on the North Slope outside of villages. However, these potential impacts can be minimized by proper siting of roadways and by using construction methods that minimize streambed alteration and erosion impacts. On a regional basis, these impacts would be considered additive, but still local, short-term, and minor in effect. Development of CPAI's proposal would contribute about 26 miles of road to the cumulative total of roads.

No cumulative impact to North Slope water supplies from withdrawal of water for construction and operation is expected because the annual yield (runoff and refill of lakes) is many times greater than the amount withdrawn. Localized and temporary impacts may occur at those lakes used for water supply.

4F.5.7 Surface Water Quality

4F.5.7.1 Evaluation

Cumulative impacts to surface water quality could occur in two ways: erosion and sedimentation in steams and lakes that increase turbidity and the introduction of contaminants as a result of oil spills or the release of hazardous materials from industrial facilities and activities. Other recent discussion of the cumulative effects of North Slope activities on water quality are incorporated here by reference. See Section V.C.1 of the Beaufort Sea Planning Area Sales 186, 195, and 202 EIS (MMS 2002), which is summarized below.

The mechanisms and potential for increased sedimentation from construction of new facilities, principally roads, is also discussed in Section 4F.5.6. In that discussion, potential impacts to water resources from cumulative development on the North Slope are identified, but the extent of additional additive impacts was found to be small.

The long-term quality of fresh water is not expected to be affected by any of the major projects considered in the cumulative case. The effects of construction activities are expected to be short-term, lasting as long as the individual activity, and to have the greatest impact in the immediate vicinity of the activity. The construction activities are not expected to introduce or add any chemical contaminants.

If a large oil spill were to result from oil and gas development or production, hydrocarbons could be transported to and contaminate surface water resources. The potential and extent of such contamination is governed by the time of year it occurs (winter, spring thaw/high runoff, or summer/low water flow), proximity to flowing watercourses, and the magnitude of the spill. The spill history for North Slope operations is summarized in Section 4.3. Because the risk of a spill is related both to the volume and length of time over which production occurs, in the cumulative case, future projects that extend the life of industrial activities in the region will prolong risk exposure (increase spill risk). However, spill size has historically been small (over 99 percent of all spills are less than 100 gallons [Section 4.4]), generally limiting the effects of spills to localized areas and limiting the potential for extensive impacts to water resources.

In the Prudhoe Bay area, studies have found trace metal contamination (nickel and mercury) from limited sampling in the snowpack near the ARCO (world's largest) gas-handling facility, and elevated levels of several metals (mercury, antimony, cadmium, copper, and lead) near the NSB solid-waste incinerator have been found (Woodward et al. 1988; Snyder-Conn et al. 1997)[2]. While sampling has revealed the presence of contaminants, contamination of soils and surface water has not been documented. Further, because future cumulative development does not include the addition of numerous other similar facilities, the increase of such contamination, to the extent it exists, is unlikely.

To date, exploration, development, and production activities in the Beaufort Sea estuarine waters have not generated reportable cumulative impacts. More than 40 exploration drilling units (for example, gravel islands, drill platforms) have been constructed or used in the Beaufort Sea as a result of past federal and state oil and gas lease sales. There are no reports of cumulative effects of discharges on estuarine water quality. Several million cubic yards of gravel and dredge-fill material have affected at least a few square kilometers; these activities may have temporarily and locally affected turbidity, but the effects have not been cumulative. Two long causeways have been built along the Beaufort Sea coast, one of which still creates measurable changes in water quality (that is, water temperature and salinity) in spite of enlarged breaches.

4F.5.7.2 Conclusion

Cumulative impacts to surface-water quality all across the North Slope are similar to those described from impacts to water resources and are additive, but they are expected to be limited. Cumulative impacts to water quality from the historically typical release of petroleum hydrocarbons during oil spills and contamination from hazardous materials, while they may occur, are also expected to be localized, limited in extent and persistence, and not cumulative.

2 A single total-mercury sample was collected near each facility, and "additional sampling is needed before any conclusions [regarding mercury] are drawn." The total mercury concentration for this single snow sample near the gas-handling facility was 8.4 parts per trillion (ppt), a few-fold higher than the chronic water-quality standard of 1.2 ppt, but far below the acute-toxic standard of 2,400 ppt. There are two caveats that lessen concern over the single elevated mercury value near the gas plant. First, the EPA has recommended that the states treat EPA-based metal standards as dissolved metal standards, not total metal standards as reported by Snyder-Conn et al. (1997). The concentration of dissolved mercury may not exceed the criterion. Second, the EPA-based standard is based on the assumption that all mercury present is methylmercury. The mercury in snow should be ionic and possibly metallic mercury, not methylmercury. A criterion based on ionic mercury rather than methylmercury would be much higher than the measured total mercury value.

A large crude or refined oil spill (greater than or equal to 500 bbls from a pipeline or 900 bbls from a facility) would affect water quality by increasing the concentration of hydrocarbons in the water column of nearby lakes and streams if such a spill were to occur and were to enter these environments. However, the chance of a large spill occurring is low. Also, regional (more than 1,000 square kilometers [km²] [386 mi²]), long-term (more than one year) degradation of water quality to levels above state and federal criteria because of hydrocarbon contamination is considered to be unlikely.

If a large oil spill were to result from oil and gas development in the Beaufort Sea, the marine environment would be degraded through the release of petroleum hydrocarbons into the water column. The hydrocarbon concentration could exceed the 1.5-parts per million (ppm) acute-toxic criteria for about a day in the area of approximately 2 km² (0.8 mi²). The 0.015-ppm chronic criterion also could be exceeded for 10 or more days in an area of approximately 12 to 45 km² (4.6 to 17.4 mi²). Small spills could exceed the acute-toxic level (1.5 ppm) for less that a day and chronic criteria (0.015 ppm) could be exceeded for less than a month in an area of less than 100 km² (39 mi²).

Tankering of Beaufort Sea and North Slope oil resources from the southern end of the TAPS could result in an unlikely very large tanker spill, and the oil could contact nearshore areas in Prince William Sound or the Gulf of Alaska in a relatively non-weathered state. Such a spill is estimated to affect water quality within the affected area for 1 day to 1-2 weeks in high energy areas, and for a few days to several months in low energy embayments and lagoons (TAPS Owners 2002). The magnitude of impact will decrease rapidly as the oil disperses and weathers, and the spatial extent of the impacts will depend upon wind, water currents, air and water temperature, volume of oil spilled and effectiveness of response and cleaning operations.

Development of Alternative A is not expected to contribute to cumulative impacts to marine and estuarine water quality. Development of Alternative A – FFD has the potential to contribute to temporary impacts to water quality during construction. The proximity of FFD to stream drainages and the Colville River may provide a pathway for releases from a spill event to reach and contaminate marine and estuarine waters. Similarly, spills from other oil and gas developments on marine or estuarine waters or along streams draining into such water bodies could impact those waters. The extent of such contamination would be related to the size of the oil spill. Because spill frequency and volume are expected to be low, cumulative impact from oil spills is not considered to be an additive cumulative impact. If a 500- to 900-bbl spill were to occur during the ice-covered season, the effects would be minor. If it were to happen during the open-water or broken-ice seasons, hydrocarbons dispersed in the shallow estuarine water column could exceed acute-toxic criteria during the initial spill period. However, it is expected that the effect would be short-term and localized.

4F.5.8 Air Quality

4F.5.8.1 Evaluation

Air quality impacts are evaluated in terms of regional ambient air quality, localized impacts near emissions sources or groups of clustered emission sources, and effects on climate change.

Regional Air Quality

Cumulative air quality impacts may result from the emissions of hydrocarbons and byproducts of combustion. These impacts may be regionally additive (increased concentrations of specific pollutants) or synergistic (chemical reactions that form ozone) and could degrade air quality. However, as described in Section 3.2.3, ambient air quality on the North Slope of Alaska is relatively pristine even though oil and gas exploration, development, and production have been under way for more than 30 years. Air monitoring at sites in the existing Kuparuk and Prudhoe Bay fields finds that concentrations of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and particulate matter 10 micrometers or less in diameter (PM_{10}) are well within the National Ambient Air-Quality Standards. BP's air-quality modeling for the Liberty project found that emissions from the Prudhoe Bay and Kuparuk fields have very little effect on ambient concentrations elsewhere.

Arctic haze is a phenomenon resulting from elevated concentrations of fine particulate matter found over the Arctic, primarily in winter and spring. Scientists believe that most of these pollutants are from combustion sources in Europe and Asia. It is not known to what extent local sources in Alaska contribute to arctic haze in the area of the Beaufort Sea. However, the arctic haze phenomenon was first observed in the 1950s, long before oil development started on the North Slope. The fact that emissions in the general area are expected to decrease (as the result of an overall downward trend in oil production) means that any possible contribution to arctic haze would be reduced. Emissions from development resulting from the proposed Alternative A or Alternative A – FFD would be small compared to the emissions from Prudhoe Bay and Kuparuk oilfield production. For example, actual emissions reported for the Prudhoe Bay oilfields for the year 1994 to 1995 listed 56,000 tons of nitrogen oxide, 1,471 tons of SO_2, and 6,200 tons of PM_{10} (USACE 1999, Table 4A.5.4-7). Projected emissions from the CPAI's proposed plan would be only a small percentage of current and projected emissions (see Section 4A.2.3).

Global Climate Change

The global climate change analysis performed for the OCS Oil and Gas Leasing Program: 2002-2007 (MMS, OCS EIS/EA MMS 2002-006, Herndon 2002a: Section 4.1.2 and Tables 4-7a and 4-7b) estimated that the emission rate of greenhouse gases (carbon dioxide, methane, and nitrous oxide [N_2O]) from the OCS cumulative program activities for Alaska would be from 381 to 723 thousand metric tons of carbon equivalent per year for carbon dioxide and from 1.1 to 2.1 thousand metric tons of carbon equivalent per year for methane. Emissions of N_2O were not calculated because of lack of information about emission factors. However, N_2O emissions are expected to be much smaller than for the other greenhouse gases. The total estimated greenhouse gas emissions from the three Beaufort Sea Lease Sales (186, 195, and 202), including emissions from tanker transport to U.S. west coast ports, were from 177 to 311 million metric tons of carbon equivalent. This is approximately 0.01 to 0.02 percent of current nationwide greenhouse gas emissions. The Northstar EIS estimated that the greenhouse gas emissions from current North Slope oil production (including shipping, refining, end product transportation, and consumption) is approximately 1 percent of the global fossil fuel greenhouse gas emissions (USACE, 1999). (Emissions from the actual combustion of oil produced are much greater than that from just the production activities.)

The cumulative analysis for the current Northwest NPR-A first sale proposal considers three ranges of onshore and offshore future production activity. The low range includes reserves in currently producing fields and resources and discoveries in the planning or development stage. The mid-range consists of the low-range figure plus any reasonably foreseeable future production. The high range is created by adding in potential speculative future production. Using the mid-range estimate (11 billion barrels of oil), and assuming that this entire amount would be produced over a 20-year period, an average production rate is obtained of approximately 1.4 MMbbl of oil per day. This is very close to the 1996 North Slope oil production rate. While it is difficult to estimate greenhouse gas emissions from future oil and gas production activities in Northern Alaska precisely, greenhouse gas emissions would continue to be proportional to the oil production rate at the same ratio as exists presently. Based on that assumption, the regional greenhouse gas emissions associated with future cumulative production would be approximately the same as the 1996 North Slope emission levels. This is approximately 30 percent higher than current levels (since the 1999 North Slope production rate was approximately 1.1 MMbbl of oil per day). Greenhouse gas emissions associated with production activities can be reduced by using more fuel-efficient power generators and minimizing flaring. Based on the Northstar analysis cited above, the cumulative future oil production in northern Alaska would produce a relatively small (approximately 1 percent) contribution to global greenhouse gas emissions. Nationwide and global greenhouse gas emissions can be reduced by energy conservation, improving energy efficiency, and developing alternative energy sources. The need for continued development of domestic new oil and gas resources will continue to exist regardless of any downward pressure on the growth of future oil consumption as a result of measures to reduce greenhouse gas emissions. If Alaska energy sources were not to be developed in the future, resources would have to be produced in other areas of the

globe. The impacts on greenhouse gas emissions on the planet would be very similar, regardless of the location of the energy source.

Air Quality Impacts

The air quality impact analysis for the Liberty project (MMS 2002) found that maximum concentrations from emissions would occur within 100 to 200 meters of the facility boundary and would be considerably lower at 1 kilometer from the facility. These results are representative of what we could expect from any development resulting from development in the ASDP area. Thus, there would be very little cumulative interaction between developments under this proposal and other oil-producing facilities.

Potential impacts from future lease sales on the outer continental shelf and on land are difficult to evaluate. However, one can expect that any development would be scattered over a rather large area. Modeling performed for the Lease Sale 144 Final EIS (MMS 1996a) showed that impacts from widely scattered emissions sources on the outer continental shelf are small and well within regulatory standards. The Final 5-Year Program EIS for 2002-2007 (MMS Herndon 2002a) discusses the cumulative effects of the program in all areas. The relevant major finding was that no major degradation of onshore air quality is predicted. Emissions associated with routine program activities could cause small increases in onshore concentrations of some air pollutants, although there is not expected to be any exceedance of national or state air quality standards. In the unlikely event of a large oil spill, the accidental release could cause rapid (and perhaps dramatic) increases in volatile organic carbon concentrations near the spill, but the duration of these should be too short (generally a few days) to cause major impacts.

A more comprehensive discussion can be found in the Impacts on Air Quality sections of MMS, OCS EIS/EA MMS 2002-006, Herndon 2002a: Sections 4.3.2.2 and 4.3.3.2; that discussion is incorporated here by reference. Section 4.3.2.2 (pertaining to the Gulf of Mexico) includes also a general discussion of ambient air quality standards, the effects of pollutants, and the type and relative amounts of pollutants generated by offshore operations. Section 4.3.3.2 (specific to Alaska) discusses the most commonly emitted air pollutants associated with Alaska OCS oil and gas activities, including operations in areas affected by ice cover, the construction of ice islands and gravel islands, and the concentration of activities into short time frames. The conclusions drawn there are that the impacts from the 5-year program on the pollutant levels, the ozone levels, and visibility would all be minor or negligible. Section V.C.13 of the Liberty Final Environmental Impact Statement (MMS, Herndon 2002b) discusses the cumulative effects on air quality of all North Slope of Alaska oil and gas activity since 1969. It concludes that the cumulative effects of all projects affecting that area in the past and occurring now have caused generally little deterioration in air quality, which remains better than required by national standards. The Northstar and Liberty Projects and all other reasonably foreseeable North Slope projects would not change this situation. Also, Section IV.C.6.b.(2) of the Liberty EIS concludes that from small oil spills there would be a small, very localized increase in concentration of hydrocarbons. Concentrations of criteria pollutants would remain well within federal air-quality standards. The overall effects on air quality would be very low.

Very little cumulative interaction is expected to take place between emissions from sources included in Alternative A or Alternative A FFD and any other existing, planned, or potential oil or gas development projects. For the North Slope area as a whole, we could expect the quality of the air in coming years to improve in those areas where oil production currently is the greatest and to decline in areas where future development is expected to take place. It is likely that new development would be relatively scattered, keeping regional impacts small except for higher, localized concentrations in the immediate vicinity of production facilities.

4F.5.8.2 Conclusion

The cumulative effects of all projects affecting the North Slope of Alaska in the past and occurring now have caused generally little deterioration in air quality, which remains better than required by national standards. Production levels for the foreseeable future are not anticipated to be higher than the 1996 level. Thus, all reasonably foreseeable North Slope projects are additive but are not expected to have synergistic cumulative impacts on air quality.

4F.5.9 Physical Environmental Cumulative Effects for Alternatives B, C and D CPAI Development Plan and for FFD Alternative B, C and D

Those cumulative effects to the physical environment under Alternatives B, C, and D for development of the 5 pads proposed by CPAI are expected to be similar to those described above for Alternative A. However, under CPAI's Alternatives B and D where less overall acreage will be disturbed by construction of new facilities than under Alternative A, cumulative impacts that are additive will be marginally reduced; synergistic impacts should experience greater reduction. For example, Alternative D proposes limited gravel roads with aircraft accessibility. This decrease from Alternative A in total disturbed acreage will result in less overall cumulative impacts to soil, gravel, water, and air resources from Alternative D than from Alternative A. Similarly, cumulative impacts on the physical environment are anticipated to be greatest under CPAI Alternative C and FFD Alternative C because of an increase in the disturbed acreage. While these impacts could be additive to other future development, even after the reasonably foreseeable future development occurs overall effects on the physical environmental resources would be negligible. The one exception to the above characterization among physical resources is geology. The cumulative effects on geology are the same for all the action alternatives, except for alternative b in which there would be a small reduction in oil extracted because of the relocation of CD-6**.**

4F.5.10 Cumulative Physical Environmental Impacts of the No-Action Alternative E

Under Alternative E, no action is proposed. To the extent that cumulative impacts are currently occurring, these impacts would continue. Impacts related to oil production would be expected to continue but then decline in the future if reasonably foreseeable future projects do not replace the decline in current North Slope production. No overall cumulative effects to the physical environment result from CPAI's proposed Alternative E. Impacts related to disturbance or displacement would only decline in the future if facilities are removed and the sites reclaimed. However, cumulative impacts on the North Slope are anticipated to occur from other foreseeable future development.

4F.6 Analysis of Cumulative Impacts to Biological Resources

This section describes the cumulative effects to biological resources of the North Slope that would occur from disturbance by man and natural processes. Man-induced impacts have primarily occurred as a result of disturbance from oil and gas related industrial activities (Exploration and transportation). Other disturbance has occurred from human settlements and subsistence living, archaeological excavations, cleanup of hazardous waste sites, overland moves and the small amount of tourism and recreation that has occurred on the North Slope.

4F.6.1 Vegetation and Wetlands

4F.6.1.1 Evaluation

Cumulative effects of past actions have resulted in the existing conditions described in Section 4A.3.2. In general, the greatest overall effects within the North Slope have been caused by oil and gas production and transportation.

Oil and gas exploration, development, and production; oil refining; oil and gas transport; oil storage; human habitation and development; transportation; land management activities and plans; natural resource use; and petroleum spills may affect vegetation through the construction of infrastructure (direct effects of vegetation burial and indirect effects of vegetation change caused by snow drifting, dust, etc.) and through oil spills. The primary mechanism for construction impacts is the placement of gravel overburden to provide foundations for roads and pads. In terms of acres affected by direct impacts, construction causes more than 99 percent of the impacts, with spills having a very minor role.

These actions could affect vegetation by a number of means. Construction activities would disturb soil and probably physically injure vegetation or remove vegetation within the disturbed area. In areas with a high proportion of wetlands, such as the Arctic Coastal Plain, or during construction of large projects, such as new production and pipeline facilities, wetlands could be filled. The placement of gravel to construct production pads or service roads would eliminate local vegetation and alter local hydrologic regimes, which could adversely affect terrestrial and wetland communities. These activities would also produce fugitive dust, which could injure or kill vegetation and alter vegetative communities by reducing vegetative cover, altering local soil and permafrost conditions, and changing species composition. Erosion from construction sites could result in the sedimentation of vegetative communities, particularly wetland communities. Sediments could injure or kill vegetation and alter vegetative communities.

Disturbances to vegetative communities would generally require restoration of the affected site and revegetation efforts. Vegetative communities that would then become established might not represent local natural community types and might include non-native species, which could become dominant or invade undisturbed natural areas. Activities that disturb the soil or remove vegetation could result in changes to the underlying permafrost, causing thermokarst. Terrestrial vegetative communities and some wetland communities might be eliminated by thermokarst-induced inundation.

Spills of crude oil, diesel oil, or other fluids might result from activities associated with any of the major actions contributing to cumulative effects. Spills could injure or kill vegetation, potentially leaving affected areas unvegetated or sparsely vegetated. Impacted soils might require extended periods of time to revegetate. Small spills, however, which would be considered likely or anticipated events would be cleaned up and would generally have negligible to minor cumulative effects on the terrestrial vegetation and wetland communities of the four major vegetation zones. Large spills, which would be considered unlikely or very unlikely events, would have greater effects but because of their low frequency would not be cumulative or synergistic impacts.

Activities associated with transportation, such as the proposed highway to Nuiqsut from the Dalton Highway, might result in impacts to terrestrial vegetation and wetlands from the generation of fugitive dust, particularly along unpaved highways. Oil and gas transportation might also involve the construction of pipelines. The elimination of terrestrial and wetland communities might occur on a large scale during the construction of an extensive underground pipeline system, resulting in major impacts to vegetation. Underground pipe, however, is very rare on the North Slope**.** Large-scale restoration and revegetation activities might be required. Past construction projects, such as TAPS and the construction of drilling pads on the North Slope, have involved extensive vegetation restoration. Pipeline construction and operation might also result in permafrost changes and accidental petroleum spills. The loading and transport of oil tankers south from Valdez might also result in accidental spills of crude oil that could impact shoreline vegetation.

Mining operations for sand and gravel might remove large quantities of stream bed deposits and also riparian vegetative communities. The alteration of hydrologic regimes or surface water drainage patterns could adversely affect vegetation by increasing or decreasing soil moisture or inundation. Mining activities also might result in soil disturbance, dust, erosion, and sedimentation.

Certain large-scale or global phenomena can also affect terrestrial and wetland vegetation. For example, global warming might result in long-term effects to vegetative communities and wetlands. Increasing temperature would result in an increased presence of deciduous shrubs with a decrease in sedges and grasses. Continued temperature increase could eventually result in the invasion of arctic tundra by taiga forests (Anderson and Weller 1996). Changes in vegetation could in turn affect other biological resources that utilize the vegetation. While the combined effect of these large-scale impacts with local project-specific impacts may be synergistic, data do not exist to support such a conclusion.

Specifically on the North Slope, impacts to vegetation would result from the construction and use of production pads, modifications of stream banks and channels, new access roads, pipelines, and use of sand and gravel mining sites. Although oil and gas exploration, development, and production are expected to continue on the North Slope, the area of impact from individual drilling or production sites has become considerably smaller over the past 30 years as advances in technology have reduced the area required for well pads. Losses of vegetative communities might result from direct removal, sedimentation, or spills. These communities might include lowland and upland tundra. However, less than 1 percent of the vegetation of the 56.8 -million-acre Arctic Coastal Plain would likely be impacted by oil development (BLM 1998a). The cumulative effects of these activities, including construction of CPAI's proposal and FFD, on North Slope terrestrial vegetation and wetlands would be expected to be minor. The contribution to cumulative impacts from CPAI's proposal would be minor, unless there were a large oil spill (see Section 4.3). Impacts to the North Slope vegetation communities from ASDP termination activities would result in a small temporary contribution to cumulative impacts and a recovery of localized North Slope communities over the long term, although the benefit would be very small relative to the total area of upland and lowland tundra vegetation zones.

4F.6.1.2 Conclusion

Cumulative effects of past actions on vegetation have generally been minor. Impacts to the vegetation of Alaska's North Slope from Alternative A – CPAI Development Plan and past, present and future oil and gas exploration and development in the Plan Area are expected to be additive with respect to the impacts, present and future, from other oil and gas activities outside the Plan Area. The affected area continues to be a very small fraction of the total North Slope acreage. It is not expected that synergistic impacts to vegetation would occur by affecting additional acres, nor would any effects (whether beneficial or adverse) occur to vegetation as a result of additional acres developed. In addition to oil and gas development projects that would directly affect North Slope vegetation, global climate change could alter the species composition**.**

4F.6.2 Fish

4F.6.2.1 Evaluation

This section evaluates the cumulative impacts on fish of the proposed action in combination with other past, present, and foreseeable future activities. On the North Slope, oil and gas exploration, development, and production; oil and gas transportation; human habitation and development; land management activities; natural resource use; and spills can affect fish. Additional information on the scopes of these activities is presented in Section 4.A. Like the proposed action, these other actions can affect fish in a variety of ways that can be broadly categorized into impacts that result from the following:

Alteration and loss of fish habitat

Obstructions to fish passage

Increased human access and fish harvest

Effects of oil, fuel, and chemical spills

Habitat Loss, Alteration, or Enhancement

Actions on the North Slope might all cumulatively contribute to the alteration and loss of resources and habitat for fish that occur there. Because most North Slope construction occurs in the winter when

there is prolonged darkness and thick ice cover, phytoplankton photosynthesis would not likely be substantially affected. Heavy downstream sedimentation from construction or oil production activities could smother the benthos in localized areas, but effects would probably not be widespread. In general, species occupying these areas have adapted to dynamic conditions, and they react to short-term fluctuations in water quality and habitat by either enduring and functioning under those conditions or moving out of the impact zone. Recolonization of affected areas by benthic organisms from surrounding areas would probably occur relatively rapidly in most cases.

Oil and gas exploration and development can affect fish if ground- or vegetation-disturbing activities occur in or near waterways or if chemicals or wastes are discharged into waterways. Loss of habitat in freshwater systems can result from bank hardening, draining of water bodies, changes or temporary diversions in river or stream channels, excavations of streambed materials, removal of riparian vegetation, and changes in water quality parameters. Permits are required under Alaska Title 16 for activities in or near streams that could affect anadromous fish and their freshwater habitat or the free and efficient migrations of resident fish. Discharges of wastes and treated water from oil facilities must also comply with the Clean Water Act and National Pollutant Discharge Elimination System (NPDES) permits. Compliance minimizes the cumulative effects from the described actions on aquatic habitats.

Removal of fresh water from lakes to construct ice roads and pads and for other operations could also affect fish in these water bodies. Withdrawal of water can reduce water depth in overwintering areas, thereby reducing their ability to support fish although some research suggests that such effects may be minimal. Fish may also be entrained through pumps during water withdrawal. Design considerations and mitigation are incorporated into these operations to minimize impacts on fish. Water withdrawals would continue to be necessary for future North Slope oilfield developments, but efficient and appropriate regulation, compliance, and enforcement would reduce the potential impacts. Use of other options for obtaining water for ice roads and pads (for example, use of ice chips, desalination, use of snowmelt water, and water from flooding abandoned mine sites) may also limit potential impacts.

Construction of and maintenance operations for pipelines would have impacts on freshwater habitats similar to those of the ASDP. Inspection, monitoring, and prompt corrective action would be required to limit impacts.

Alterations to freshwater habitats could reduce fish survival and potentially affect fish populations. These impacts would more likely occur if the alterations were allowed to persist for multiple years and if overwintering habitat were affected. However, such alterations would typically be minor in scope and would not substantially affect fish populations. In addition, many potential impacts would probably be identified and corrected before impacts to populations ever occurred.

Former gravel extraction sites located in river or stream beds or in areas where inundation could occur may provide additional fish spawning habitat. These sites may be available following decommissions or during periods when they are not in active use for gravel extraction.

Obstructions to Fish Passage

Drainage structures such as culverts and low water crossings can impede fish migration and obstruct fish passage (Section 4A.3.3). Generally, such impacts may occur intermittently at some, but not all, stream crossings that require drainage structures or that require vehicles to cross streams. Impacts at stream crossings are typically addressed through proper design and maintenance of roads, pipeline river crossings, and culverts, coupled with regulation, monitoring, and corrective actions.

Little or no discernable impact to fish passage in freshwater habitats has occurred in North Slope oilfields as a result of past activities, and it is anticipated that this will also be the case for future North Slope oilfields. Construction and operation of pipelines would likely have impacts similar to those from the ASDP. For example, new roads, production pads, and buried pipeline crossings would affect

new areas. Construction of additional roads and increased numbers of workers would result in new stream crossings, vehicles crossing streams, and consequently impacts to fish from obstructed passage at disturbed stream crossing areas. Other development on the North Slope could further increase such impacts, depending on the applicable location, extent of development, level of mitigation, and regulatory control.

Inhibiting fish movement in streams can reduce access to spawning areas and potentially affect fish populations. These results are more likely if the obstructions are allowed to persist for multiple years. For example, fish passage in freshwater habitats has been a continuous maintenance issue along the TAPS right-of-way (TAPS Owners 2001b), and it is also likely to be an issue in cumulative actions throughout the North Slope. However, obstructions to fish passage would probably be identified and corrected before impacts to populations would occur.

Effects on Fish Populations from Increased Human Access

Increased public access as a result of new pipeline and facilities construction or development would probably have only small impacts on fish habitat, primarily resulting from the increased erosion of stream banks by off-road vehicles and the increased amount of dust deposited by vehicles traveling on unpaved roads.

Increased human access along new roads and highways would likely result in additional recreational and subsistence fishing pressure on fish populations, which have low productivity in these northern latitudes. Currently, recreational fisheries are regulated to maintain adequate stocks and are adjusted to compensate for changes in fishing pressure. However, increased access could result in overharvest if regulations and enforcement were inadequate. The BLM and USACE (1988) reported that individuals of the species preferred for harvest were smaller and less numerous after the construction of the TAPS in areas newly accessible to anglers.

In the North Slope oilfields and Beaufort Sea, increased human access, with its accompanying increased fishing pressure, has not affected fish populations, although some subsistence, sport, and very limited commercial fishing occur. Fishing activities are managed by the ADF&G and the federal land management agencies within federal conservation units. The Federal Subsistence Board manages subsistence fishing by rural Alaska residents. Maintenance of fish at the desired sizes and population levels has been largely accomplished by regulations established by the Alaska Board of Fish and enforced by ADF&G and the Alaska Department of Public Safety.

Effects of Oil, Fuel, and Chemical Spills on Fish

Oil, fuel, and chemical spills are a primary concern with regard to oil and gas development, production, and transportation. The potential impacts of freshwater spills are primarily localized and restricted to gravel pads at facilities or roads. Large spills into freshwater have not occurred. However, should one occur in the future, it could have substantial impacts on fish in the affected area.

Future oil and gas operations carry the risk of small-scale spills of oil, fuel, and chemicals from vehicles and machinery. Present and future North Slope oilfield developments might have an impact on fish, particularly in the marine environment. Spills in solid ice or broken ice in this region may be particularly difficult to clean up. Impacts to fish from oil spills would cause differential impacts depending on the location, timing, and volume of the spill, presence of fish in various life stages, and persistence of toxic compounds in the water column following the spill. Impacts could be lethal or sublethal depending on exposure.

4F.6.2.2 Conclusions

The combined impacts to fish from Alternative A – CPAI Development Plan and other past, present, and future projects, while additive, are not expected to affect the viability of species or populations.

Little or no discernable impact to fish passage in freshwater habitats has or would likely occur as a result of North Slope oilfield developments. Overall, cumulative impacts from blocking fish passage in North Slope freshwater habitats are and would be low to moderate under the proposed action.

The cumulative impact of increased human access to fish populations (for example, along new roads and highways) is expected to be minor and additive.

Although there is a potential for large impacts to fish from large oil spills, the risk of such spills is relatively small (Section 4.4.1). The probability of smaller spills is higher, but the impacts from such spills if they entered freshwater habitats would probably be small, temporary, and additive and unlikely to severely affect fish populations, especially in light of control and cleanup activities implemented in response to spill events.

Adverse effects related to material extraction at gravel sites are possible in certain situations. However, past reclamation of deep pits that have been mined has proved beneficial when new habitat for arctic fish species has been established and could be a countervailing impact on fish**.**

In summary, wide-ranging increased impacts to arctic fish populations found on the North Slope would not be anticipated. Also, synergistic impacts to fish from disturbance related to oil and gas production in this plan are not anticipated.

4F.6.3 Birds

4F.6.3.1 Evaluation

This section evaluates the cumulative impacts on birds of the Alternative A – CPAI Development Plan and other past, present, and reasonably foreseeable actions. Oil and gas exploration, development, production, and transport are activities that may affect birds on the North Slope. Additional activities that potentially could contribute to current and future cumulative effects include subsistence and sport harvests; predation; human habitation and development; transportation; land management activities and plans; natural resource use, and wildlife research and survey activities. Individually or in combination, these additional activities potentially affect bird populations as much as or more than potential effects from petroleum development and may have contributed importantly to recent declines in some populations. Petroleum spills and other hazardous material releases also may affect birds on the North Slope.

Cumulative impacts on birds would be similar to the impacts of Alternative A – CPAI Development Plan described in (Sections 4A.3.4). Cumulative actions that could affect these birds include habitat loss, alteration, or enhancement; disturbance or displacement; mortality; obstruction to movement; and spills. The effects that these actions may cause include mortality; increased energy expenditures or changes in physiological condition that may reduce survival or reproduction rates; or long-term changes in behavior (Calef et al. 1976). Possible differences between cumulative impacts and the impacts from the proposed action would depend on the intensity (magnitude), scale (geographic area), duration, timing and frequency, any synergies (impact interactions), and likelihood of the impacts associated with the cumulative actions (USACE 1999).

Habitat Loss, Alteration, or Enhancement

Within the North Slope, oil and gas exploration, development, and production, along with the construction and operation of ancillary facilities (for example, gravel mines, roads, pipelines, and production pads), could result in a cumulative reduction in avian habitat. Future developments within the North Slope could result in continued habitat alteration, although new developments would have smaller footprints and result in a relatively smaller impact than in the past (TAPS Owners 2001a). Because the footprints of oilfield facilities, such as well pads and processing facilities, are smaller than in

the past, the amount of gravel required is comparatively smaller, and thus the area disturbed by gravel mining also is less.

Overall, fragmentation of the tundra by oil facilities has not been a major factor affecting bird use of the Prudhoe Bay oilfield. There may have been a rearrangement of birds, but there was probably no net change in bird abundance (Troy and Carpenter 1990; TERA, 1993). Within the North Slope, more than 17,769 acres (Table 4F.5.1-1) have been filled and covered by gravel for airstrips, production pads, roads, and other structures. However, this represents a very small portion (approximately 0.02 percent) of the more than 56.8 million acres within the Arctic Coastal Plain (Gilders and Cronin 2000).

The loss of bird habitat from the development projects represents a small decrease in the amount of available tundra habitat in the North Slope (MMS 1998). The avoidance by birds of areas near industrial developments that might otherwise be usable habitat (that is, functional habitat loss) also contributes to the cumulative loss of habitat associated with facility development (Cameron et al. 1995; Nellemann and Cameron 1998; James and Stuart-Smith 2000).

Gravel fill generally eliminates tundra habitat. However, it can provide habitat for some species. For example, it provides nesting sites for semipalmated plover, ruddy turnstone, and Baird's sandpiper; and feeding habitat for Lapland longspurs (Pollard et al 1990; Truett et al. 1994 and references cited therein).

Structures may occasionally provide a haven from predators, pests, or weather, or a platform for feeding, hunting, or nesting (Truett et al. 1994). In general, birds use gravel pads more for feeding and resting than for nesting (Pollard et al. 1990).

Shorebirds and waterfowl commonly feed and rest on impoundments associated with gravel pads (Pollard et al. 1990). Some Pacific loons nest and rear their young in impoundments created by oilfield developments (Kertell 1996).

Several studies have documented that birds, such as raptors**,** perch and nest on oilfield and pipeline structures and that other birds nest on structures (for example, several TAPS pump stations). Similarly, Pollard et al. (1990) and Rodrigues (1992) documented extensive use of gravel pads and adjacent disturbed sites in the North Slope oilfields by birds.

Water withdrawn from lakes during winter for construction of ice roads and pads is replaced rapidly by snowmelt runoff in spring; therefore, it is not likely that water bodies depleted somewhat in winter would present decreased foraging opportunities for birds. However, nest sites may be effected by lowering the water level in lakes. Some species with small and/or declining populations are present at low density on the coastal plain; it is unlikely that more than a very few individuals would by chance attempt to nest at lakes used as winter water sources. In addition, most species potentially affected are not considered limited by habitat because they have rather general nest site requirements, so acceptable nesting habitat would be widely available if areas used for water withdrawal were to lack some necessary characteristics.

Disturbance or Displacement

Future oilfield development may contribute to the disturbance and displacement of birds. Protective measures, some of which are currently adopted for existing development**,** such as restricting the timing of activities and locating facilities away from nesting areas, could minimize these impacts.

High levels of air and vehicle traffic are associated with the petroleum industry on the North Slope. Such activities could cause short-term displacement of nesting, feeding, and/or molting birds (MMS 1998).

Helicopter and fixed-wing aircraft flights associated with the multitude of North Slope projects could result in combined or repeated disturbances to birds. For example, brant react to aircraft by alert posturing, running, or entering water. Interruptions of feeding may have deleterious effects on body reserves; and molting birds that move to undisturbed areas would be exposed to predators within the open tundra. A single aircraft could disturb birds from dozens of lakes in its flight path (Simpson et al. 1982). Such impacts could be effectively reduced by restricting flight paths to avoid sensitive nesting areas during active breeding and brood-rearing periods and by establishing minimum flight altitudes to reduce ground-level noise (USACE 1999). Because of the relatively low density of most species nesting on the North Slope, disturbance resulting from support aircraft noise and visual presence would be likely to be temporary, with effects lasting less than an hour.

Regardless of attempts to mitigate effects by adjusting routes, continued activity in support of developing fields and future development would be likely to result in some low-altitude flights over nesting, brood-rearing, molting, staging, or migrating birds. Such disturbance would be expected to cause excessive short-term energy use by disturbed individuals and displacement of birds from the vicinity of routinely used air corridors. The latter would be similar to bird responses observed during low-level aerial bird-survey overflights, where some individuals either run or take flight, depending on species and circumstances. Such disturbance could flush females from nests, resulting in lower productivity if eggs are lost to predators or exposure to low temperatures, or could cause displacement of females with broods from preferred foraging areas during brood-rearing, or could disturb any individuals during preparation for migration. Long-term displacement (one year or more) from the vicinity of heavily used air traffic corridors and onshore facilities could result in fewer young produced and lower survival of both adults and young. For example, helicopter pipeline inspection flights during a facility's production phase could displace some species from within at least 1 kilometer (0.62 mile) of a pipeline. Such disturbances would likely be temporary (likely lasting less than an hour) and affect few birds because of the relatively low density of most species nesting in the on the North Slope. Some species may tolerate disturbance and nest, rear their broods, and/or forage within a pipeline corridor or near a facility.

Aircraft that fly over open water areas in spring could displace loons, king and common eiders, long-tailed ducks, and other species from this essential habitat. Because of the limited quantity of open water in spring, access to such areas is likely to be less available than in the postbreeding period. This could increase competition for food during the energetically stressful period following spring migration and could result in decreased survival or breeding success. During the summer, nonbreeding individuals, failed breeders, molting individuals, and males may feed in nearshore areas. Helicopters flying numerous round trips per day over these areas could cause birds to move away from routinely used flight paths, increasing the stress of preparing for migration in some individuals and lowering survival chances.

Traffic along hundreds of miles of existing and future pipeline roads could also repeatedly disturb and thus displace wildlife. Although most future oil and gas developments on the North Slope are expected to be isolated from existing road systems, production pads would be connected by roads several miles long and would have an associated airstrip approximately 1 mile long. Gravel transport is assumed to occur during winter. Summer traffic, though expected to be relatively low volume, could disturb nesting, brood-rearing, or molting waterfowl in the immediate vicinity of pads and roads throughout the life of the field. For example, during development of the Lisburne field, geese and swans appeared tolerant of vehicle traffic on roads during most seasons; however, during brood-rearing, they moved away from roads (Murphy and Anderson 1993). Early season snowmelt in dust shadows of roads or pads may attract nesting birds. The Lisburne development activities had no apparent effect on overall bird habitat use in the area. However, some species of shorebirds such as the semipalmated sandpiper and the dunlin were reduced in density (by as much as 40 percent) within approximately 100 meters of roads during breeding compared to post-breeding periods and undisturbed areas (Troy 1988; TERA 1993b).

Obstruction to Movement
Present and future North Slope oilfield developments could further obstruct bird movements. For example, during the brood-rearing period when species such as brant are flightless, roads, causeways, and other structures could present a barrier to movement (ADNR 1999). Movements of flying birds would not be obstructed**,** though fog and low light may reduce visibility and create situations where collisions occur to flying birds**.**

Mortality
Increased access to the North Slope resulting from the ASDP and other future energy development and road or highway construction will provide new avenues for human access and in turn bring increased hunting pressures on wildlife. Birds that nest or forage in these newly accessible areas will be affected. Subsistence users will take not only weapons-based harvest but also harvest of eggs. Waterfowl are especially vulnerable during nesting and molting periods (when flightless), and thus entire nesting colonies are potentially at risk. Vehicle collisions will also increase as a result of increased road access. Management and research mortality are also contributing factors. Disease, predation, fluctuations in prey, and severe weather are among the natural phenomena that also contribute to cumulative impacts on birds (MMS 1998).

Increased densities of predators and scavengers attracted to areas of human activity may result in increased predation pressure on bird populations. This situation has recently become a management issue, mainly for ground-nesting birds on the North Slope (Day 1998), but it is difficult to document. Increases in the abundance of foxes are well-documented in the North Slope oilfields (Burgess 2000). Within the North Slope, losses of birds from elevated levels of predators would be in addition to other losses such as those associated with habitat loss and displacement (BLM 1998).

Birds, especially those using early green-up areas in dust shadows along roads, could be killed by vehicles (Shoulders 1999; Schmidt 1999). Road kills have not been a problem in the North Slope oilfields. The same situation would be likely during present and future North Slope oilfield developments. Increased public access might increase the numbers of road kills on the North Slope.

Birds might also fly into structures, particularly nearshore structures during periods of fog. Also, some birds (such as snow buntings) that nest at oilfield facilities (for example, the Alpine Processing Facility) might fly into the facility structures. Because structures cumulatively represent relatively small obstructions on the landscape, and birds encountering them when visibility is good are expected to see and avoid them, bird mortality from collisions is expected to be low. However, there is little information on which to base a projected mortality estimate.

High predator populations in the North Slope oilfields are associated with natural factors such as high prey availability and natural den sites. However, because of the availability of supplemental food at the NSB Landfill and in dumpsters throughout the North Slope oilfields, populations of predators, such gulls and ravens, have increased over the past three decades. Although there is no definite cause-and-effect relationship between human food and predator numbers, predators have adversely affected nesting success of birds that nest on the ground, especially colonial nesting snow geese, and possibly some ducks and shorebirds (TAPS Owners 2001a).

The introduction of exotic animals (mostly foxes, but also rats, voles, ground squirrels, and rabbits) has been among the most damaging source of direct mortality to seabirds of all the factors associated with human activity (Bailey 1993). Unlike an oil spill or some other one-time catastrophe, predators have a continuing negative impact on seabird populations. Combined with this source of seabird loss is the detrimental impact of large fish harvests on seabirds (seabirds are accidentally killed in drift gill nets, major shifts in fish stocks have altered seabird food supplies, and possible effects of fish biomass) (Hatch and Piatt 2001).

The populations of a number of bird species that spend at least part of the year in the vicinity of oilfields are either stable or larger than when oilfield development began. These include snow goose, brant, and other waterfowl and shorebirds. At least some of these population increases may be due to factors remote from the North Slope oilfields (for example, decreased mortality of snow geese on wintering grounds).

Spills

Approximately 400 spills of diesel, crude, and hydraulic oils and other substances (such as drilling wastes and seawater) occur yearly on the North Slope. Many of the oil spills occur as a result of corroded infrastructure (Schmidt 2002). Multiple spills could adversely affect birds if more disturbances occurred while populations were still recovering from the initial disturbance (USACE 1999). Species such as brant and snow goose could be affected by oil spills into coastal areas such as the Colville River Delta (MMS 1998). Over the life of the oilfields, tens of thousands of birds (for example, long-tailed ducks, common eider, and other sea ducks) potentially could be killed by oil spilled on the North Slope if quantities of that oil entered the Beaufort Sea (via waterways such as the Colville River). Bird losses would be an incremental addition to the hundreds of thousands of birds that annually die in drift nets within the North Pacific, Bering Sea, and Gulf of Alaska (MMS 1998).

Historically, land-based spills of crude oil in the oilfields are uncommon and have only impacted tens of acres. Diesel spills have been more common and have affected hundreds of acres but mostly within gravel pads (Jorgenson 1997), and thus have had a negligible biological impact. Current management and cleanup techniques are effective in reducing the occurrence of spills and in removing spills when they occur (Jorgenson 1997).

Present and future North Slope oilfield developments could include more offshore facilities, which would increase the potential for marine oil spills (USACE 1999). For example, oil pipelines will be used for the Northstar development in the Alaskan Beaufort Sea, and fuel barges will be used for supply. Depending on the time of year and the volume of the oil spill, several thousand birds could be affected by a spill in the Beaufort Sea (USACE 1999). Significant impacts could occur to post-nesting birds that concentrate along the coast for brood rearing, molting, pre-migratory staging, or migration (BLM 1998).

As discussed in Section 4.3, a land-based oil spill can contaminate individual animals, their habitats, and their food resources. Birds are often oiled after being attracted to standing pools of oil or oil floating on water. A very large spill and subsequent cleanup efforts would probably disturb and displace most birds from the area because of extensive activities associated with spill cleanup activities (ADNR 1999). Leaving some residual oil in place may be less damaging than the potential long-term effects of intensive cleanup activities (Jorgenson and Cater 1996).

4F.6.3.2 Conclusions

The additive impacts of past, present, and reasonably foreseeable future activities are not expected to cause pervasive cumulative impacts, including impacts from synergistic effects to bird populations on the North Slope. It is expected that the effects on bird populations of facilities for future projects, though additive, would be substantially less than those of past projects because of the smaller areas involved. Oil spills would not significantly add to cumulative impacts, except for an unlikely to very unlikely large spill to aquatic habitats. Increased harvests, especially from subsistence hunting, resulting from increased access to remote areas via new roads, may be the most serious cumulative factor.

The cumulative loss of habitat from all listed projects in the North Slope may have localized effects on the distribution or density of some bird species over the life of the oilfields (MMS 1998). However, cumulative impacts of wildlife habitat loss would be negligible because the amount of habitat physically affected would be small compared to the amount available (ADNR 1999).

Withdrawal of fresh water from lakes during winter for construction of ice roads and pads is expected to have almost no effect on tundra-nesting bird populations.

Road kills should occur only at very low levels in the North Slope oilfields during present and future North Slope oilfield developments.

Predators may be attracted to human activity, resulting in localized population increases and increased pressure on bird populations on which they prey. Introduction of exotic animal species may also have severe effects on nesting birds.

Disturbance of some individual birds as a result of both onshore and offshore oil and gas operations is likely to be unavoidable over the long term. The cumulative effects from typical activities associated with exploration and development of oil and gas prospects on the North Slope and adjacent marine areas could include small declines in local nesting, or loss of small numbers of waterfowl and loon species through disturbance effects on survival and productivity, predation pressure enhanced by human activities, and collisions with structures.

Declines in fitness, survival, or production of young could occur where birds are exposed frequently to various disturbance factors, particularly helicopter traffic. Human presence that disturbs nesting or brood-rearing birds or attracts predators may result in predation of unprotected eggs or young. Because the disturbed area will be smaller, the effect of future project infrastructure on bird populations, although additive to prior effects, is expected to be less severe than that of previous arctic developments. Disturbances often may last less than an hour, but could continue for extended periods in the case of summer drilling operations, and overlap between cumulative project developments could increase disturbance effects. Several water bird populations currently declining at non-significant or significant rates could be slow to recover from small losses or declines in fitness or productivity. No significant overall population effect would be expected to result from small losses. However, for species (such as the common eider) that are experiencing a population decline, recovery from short-term losses associated with oil and gas development could be hindered by already-lowered productivity resulting from natural occurrences. For example, greatly reduced potential nesting habitat resulting from the major storm in August 2000 could substantially reduce productivity in the region.

Onshore spills are considered unlikely to occur and are expected to be contained and cleaned up. However, a spill entering a lake could cause some loss of molting and brood-rearing waterfowl, along with smaller losses of nesting waterfowl, shorebirds, and passerines. In the event a large oil spill were to enter the marine environment during high-use periods, mortality of loons, king and common eiders, and long-tailed ducks is possible; any substantial loss of long-tailed ducks or common eiders would represent a significant effect. Mortality resulting from the cumulative effects of oil and gas projects would be additive to natural mortality and could interfere with the recovery of these species' Arctic Coastal Plain populations.

Disturbance could cause some small loss of productivity and lowered fitness or survival of birds occupying areas with high levels of industrial activity, but these effects are not expected to be significant. Effects resulting from oil and gas development activities likely would be additive to naturally occurring effects or those occurring as a result of other activities on the North Slope.

4F.6.4 Mammals

4F.6.4.1 Terrestrial Mammals

Evaluation

Habitat Loss, Alteration, or Enhancement

Within the North Slope, oil and gas exploration, development, and production, along with the construction and operation of ancillary facilities (for example, gravel mines, roads, pipelines, and produc-

tion pads) could result in a cumulative reduction in terrestrial mammal habitat. Future developments within the North Slope could result in continued habitat alteration, although new developments would have smaller footprints and result in a relatively smaller impact than in the past (TAPS Owners 2001a). The cumulative loss from all listed projects in the North Slope may have localized effects on the distribution or density of some wildlife species over the life of the oilfields (MMS 1998).

Within the North Slope, more than 9,600 acres have been disturbed and covered by gravel for airstrips, production pads, roads, and other structures. The loss of wildlife habitat from the development projects represents a small decrease in the amount of available tundra habitat in the North Slope (MMS 1998). The avoidance by wildlife of areas near industrial developments that might otherwise be usable habitat (that is, functional habitat loss) also contributes to the cumulative loss of habitat associated with facility development (Cameron et al. 1995; Nellemann and Cameron 1998; James and Stuart-Smith 2000). However, there is disagreement about the cumulative impacts from this development on caribou. If the impact is of consequence, it cannot be quantified.

Gravel fill generally eliminates tundra habitat. However, it can provide habitat for some species. For example, it provides insect relief areas for caribou and denning habitat for arctic foxes and ground squirrels (Pollard et al. 1990; Truett et al. 1994 and references cited therein). The density of arctic fox dens was found to be greater within developed areas than on adjacent undeveloped tundra; foxes were using culverts and road embankments as den sites (Ballard et al. 2000a).

Structures may occasionally provide a haven from predators, pests, or weather, or a platform for feeding, hunting, or nesting (Truett et al. 1994). Mammals rest and, less often, feed on the gravel pads (Pollard et al. 1990). Caribou use gravel pads and roads as insect relief habitat infrequently during the mosquito season (June to mid-July) and more commonly during the oestrid fly season (mid-July to early August), and also use the shade of oilfield structures (pipelines and buildings) and parked vehicles when oestrid flies are abundant (Lawhead and Prichard 2002; Pollard et al. 1996a). The availability of man-made insect-relief habitats may allow caribou to remain near preferred foraging habitats, thereby lessening the energy demands normally imposed upon caribou during the insect season (Pollard et al. 1996a). However, since relatively few caribou occupy the area proposed for development during insect season, it is uncertain that this would represent any population level benefit.

Dust shadows might be increased by the addition of roads, facility pads, and greater traffic loads associated with North Slope oil and gas development. The dust shadows affect a limited amount of habitat but will continue as long as heavy traffic occurs on gravel roads. Cumulative impacts of dust shadows on wildlife would be similar to those addressed in Section 4A.3.5.

The cumulative effects of future land-use allocations on terrestrial mammals throughout North Slope would vary depending on which lands are developed. In particular, if much of the Teshekpuk Lake Herd (TLH) caribou calving and insect-relief habitat is either closed to leasing or designated as no surface occupancy, the potential for cumulative impacts to the TLH caribou from oil and gas development would be reduced. However, if all or most TLH caribou habitat were made available for leasing, the cumulative impacts would be greater.

The reduction in use of calving habitat near oil development facilities, in theory, eventually could limit the growth of the arctic caribou herds within their present ranges and could prevent the herds from reaching the maximum population size that they could achieve on their present ranges without the presence of development. Such an effect may not be apparent, because natural changes in the distribution and productivity of the herds would be likely to influence the abundance and growth of caribou populations over and above the effect of reduced habitat use caused by cumulative oil development. However, recent information on the body weights of Central Arctic Herd (CAH) cow caribou that calve west of the Sagavanirktok River compared with CAH cow caribou calving east of the Sagavanirktok River suggests that disturbance displacement of cow caribou may be affecting CAH

caribou productivity (Cameron 1994; Nellemann and Cameron 1996; Cameron 2002). On the other hand, differences in densities and movements between segments of the CAH on the oilfields and east of the fields may have contributed to the decline (Cronin et al. 1997).

Current oil development in the Prudhoe Bay-Kuparuk area encompasses more than 500 square miles, and hundreds of miles of gravel roads cross a large portion of the calving range of the CAH. Nearly CPAI's proposal 11,000 acres of tundra habitat have been altered where roads, gravel pads, gravel quarries, pipelines, pump stations, and other facilities are situated on the Arctic Slope, and approximately 3,300 additional acres may be developed as part of reasonably foreseeable projects. (Table 4F.5.1-1) Oil and gas activities on the North Slope would subject TLH and CAH caribou and their summer and calving ranges to effects of oil-development projects. Some TLH insect-relief habitat and Western Arctic Herd (WAH) summer habitat may be altered or destroyed through construction associated with oil and gas development. The loss of additional TLH and WAH grazing habitat from facility construction in future oil development on the North Slope is expected to represent a smaller proportion of the available grazing habitat than that experienced by the CAH because of consolidation of facilities and roadless development. This particular loss or alteration of habitat is expected to represent a minor effect on caribou. Displacement of calving caribou caused by disturbance has resulted in a functional loss of habitat for the CAH in areas of existing development. A comparable functional loss of calving habitat might occur in the Teshekpuk Lake area.

The alteration of nearly 11,000 acres of tundra habitat in the Prudhoe Bay area has not had any apparent effect on the distribution and abundance of other terrestrial mammals, with the possible exception of arctic foxes that have increased in numbers near the oilfields. Muskoxen have continued to expand their range westward across the North Slope from an introduced population in the Arctic National Wildlife Refuge. There does not appear to be any effects of this development on grizzly bears, wolves, and other terrestrial mammal populations.

An increase in abundance of deciduous shrubs, especially birch (less favorable caribou forage), and a decline in the abundance of grasses and sedges such as Eriophorum vaginatum (an especially important food of calving caribou) are predicted to occur if a significant increase in temperatures were to occur in the Arctic, thereby reducing productivity of caribou habitats on the Arctic Slope (Anderson and Weller 1996). Over decades, warming temperatures could result in the invasion of tundra habitat by taiga woody plants (taiga forests), a less favorable habitat for tundra mammals and some bird species, thereby adversely affecting their populations (Anderson and Weller 1996).

Cumulative oil development on the North Slope also is expected to result in an increase in abundance of arctic foxes near development areas, which in turn could adversely affect tundra-nesting birds (see Section 4F.6.3).

Disturbance or Displacement

Future North Slope oilfield developments may contribute to the disturbance and displacement of wildlife. However, mitigation measures, such as restricting the timing of the activity and locating facilities away from calving areas, could minimize impacts. Operation of the gas pipeline project would have a negligible impact. Localized disturbances to wildlife would occur during its construction. The level of non-oil and gas activities on the North Slope is very low, and impacts consist primarily of short-term disturbance of individual animals. Disturbance of terrestrial mammals by aircraft traffic associated with cumulative resource-inventory survey activities (particularly by helicopter traffic) is expected to have short-term effects on some caribou and muskoxen (particularly cow/calf groups), with animals being briefly displaced within approximately one mile from feeding and resting areas when aircraft pass nearby. Potential oil spills from both offshore and onshore oil activities associated with federal and State of Alaska leases would be likely to have a small effect on terrestrial mammals because comparatively low numbers of animals would be expected to be contaminated or to ingest contaminated food sources and die as a result.

Several factors influence caribou populations, including winter weather, oilfield disturbances and developments, hunting, predation, intersegment or interherd movements, and insect harassment (Cronin et al. 1997; Klein 1991). All major caribou herds on the North Slope have increased in size, independent of oilfield development (Klein 1991). These higher population densities may cause dispersal or range changes among caribou herds. Thus, no single cause-and-effect explanation can be made regarding changes over time in caribou herd size and distribution (Cronin et al. 1997). The CAH has increased in size since oilfield development and operation began. Similar increases have occurred to all major caribou herds in northern Alaska and Canada, and are presumed to be independent from the effects of oilfield development (Klein 1991). In fact, populations of a number of species that spend at least part of the year in the vicinity of oilfields are either stable or larger than when oilfield development began. In addition to caribou, these include muskoxen, brown bear, polar bear, and arctic fox.

Past seismic exploration activities probably briefly disturbed and displaced caribou near seismic grids, exploration drill sites, and along ice roads and aircraft transportation routes. However, this effect would not have persisted after exploration was complete and probably had no consequential effect on the abundance or productivity of the caribou. Future exploratory work may occur in TLH habitat, and disturbance would be temporary. Disturbance of wintering WAH caribou would be minimal, as the majority of the herd winters south of the Brooks Range. Exploratory work would not result in additional cumulative impacts to the CAH.

Helicopter and fixed-wing aircraft flights associated with North Slope projects could result in combined or repeated disturbances to wildlife. Such impacts could be effectively reduced by establishing minimum flight altitudes to reduce ground-level noise (USACE 1999). While a few species, such as wolves and foxes, habituate to human presence, they are nevertheless disturbed by aircraft and other vehicles (ADNR, 1999). Repeated exposure of caribou to low-level military jet overflights, especially during sensitive periods, may reduce calf survival and increase daily activities (Calef et al. 1976; Maier et al. 1998; Wolfe et al. 2000). Females of the Delta caribou herd with newborn calves apparently move away from areas where they are disturbed by jet aircraft overflights (Murphy et al. 1993). However, Valkenburg and Davis (1984) believe that the effects of disturbance from hunters on snowmobiles may be more important than aircraft overflights.

Motorized traffic along existing roads and future construction of up to an additional 500 miles of roads associated with future development (as well as traffic on ice roads) would disturb, impede movement of, or displace caribou and other terrestrial mammals. Traffic and human activity associated with oilfields and roads/highways can disturb female caribou with young calves (Cameron and Whitten 1980). Disturbance to caribou would be generally short term (a few hours or less). Less time spent lying down and more time moving about are the two consistent reactions by caribou to disturbance. Disruption of the feeding and resting cycle, accompanied by increased energy expenditures by running may contribute to energetic stress (Murphy and Curatolo 1987). If calving caribou are displaced from a high-quality forage area, there is a potential for lowered calf survival (ADNR 1999). To date, the cumulative impacts of North Slope oil and gas developments have caused minor displacement of the CAH from a small portion of its calving range without an apparent adverse effect on herd abundance or overall productivity.

In the cumulative case, disturbance of caribou by road traffic associated with pipelines would be expected to cause short-term displacement of caribou within approximately one mile of the road. Road traffic temporarily delays caribou from successfully crossing pipelines and roads and may have significant energetic effects on some animals, but it generally has no measurable effect on herd abundance or overall distribution. The exception would occur when disturbance levels were very high or when development facilities on the calving grounds caused long-term (over the life of the field) displacement or local change in distribution of cows and calves (Dau and Cameron 1986a; Cameron et al. 1992b; Nellemann and Cameron 1996). Potential construction of an east-west road from the Dalton Highway to Nuiqsut would add to the cumulative impacts on the CAH by creating an east-west barrier to movement in addition to the existing north-south barrier created by the Dalton Highway. Grizzly

bears, wolves, arctic foxes, and other mammals cross these roads, travel on them, and feed on animals killed by vehicle traffic. However, increases in traffic eventually would reduce the use of roads and adjacent habitat by these animals.

During the post-calving season, caribou distribution is largely unrelated to distance from infrastructure; they regularly occur within the oilfields, and they often occur close to infrastructure (Cronin et al. 1998a). Although some level of cumulative effect to caribou is likely from petroleum development, clear separation of the cumulative effects from natural variation in caribou habitat use and demography is difficult (Wolfe et al. 2000). No population-level impacts to any wildlife species have been documented (reviewed in Truett and Johnson 2000).

Cumulative oil and gas development on the North Slope could result in a long-term displacement and/or functional loss of habitat of CAH, TLH, and WAH caribou over the productive life of CPAI'S proposed development. At present, cumulative oil development in the Prudhoe Bay-Kuparuk area has caused displacement of CAH caribou from a portion of the calving range, with a shift in calving distribution away from the oilfields (Lawhead 1997; Nellemann and Cameron 1996; Cameron et al. 2002). Future state oil-lease sales on the Arctic Slope between NPR-A and the Arctic National Wildlife Refuge and the foothills of the Brooks Range would increase the amount of activity associated with oil exploration and development within the CAH range. Future state offshore leases in the Beaufort Sea could expose TLH and CAH caribou to additional activities related to oil and gas development (through onshore facilities to support offshore leases). Ongoing and future lease sales in NPR-A could expose a large number of the TLH calving caribou to exploration and development activities. Offshore oil development could result in a pipeline corridor north of Teshekpuk Lake connecting with existing facilities at Kuparuk. This corridor would transect TLH insect relief and calving habitat. Calving by TLH caribou could be reduced near the pipeline corridors. If displacement of calving activity (reduction in habitat use) were to persist beyond the construction period and endure over the production life of the developed fields, this would represent a long-term (several-generation) effect on the distribution**,** and perhaps population size**,** of the TLH caribou.

Oil development on the North Slope could expose summering WAH caribou to noise and disturbance impacts. This herd is not exposed to oil and gas development activities in any other part of their primary range, and cumulative impacts to the WAH would be low.

Obstruction to Movement

Present and future North Slope oilfield developments could further obstruct wildlife movements. Roby (1978) reported that during summer, caribou with calves were the group most sensitive to the Dalton Highway. Caribou cows with calves may be underrepresented along the Dalton Highway during the calving season because of avoidance of the road, habitat selection, or predator avoidance. Roads (without adjacent pipelines) that have heavy traffic (that is, more than 60 vehicles per hour) appear to impede caribou movement. Pipeline-road combinations tend to have a synergistic effect on impeding caribou movements (Curatolo and Murphy 1986; Cronin et al. 1994). Regardless, the CAH has grown in numbers since the mid-1970s (from approximately 5,000 in 1975 to more than 27,000 in 2000 (ADF&G undated; Cronin et al. 1998b), and any redistribution of caribou in the spring has apparently not adversely affected population growth (TAPS Owners 2001a). The ADF&G management objectives for this herd (10,000 individuals) are being met, and herd-level impacts from the oilfield are not apparent (Cronin et al. 1998b).

Development of onshore oil and gas resources in Northeast NPR-A could result in construction of an additional pipeline south of Teshekpuk Lake. Development in Northwest NPR-A could result in the construction of a pipeline from Northwest NPR-A east to Kuparuk and a southern pipeline route connecting to TAPS Pump Station 2. Movement of CAH and TLH caribou between coastal insect-relief habitats and inland foraging areas and calving grounds could be disrupted. Pipelines associated with sales would not have roads and should have minimal effect on caribou movements once construction is completed. Existing State of Alaska oil and gas leasing offshore and adjacent to the CAH and TLH

ranges—as well as Federal OCS leases in Harrison Bay west to Barrow—might include offshore pipelines that would come ashore within either TLH or CAH ranges and connect with the facilities at Kuparuk. Potential offshore oil development adjacent to the TLH and CAH ranges could increase disturbance of caribou by surface-vehicle traffic along transportation corridors that would connect offshore oil discoveries with the existing infrastructure. Offshore oil development in the area probably would result in the expansion of existing coastal facilities at Camp Lonely, west of Cape Halkett. Development also might increase disturbance of caribou by motor-vehicle and air-traffic at insect-relief areas along the coast, and perhaps reduce the seasonal use of coastal areas by cows and calves.

It is reasonable to expect that measures designed to provide caribou and other large mammals with unimpeded movement (for example, placing pipelines at least 5 feet above ground and minimizing permanent roads alongside pipelines) would also be used in the future.

Mortality

The increase in the number of development facilities on the North Slope would be expected to increase the number of adverse interactions between humans and grizzly bears and to result in the loss of bears because of their attraction to human refuse. These interactions could eventually result in a decline in grizzly bear abundance near development areas.

Vehicle collisions will increase as a result of increased road access. Management and research mortality are also contributing factors. Disease, predation, fluctuations in prey, and severe weather are among the natural phenomena that also contribute to cumulative impacts on wildlife (MMS 1998).

Other causes of wildlife mortality include intentional mortality (sport and subsistence harvest; management and research mortality) and unintentional mortality (road kills; unreported harvests; defense of life and property mortality) (TAPS Owners 2001a). Vehicle collisions with terrestrial mammals, particularly moose, are an issue of public safety, as well as a source of wildlife mortality (TAPS Owners 2001a).

The Dalton Highway has provided access to previously remote areas north of the Yukon River. Concern exists that this increased access has adversely affected moose, caribou, wolf, and bear populations as a result of increased harvests (McLellan 1989; Yokel 1999). Similar pressures will likely result from increased human access resulting from the ASDP and future development on the North Slope. The ADF&G has responded to this pressure where necessary by restricting seasons and bag limits and by implementing intensive management programs to achieve and maintain population objectives for ungulates available to hunters (see TAPS Owners 2001a).

Increased densities of predators and scavengers attracted to areas of human activity may result in increased predation pressure on prey populations (for example, small mammals). This situation has recently become a management issue, mainly for ground-nesting birds on the North Slope (Day 1998), but it is difficult to document. Increases in the abundance of foxes are well-documented in the North Slope oilfields (Burgess 2000).

Similarly, increased densities of predators and scavengers might increase the occurrence and rate of transmission of wildlife diseases, including rabies (Follmann et al., 1988). The primary reservoir of rabies in the North Slope area is the arctic fox, whereas south of the Brooks Range, the red fox and other carnivores are sources of greater concern (Winkler 1975).

Mortality of predators such as bears occurs primarily from sport and subsistence hunting. Overall, only approximately 5 percent of brown bear mortality is related to defense of life and property. Oil and other resource extraction industries have indirectly contributed to brown bear mortality by the construction of roads that have increased access by hunters, poachers, and settlers (McLellan 1989). The oil industry, in cooperation with the ADF&G, has implemented management activities to reduce impacts to wildlife. These measures have included the closing of the developed areas to big game

hunting, prohibiting firearms within the oilfields proper, educating workers on wildlife safety, and training security personnel on proper techniques for hazing problem animals (Shideler and Hechtel 2000).

Road kills have not been a problem in the North Slope oilfields, although there have been occasional mortalities of caribou and bears. The same would probably remain true following present and reasonably foreseeable future North Slope oilfield development and construction of the road between the Dalton Highway and Nuiqsut that the state is currently considering. Traffic associated with other industrial activities might result in road kills, depending on the location and extent of developments.

Spills

Approximately 400 spills of diesel, crude, and hydraulic oils and other substances (drilling wastes and seawater) occur yearly on the North Slope (Schmidt 2002). Multiple spills could adversely affect wildlife if additional disturbances occurred while populations were still recovering from the initial spill (USACE 1999). Additional details on spills can be found in Section 4.0.

Caribou could be affected by a large oil (for example, from a pipeline) spill in the North Slope if it occurred during the spring or insect-harassment period, when caribou are found in coastal waters or on beaches. Some individuals or groups of caribou might come in contact with oil and be adversely affected. However, impacts to the herd as a whole would be negligible.

A land-based oil spill can contaminate individual animals, their habitats, and their food resources. Species such as foxes may be attracted by dead oiled wildlife at a spill site or by human activity associated with spill cleanup. A large spill would likely disturb and displace most animals (other than foxes and other scavengers) from the area because of human activity associated with spill cleanup. (ADNR 1999). Leaving some residual oil in place may be less damaging than the potential long-term effects of intensive cleanup activities (Jorgenson and Cater 1996).

Conclusions

Past, present, and reasonably foreseeable future activities, including CPAI's proposed development, are not expected to affect the viability of mammal populations. However, some populations may be reduced in number such an extent as to have an adverse impact on subsistence users. Cumulatively, non-oil and gas activities and spills would have little impact on terrestrial mammals.

Cumulative effects on caribou calving distribution are likely to be long term over the life of the oilfields, but would occur locally within 3 to 4 kilometers (1.8 to 2.5 miles) of roads or other facilities situated within calving areas. Any reduction in the calving and summer habitat use by cows and calves from future onshore leasing represents a function loss of habitat that may result in long-term effects of the caribou herd's productivity and abundance. However, this potential effect may not be measurable because of the great natural variability in the caribou population productivity. Cumulative impacts that would obstruct wildlife movements would be minor (USACE 1999), and synergistic effects at the herd level would not be anticipated.

Cumulative oil development on the North Slope would likely result in increased abundance of arctic foxes near development areas, which may present a rabies health hazard to humans in the oilfield areas. The attraction of grizzly bears to human refuse would lead to the loss of bears as the result of interactions with humans and eventual decline in bear abundance near development areas. The cumulative effects on muskoxen, moose, wolves, wolverines, and small mammals from oil and gas development on the North Slope would be local and short term, within one to two miles of the exploration or development facilities, with no adverse effects on populations.

4F.6.4.2 Marine Mammals

This section discusses the cumulative effects of the proposed project and ongoing and future development on marine mammals in the Alaskan Arctic. Development could have actual or potential adverse effects on the distribution or abundance of ice seals (ringed, spotted, and bearded seals), walruses, beluga whales, gray whales, and polar bears in the Alaskan Arctic (and subarctic Bering Sea), and harbor seals and sea otters in the Gulf of Alaska. Oil and gas development could affect these species as a result of oil spills, noise and disturbance, and habitat alteration. Other activities with potential effects would be contamination by hazardous materials from past development activities on the North Slope, atmospheric environmental pollutants accumulating in the Arctic, global warming, commercial fishing and hunting/harvesting of marine mammals.

Cumulative effects of offshore activities on marine mammals in the Alaska Arctic, as well as downstream along marine tanker routes have been addressed adequately in other recent documents (such as the Northwest NPR-A EIS [BLM 2003b]) and are herein incorporated by reference and summarized below.

4F.6.4.2.1 Evaluation

Habitat Loss, Alteration, or Enhancement.

Other than minor loss, numerous scientific studies have shown that atmospheric contaminants are being deposited in the Arctic (Proshutinsky and Johnson 2001; Aguilar et al. 2002). The contaminants of greatest concern are persistent organic pollutants such as organochlorines and heavy metals such as mercury. These pollutants are known to biomagnify up the food chain. Organochlorines have been shown to adversely affect marine mammal reproduction and immune systems in temperate regions (Aguilar et al. 2002). While marine mammals possess biochemical methods of deactivating the toxic effects of heavy metals such as mercury (binding it with proteins), the role that organochlorines might play in affecting arctic marine mammal populations is unclear.

The dumping and discarding of solid and liquid hazardous materials has been associated with Department of Defense facilities on the North Slope (including the NPR-A) and with past oil and gas exploration drilling on the NPR-A (see Section 3.1.2.3 on Hazardous Materials). These wastes included fuel drums and solid wastes stored or buried onshore. Several landfill sites contain low concentrations of petroleum hydrocarbons and the pesticide d-BHC. Other sites have been cleaned up and the debris has been removed or burned. While these hazardous material sites are small local sources of contamination and environmental degradation, they probably do not represent enough habitat degradation to affect marine mammal abundance and distribution.

Recent analysis of seasonal ice cover in the Arctic over the past 20 to 30 years shows a decrease in ice extent and thickness coincidental with temperature warming trends (Maslanik et al. 1996 and Martin et al. 1997 as cited by Tynan and DeMaster 1997). Climate warming has reduced the total arctic sea ice coverage by approximately 15 percent in the past 20 years (Stirling and Lunn 2001). Changes in the extent, concentration, and thickness of the sea ice in the Arctic may alter the distribution, geographic ranges, migration patterns, nutritional status, reproductive success, and ultimately the abundance of ringed and bearded seals and other arctic pinnipeds that rely on the ice platform for pupping, rest, and molting (Tynan and DeMaster 1997). Reductions in sea ice coverage would adversely affect the availability of pinnipeds as prey for polar bears (Stirling and Lunn 2001). If the current warming trend—and associated reduced ice coverage—continues, polar bear and arctic pinniped populations are expected to decline drastically.

Disturbance or Displacement

With respect to onshore development, the proposed facilities along the Colville River would expose some spotted seals and a few polar bears to increased noise and disturbance associated with vessel and air traffic along the Colville River. Future facilities in river deltas and elsewhere along the coast and near rivers would have the potential to affect seals, whales, and/or polar bears.

Ringed and bearded seals, walruses, and beluga and gray whales have already been exposed to oil-exploration activities in the Beaufort Sea, including seismic surveying, drilling, air and vessel traffic, dredging, and gravel dumping. These activities in the Beaufort Sea (especially barge traffic to the North Slope, and some icebreaker activity to support oil exploration)—if they were to increase in the future—could affect how seals are distributed near the activity for one season (less than one year) during high levels of activity. However, some seals would get used to marine and air traffic, industrial noise, and human presence. Displacement from cumulative industrial activities is not likely to affect the overall abundance, productivity, or distribution of ringed and bearded seals, walruses, gray, and beluga whales in Alaska's Beaufort Sea.

Helicopters flying along the coast to and from Camp Lonely, Prudhoe Bay, and North Slope exploration and production facilities could disturb some polar bears and seals hauled out near the coast. Disturbance of some hauled-out seals during the spring pupping season could cause them to panic and charge into the water, resulting perhaps in the injury, death, or abandonment of small numbers of seal pups. This potential disturbance of seals and polar bears would be expected to cause short-term displacement of individual animals (a few minutes to less than a few days) within approximately one mile of the air-traffic route and to have no significant effects on their populations on the North Slope.

Individual air- and vessel-traffic disturbances assumed for this analysis likely would disturb a few polar bears for a few minutes to less than an hour. Seismic operations, ice-road traffic, and other activities could disturb some coastal denning sites in Alaska. A few females may have abandoned maternity dens because of nearby noise and humans, and some cubs might have been harmed. However, the number of bears disturbed in any given year is likely to be very low (probably no more than one to three animals). Bears disturbed in one year would not necessarily be expected to be disturbed the next year, because den locations change with snow cover. Current information of the distribution of den locations near oil facilities does not show that bears were permanently displaced from denning habitat. There is no clear indication that disturbance from oil exploration and development has had an additive or synergistic effect on the polar bear population. It has been stated that "Two hunters from Nuiqsut reported that polar bear activity has decreased in recent decades around Prudhoe Bay and west, to the Colville River," while "some hunters stated that the number of polar bears varies from year to year but has remained stable overall" (Kalxdorff 1997).

The MMPA requirements should prevent excessive disturbance to polar bears. Letters of Authorization (LOA) requested by industry and issued by the USFWS for incidental take of polar bears recommend a one-mile buffer around occupied polar bear dens. Significant disturbance of polar bears in the Beaufort Sea and along the coast of the North Slope would be avoided by compliance with the LOA.

Obstruction to Movement

Future activities are not expected to obstruct movements of marine mammals.

Mortality

A very small number of polar bears have been and could continue to be killed in encounters with humans near industrial sites and settlements associated with cumulative oil development. In the Northwest Territories in Canada, conflicts with humans near industrial sites from 1976 to 1986 accounted for 15 percent (33 out of 265) of the polar bears killed (Stenhouse et al. 1988). Some of these losses were unavoidable, and the polar bear population recovered through recruitment within one year. Four bears were unavoidably killed after being attracted to offshore platforms in the Canadian Beaufort Sea during five years of intensive oil exploration (Stirling 1988). Fewer losses of polar bears in arctic Alaska are expected, because the MMPA requires that the oil industry avoid killing bears. Polar bear loss in Alaska would not be likely to exceed one animal per year, and it probably would be less. Three lethal takes of polar bears have been related to industrial activities on the North Slope over the past 20 years (Gorbics et al. 1998). These losses have not significantly increased the mortality rate of the polar bear population over that from subsistence harvest and natural causes. The loss rate in Canada over a

five-year period was higher than that in Alaska but was not significant to the population, which increased at 2.4 percent per year. The MMPA has kept losses low in Alaska.

International subsistence hunting of seals and polar bears would have no more than a very short-term effect on the abundance of these species (MMS 1998).

Spills

Cumulative oil-spill risks to marine mammal habitats along the North Slope could develop from activities associated with federal OCS offshore development (at Endicott, North Star, and Liberty); onshore and possible offshore development in the Dease Inlet in the NPR-A; and at Sourdough, Alpine, and Badami, as well as possible barging of fuel oil for oil exploration and development.

Offshore spills obviously pose a higher risk to marine mammals than onshore spills, but along the coast of North Slope, some aggregations of seals and walruses and a small number of polar bears could be contaminated by onshore spills that might reach marine waters from onshore sites (especially via watercourses) and could suffer lethal or sublethal effects. Polar bears would be most vulnerable to spills contacting the flaw zone or the coast.

Spills that occurred during the open-water season (summer)—or that occurred during the winter and persisted in the Beaufort Sea area after meltout—would pose the highest risk to marine mammal habitats. However, spills also could cause effects in winter. A small number of breeding ringed seals and their pups would be likely to be contaminated by spills that might occur during the winter, resulting in the death of a relatively small number of pups because of the sparse distribution of pupping lairs. During the winter season, non-breeding ringed seals, bearded seals, and polar bears could be exposed to cumulative oil spills that might contact the ice-flaw-zone habitat and the Northern Lead System off Point Barrow. During the summer, or open-water season, marine mammals in the western Beaufort Sea could be exposed to spills that might occur to the east during the winter and contact the flaw-zone habitat.

The most noticeable effects of potential oil spills from offshore oil activities would be through contamination of seals, walruses, and polar bears, with lesser effects on beluga whales. Losses of seal pups and adults, walrus calves and adults, and polar bears would be likely to be replaced within one generation or less, with a generation time of approximately five years for ringed seals and at least seven years for polar bears (Kelly 1988; USFWS 1995). Beluga whales would be likely to suffer low mortality (fewer than 10 whales), with population recovery expected within one year.

Conclusions

The overall cumulative effects of Alternative A – CPAI Development Plan and other past, present, and reasonably foreseeable future activities (mainly from one oil spill estimated to occur in the marine environment) would be minor. Impacts are expected to be the potential loss of up to 10 polar bears, several hundred seals and walruses, and probably less than 10 beluga and gray whales. In the event of a 1,000-bbl spill, pinniped, polar bear, and beluga and gray whale populations would be expected to recover within one year. Cumulative noise and disturbance in the Beaufort Sea and on the North Slope are expected to briefly and locally disturb or displace a few seals, walruses, beluga and gray whales, and polar bears. A few polar bears could be temporarily attracted to oil development facilities, with no significant effects on the population's distribution and abundance.

4F.6.5 Threatened and Endangered Species

The cumulative impacts of Alternative A – CPAI Development Plan and other past, present, and reasonably foreseeable future activities were evaluated for three endangered and threatened species: Bowhead Whale, Spectacled Eiders, and Steller's Eiders.

4F.6.5.1 Bowhead Whale

Cumulative effects of offshore activities on marine mammals in the Alaska Arctic, as well as downstream along marine tanker routes have been addressed adequately in other recent documents (for example, the Northwest NPR-A DEIS [BLM 2003b]) are incorporated by reference and summarized below. Cumulative effects of onshore activities have also been addressed in the Marine Mammals sections.

A large oil spill that enters marine waters could have effects that are sufficiently far-reaching to affect bowhead whales. If marine traffic is used to supply North Slope activities, there is potential for impacts to bowhead whales from noise, habitat degradation, displacement, and vessel strikes. Other future North Slope activities are not expected to affect bowhead whales. Any impacts would be expected to be similar to those described in Section 4F.6.4.2 and would be expected to be negligible overall.

Cumulative noise effects on bowhead whales from onshore and offshore activities would be similar to those described in Section 4F.6.4.2. Bowhead whales might experience cumulative effects from OCS activities, such as noise from drilling, vessel and aircraft traffic, construction, seismic surveys, oil spills, or oil-spill-cleanup activities. The bowhead whale population has been increasing steadily at the same time that oil and gas activities have been occurring in the Beaufort Sea and throughout the bowhead whale's range.

Bowheads may exhibit temporary avoidance behavior to vessels at a distance of one to four kilometers. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period. Many earlier studies indicate that most bowheads exhibit avoidance behavior when exposed to sounds from seismic activity at a distance of a few kilometers but rarely show avoidance behavior at distances of more than 7.5 kilometers. Bowheads also exhibited tendencies for reduced surfacing and dive duration, fewer blows per surfacing, and longer intervals between successive blows. Bowheads appeared to recover from these behavioral changes within 30 to 60 minutes following the end of seismic activity. However, recent monitoring studies indicate that most bowhead whales during the fall migration avoid an area around a seismic vessel operating in nearshore waters by a radius of approximately 20 kilometers. Avoidance did not persist beyond 12 hours after the end of seismic operations. Bowheads have been sighted within 0.2 to 5 kilometers from drill ships, although some bowheads probably change their migration speed and swimming direction to avoid close approach to noise-producing activities. A few bowheads may avoid drilling noise at 20 kilometers or more. There are no observations of bowhead reactions to icebreakers breaking ice, but it has been predicted that roughly half of the bowheads would respond at a distance of 4.6 to 20 kilometers when the signal-to-noise ratio is 30 dB. Since offshore oil and gas activities in state waters generally are well shoreward of the bowhead's main migration route—some activities occur inside barrier island chains—the effects from activities on state leases is likely to be minimal. Avoidance effects from an encounter with aircraft generally are brief, and the whales should resume their normal activities within minutes**.** Overall, bowhead whales exposed to noise-producing activities most likely would experience temporary, nonlethal effects. Some avoidance behavior could persist up to 12 hours.

If an oil spill were to occur as a result of development and production operations associated with any past, present, or reasonably foreseeable future development projects in the arctic region, some bowheads could be affected. However, most exposed whales would be expected to experience temporary, nonlethal effects from skin contact with oil, inhalation of hydrocarbon vapors, ingestion of oil-contaminated prey items, baleen fouling, reduction in food resources, or temporary displacement from some feeding areas. A few individuals could be killed if they were to experience prolonged exposure to freshly spilled oil. Considering the low probability of spilled oil contacting bowhead habitat, the number of individuals so affected would be expected to be very small.

Activities that are not related to oil and gas also could have cumulative effects on bowhead whales. A small number of whales could be injured or killed as a result of entrapment in fishing nets or collisions

with ships. Native whalers from Alaska harvest bowheads for subsistence and cultural purposes under a quota authorized by the International Whaling Commission. An average annual take of 51 whales during the subsistence harvest was allowed between 1995 and 1998. Bowheads also may exhibit avoidance behavior in the presence of subsistence-hunting vessels. Native whalers from Russia also are authorized to harvest bowhead whales under a quota authorized by the International Whaling Commission. The contribution of OCS activities to cumulative effects on bowhead whales is likely to be of short duration and to result primarily in temporary, nonlethal effects.

4F.6.5.2 Spectacled and Steller's Eiders

Routine annual management actions, subsistence and sport harvest, oil and gas exploration and development are the principal activities that could contribute to cumulative effects on threatened eiders. Activities associated with other federal and state projects—as well as actions of nongovernmental entities—on the Arctic Coastal Plain, along migration routes, or on winter ranges that potentially could contribute to current and future cumulative effects include wildlife research and survey activities, subsistence and sport harvests, predation, commercial fishing, commercial development, environmental contamination, marine shipping, and recreational activities. Most projects and activities not associated with petroleum development affect eiders at latitudes south of the Beaufort Sea and outside the summer breeding season. Several of these activities, individually or in combination, probably affect eider populations as much or more than potential effects of petroleum development and may have contributed importantly to recent declines in these populations. Oil exploration and development (and other projects and activities) could result in (1) oil or other toxic pollution effects (see discussions in Section 4A.3.6); (2) additional disturbance during breeding and post-breeding periods; and (3) habitat degradation. Disturbance of some individuals by oil and gas operations would be expected to be unavoidable.

Offshore cumulative effects on North Slope eiders, as well as downstream along marine tanker routes—such as displacement from the vicinity of vessel transportation corridors and oil spills—have been addressed adequately in other recent documents (such as the Northwest NPR-A DEIS [BLM 2003b]) and are herein incorporated by reference.

Habitat Loss, Alteration, or Enhancement.

Future oil and gas development are expected to occur with a much smaller disturbed area (footprint) than has occurred in the Prudhoe Bay-Kuparuk area. For example, the total area covered by roads, pads, and airstrips for the Badami and Alpine developments is approximately 182 acres plus 89 acres of gravel mines (MMS 2002). Presumably, the effects on bird populations of facilities for future projects, though additive, would be substantially less severe because of the smaller areas involved. Effects from dust fallout, thermokarst, and hydrologic change (MMS 1998) would be restricted to much smaller areas and, thus, result in smaller habitat loss. Comparison of gravel mine areas alone indicates that the Alpine and Badami developments disturbed 0 and 5.9 percent (respectively) of that altered by Prudhoe Bay region development. Withdrawal of fresh water from lakes during winter for construction of ice roads and pads would be expected to have almost no effect on tundra-nesting eiders. Water used for this purpose is replaced rapidly by snowmelt runoff in spring; therefore, it would not be likely that water bodies depleted somewhat in winter would later present decreased foraging opportunities for eiders. Also, eiders are present at such low density on the coastal plain that it would be unlikely that more than a very few individuals would by chance attempt to nest at lakes used as winter water sources.

Disturbance or Displacement

Human presence, construction and drilling activities, spill cleanup, and predators attracted to oil and gas development areas vary considerably in how much disturbance they cause. The presence of unconcealed humans, whether associated with oil and gas, hunting, or recreational activities, is disturbing to eiders, especially during nesting and brood-rearing periods. Common experience confirms that such presence generally causes birds to move from the immediate area of disturbance and may dis-

place them for several hours or longer. Cumulative effects of such disturbance, with several activities occurring in the same period or one after the other through the summer season, could cause decreased production and survival of young or recruitment into the population.

Although most future oil and gas developments on the North Slope (particularly in NPR-A) are expected to be isolated from existing road systems, production pads would be connected by roads several miles long and would have an associated airstrip approximately one mile long. Gravel transport would be assumed to occur during winter. Summer traffic, though expected to be relatively low volume, could disturb nesting or brood-rearing eiders in the immediate vicinity of pads and roads throughout the life of the field. Early season snowmelt in dust shadows of roads or pads could attract eiders.

Oil and gas development and production—especially if roadless—is likely to require substantial fixed-wing aircraft, helicopter, and occasional barge support during periods when eiders are present. Exploration is expected to occur primarily during winter months when eiders are absent. Roadless developments such as Alpine and Badami require substantial air support for construction, development, and production, although most construction has been done during winter months, as would be expected for any North Slope development. Construction of these two projects required an estimated 300 to 600 helicopter round trips per month for one to two years. If two projects were to overlap at this level of air support, 30 to 40 round trips per day could occur. This could represent a significant increase in air traffic above that annually required for aerial surveys and transportation. Development of these projects required an estimated 28 to 56 round trips per month, and production required an estimated 12 to 28 per month, representing substantial increases that would continue through the nesting season. Offshore development at Northstar required 2,480 aircraft operations (all types) per winter season extending approximately from 30 November to 20 April or approximately 18 flights per day. Cumulative air traffic activity in the Prudhoe Bay area, Kuparuk River, Point McIntyre, Northstar, and Alpine fields is likely to represent the greatest source of disturbance to eiders from currently developed areas.

Regardless of attempts to mitigate effects by adjusting routes, continued activity at this level to support developing fields and future development would likely result in some low-altitude flights over nesting, brood-rearing, staging, or migrating eiders. Such disturbance would be expected to cause excessive short-term energy use by disturbed individuals and displacement of eiders from the vicinity of routinely used air corridors. The latter would be similar to eider responses observed during low-level aerial bird survey overflights where individuals either run or take flight, depending on species and circumstances. Such disturbance could flush females from nests, resulting in lower productivity if eggs are lost to predators or exposure to low temperatures, or could cause displacement of females with broods from preferred foraging areas during brood-rearing, or any individuals during preparation for migration. Long-term displacement (one year or more) from the vicinity of heavily used corridors and onshore facilities could result in fewer young produced and somewhat lower survival of adults and young. For example, helicopter pipeline inspection flights during production could displace some eiders from within at least one kilometer (0.62 mile) of a pipeline, whether a regional pipeline or the TAPS. Although such flights would occur frequently, they would be intermittent, thus some individuals might tolerate this level of disturbance and nest, rear their broods, or forage within the pipeline corridor. However, due to the relatively low density of eiders nesting on the North Slope, disturbance resulting from support aircraft noise and visual presence would likely be temporary, with effects lasting less than an hour.

If aircraft were to frequently fly over open water areas in spring, some eiders would likely be displaced from this essential habitat. Because there is so little open water available in spring, access to such areas is likely to be more restricted than in the post-breeding period. This could increase competition for the food available during the stressful period following spring migration and could result in decreased survival or breeding success. Beginning in early summer, non-breeding individuals, failed breeders, molting individuals, and males could be feeding in nearshore areas. Helicopters flying 15 or more round trips per day over these areas could cause birds to move away from routinely used flight

paths, increasing the stress of preparing for migration in some individuals and decreasing chances for survival.

The presence of onshore facilities could cause eiders to avoid the immediate vicinity for variable periods up to the duration of such presence. This potentially could result in lowered productivity, although adequate nesting habitat is not likely to be a limiting factor.

Obstruction to Movement

In general, oil and gas infrastructure is not expected to obstruct eider movements. The birds' ability to fly will allow them to move over or around facilities. As described in Section 4F.6.2, facilities may present some temporary obstacles during brood-rearing and molting when the birds are flightless; however, some observations indicate that spectacled eiders do not avoid facilities and are known to cross roads.

Mortality

Attracted predators and hunting, of course, may cause direct mortality. Predators such as foxes attracted to nesting areas could cause losses up to total failure for the season.

Low-flying eiders could collide with onshore buildings or structures (or offshore drilling structures) under conditions of poor visibility (darkness, fog). Because structures cumulatively represent relatively small obstructions on the landscape, and birds encountering them when visibility is good would be expected to see and avoid them, bird mortality from collisions would be expected to be low. However, there is little information on which to base a projected mortality estimate.

Subsistence harvesting is estimated to remove hundreds of spectacled eiders from the Alaskan population annually (58 FR 27474). Programs currently are under way by the USFWS and the NSB to inform hunters of harvest closures on these two species in an effort to decrease this source of mortality (USFWS, per. comm. 2002). Effects of the other factors (for example, entanglement in fishing nets, bioaccumulation of toxins in the food chain) on the spectacled eider population currently are undetermined. The effects of these activities on Steller's eiders are also undetermined. Another factor that could potentially affect the population is improper containment or disposal of refuse at onshore support camps, which could attract potential bird predators. It is possible that an increase in predators could result in the loss of eggs, chicks, or even adult eiders.

Spills

Although the magnitude of oil spill effects is uncertain, if a large 500-bbl pipeline spill or 900-bbl spill at a gravel pad were to occur in or enter the marine environment, substantial losses could result—potentially tens to low hundreds of individuals—if released during the summer/fall season when flocks of eiders could be present. Using average estimated density of spectacled eiders in the central Beaufort Sea area calculated from USFWS survey data and average severity of spill-trajectory paths (and thus exposure of birds to oil), a USFWS model estimates an average of only two eiders would be exposed to a large spill (5,912 bbls) within 30 days in July (see details in Stehn and Platte 2000). However, in late July one group of 144 individuals was observed, suggesting a potential for much higher mortality. Also, most eiders observed during USFWS aerial surveys in 2001 from Point Barrow east were located along the northern Northwest NPR-A boundary. It is likely that mortality resulting from oil spills would be additive to naturally occurring mortality. In addition to direct contact losses, any declines of prey populations in foraging areas contacted by oil from a spill at any time of year could result in secondary impacts to eiders, affecting productivity and/or survival. Likewise, negative effects of a spill on shoreline and coastal marsh habitat and water quality could affect eiders adversely when they are moving from onshore brood-rearing areas to the marine environment, or in subsequent years.

A large onshore spill released during the summer season could cause losses of molting and brood-rearing eiders —in addition to smaller numbers of nesting eiders—if it were to enter a heavily used lake/river system or coastal habitat.

Spills from a regional pipeline or the TAPS would not be expected to cause substantial losses of eiders, because there are relatively low densities so far to the east on the Arctic Coastal Plain, and Steller's eiders would not be expected to be present in this area. Some habitat in the immediate vicinity of the pipeline contacted by oil would become unsuitable for nesting, brood-rearing, or foraging by eiders. Oil entering freshwater aquatic habitats could spread more widely, including into river deltas and nearshore marine habitats, and result in death of individuals contacted and/or a rendering larger area of habitat unsuitable.

In the unlikely event that a large spill of oil produced by cumulative arctic oil development were to occur along the tanker route in the Gulf of Alaska, Steller's eiders could be affected. According to spill simulations by LaBelle and Marshall (1995), a large tanker spill assumed to occur 100 to 200 miles offshore would not be expected to contact sensitive coastal bird habitats for more than 30 days. Model spills 80 to 100 miles offshore contacted shore in 30 days. In either case, the probability of spills contacting eiders in winter would be less than 0.5 percent, and the oil would have dispersed as weathered patches. In addition, eider densities are generally quite low in nearshore winter habitats. Although the effect of such a spill on the eider population wintering in the Gulf of Alaska is likely to be substantial, this represents a relatively modest proportion of the world population.

Small spills, whether from field pipelines or spills of refined products, are expected to be contained on gravel pads and/or cleaned up before substantial losses could occur. However, some mortality could result from the cumulative effects of numerous small spills over the 30-year time span considered in this analysis.

Cumulative Impacts

The effects on spectacled and Steller's eiders of various cumulative factors would likely be substantially greater than for any single activity or activities associated with any individual oil and gas lease sale. Disturbance of some individual eiders as a result of both onshore and offshore oil and gas operations would likely be unavoidable over the long term. The effects from typical activities associated with cumulative exploration and development of oil and gas prospects on the North Slope and adjacent marine areas may include small declines in local nesting or loss of small numbers of spectacled eiders, and potentially Steller's eiders, through disturbance effects on survival and productivity, predation pressure enhanced by human activities, and collisions with structures. Increased human access via new roads and highways may result in locally severe increases in subsistence hunting pressures.

Declines in fitness, survival, or production of young could occur where eiders are exposed frequently to various disturbance factors, particularly helicopter traffic. Human presence that would disturb nesting or brood-rearing eiders, or attract predators, could result in predation of unprotected eggs or young. Because of smaller disturbed areas, the effects of future project infrastructure on eider populations—although additive to natural effects—would be expected to be less severe than effects of previous arctic developments. The frequency of such disturbance is expected to be highest in the vicinity of primary support facilities. Disturbances often would last less than an hour, but could continue for extended periods in the case of summer drilling operations. Overlap between future project schedules could increase disturbance effects. Eider populations—currently declining at a non-significant rate (spectacled) or unknown rate (Steller's)—could be slow to recover from small losses or declines in fitness or productivity. No significant overall population effect would be expected to result from small losses. However, for species such as the spectacled eider that are experiencing a population decline, recovery from any short-term losses associated with oil and gas development could be hindered by lowered productivity resulting from natural occurrences.

Most disturbance associated with commercial activities could be controlled by mitigation. Although it is likely that behavioral effects resulting from disturbance associated with oil and gas development would be additive to naturally occurring disturbances, there is no evidence for synergism, in which the combination of effects from natural and/or development-related factors would be greater than their additive effects.

If a large oil spill were to occur in or reach the marine environment during high-use periods, some mortality of eiders would be possible; and any substantial loss of eiders could represent an important obstacle to full population recovery. Mortality resulting from the cumulative effects of oil and gas projects would be additive to natural mortality and would interfere with the recovery of these species' Arctic Coastal Plain populations. Recovery from substantial mortality would not be expected to occur while the population exhibits a declining trend, but determination of population status could be obscured by natural variation in population numbers and difficulty in obtaining precise survey data. Onshore spills (also considered unlikely to occur) would be expected to be contained and cleaned up; however, a spill entering a lake could cause some loss of brood-rearing eiders, plus smaller losses of nesting individuals. Any tanker spill in the Gulf of Alaska could result in the loss of wintering Steller's eiders that use Arctic Coastal Plain habitats during the breeding season.

The overall contribution of CPAI's proposal to the cumulative effects on spectacled and Steller's eiders is likely to be limited to occasional disturbance from aircraft overflights resulting in temporary, nonlethal effects. The activities discussed above are unlikely to cause significant population effects.

4F.6.5.3 Conclusions

Past, present, and reasonably foreseeable future oil and gas activities are not expected to cause cumulative impacts to Bowhead Whale populations. However, cumulative impacts may occur as a result of non-development activities such as approved hunting or loss/injury from encounters with fishing nets and vessels at sea. Some limited cumulative effects are anticipated for eiders, though these impacts are unlikely to produce significant population effects.

4F.6.6 Essential Fish Habitat (EFH)

Cumulative impacts to EFHt across the North Slope would be expected to be similar to those for fish habitat described in Sections 4A.3.2 and 4F.6.5. However, the salmon fishery is present at only very low levels across the North Slope, as described in Section 3.3.2.5. Furthermore, given that essentially all of the Plan Area is north of 70°N latitude and there is marginal habitat to sustain populations, Essential Fish Habitat is unlikely to be affected by future actions.

4F.6.7 Cumulative Biological Impacts for Alternatives B, C, and D CPAI Development Plan and for FFD Alternative B, C, and D

Cumulative effects to biological resources under Alternatives B, C, and D for development of the 5 pads proposed by CPAI are expected to be similar to those described for Alternative A. However, under Alternatives B and D, where less overall acreage will be disturbed by construction of new facilities than under Alternative A, cumulative impacts associated with the loss of tundra habitats will be marginally reduced, while under Alternative C, impacts related to tundra habitat, and especially that of the lower Colville River Delta, will be increased. Impacts from disturbance will also vary among alternatives, with greater impacts from aircraft associated with Alternative D, and to a lesser extent Alternative B. There may also be added potential impact from hunters and other visitors to the area, especially under Alternative C, if a road is constructed between the Dalton Highway and Nuiqsut, though this may not be the case if the State prohibits other than local residents and industry traffic on the road.

4F.6.8 Cumulative Biological Impacts of the No-Action Alternative E

Under Alternative E, no action is proposed. To the extent that cumulative impacts are currently occurring, these impacts would continue. Impacts related to oil production would be expected to continue

but then decline in the future if reasonably foreseeable future projects do not replace the decline in current North Slope production. Impacts related to disturbance or displacement would only decline in the future if facilities are removed and the sites are reclaimed. However, cumulative impacts on the North Slope could occur from other foreseeable future development**,** such as the proposed road between the Dalton Highway and Nuigsut

4.F.7 Analysis of Cumulative Impacts to Social Systems

4F.7.1 Socio-Cultural Characteristics

4F.7.1.1 Evaluation

The cumulative development and operation of oil and gas production facilities on the North Slope may affect the socio-cultural organization of Native populations who inhabit the North Slope. The effects include changes to social organization, impacts on cultural values, and impacts on general community (health and education). Cumulative effects have been addressed in other recent documents (such as the Northwest NPR-A EIS [BLM 2003b]) and are herein incorporated by reference and summarized below.

Social Organization

In the cumulative case, effects on social organization could result from industrial activities, changes in population and employment, and changes in subsistence-harvest patterns, social bonds, and cultural values. Such changes in turn exert stress on social systems (see Impact Assessment Inc. 1990a,b,c; Human Relations Area Files, Inc. 1995; State of Alaska, Dept. of Fish and Game 1995b). These effects as they relate to Alternative A – CPAI are described in Section 4A.4.1. For Alternative A – FFD, which increases the level of future development, impacts would be similar to those described for Alternative A, but the cumulative level of effects would increase because, collectively, the level of development is increased. Increased air traffic and the presence of non-Native workers in the North Slope region could increase the interaction and perhaps conflicts with Native residents. In the past, non-Native workers have stayed in isolated enclaves (work camps), which minimized interactions with local residents. However, recent development in the Alpine field has brought non-Natives directly into the Native village of Nuiqsut and increased the demand for community services. Increases in local population and employment could cause long-term disruptions to (1) the kinship networks that organize the Inupiat communities' subsistence production and consumption, (2) extended families, and (3) informally derived systems of respect and authority (mainly respect of elders and other leaders in the community). In response to these types of social system disruption, the NSB, the Alaska Eskimo Whaling Commission (AEWC), regional and tribal governments, local governments, and village corporations have instituted efforts to institutionally foster and protect Inupiat cultural traditions. Cumulative effects on subsistence-harvest patterns (which also would be long term) would affect Inupiat social organization through disruptions to kinship ties, sharing networks, task groups, crew structures, and other social bonds. Effects on sharing networks and subsistence-task groups could break down family ties and threaten the communities' well-being, creating tensions and anxieties that could lead to high levels of social discord. The NSB, the AEWC, and local whalers have set precedents for negotiating agreements with the oil industry to protect subsistence-whaling practices. Such cooperation is expected to continue. Negotiated agreements exist for development effects onshore at the Alpine Unit north of Nuiqsut. The BLM has convened a Subsistence Advisory Panel for the Northeast NPR-A IAP/EIS that consists of community members. This group is tasked with investigating conflicts between subsistence activities and oil exploration and development, verifying the levels of conflict, and making recommendations proposing actions to the lessee and the BLM for resolution.

Cultural Values

Cumulative effects on cultural values also could result from industrial activities, changes in population and employment, and changes in subsistence-harvest patterns. These effects as they relate to Alternative A are described in Section 4A.4.1. For Alternative A – FFD, which increases the level of future development, effects would be similar to those described for Alternative A, but the cumulative level of

effects would increase because, collectively, the level of development is much more extensive, especially in proximity to the village of Nuiqsut.

Cumulative effects on social organization could include decreasing importance of the family, cooperation, sharing, and subsistence as a livelihood, and increasing individualism, wage labor, and entrepreneurship. Long-term effects on subsistence-harvest patterns also would be expected. Chronic disruption could affect subsistence task groups and displace sharing networks, but it would not displace subsistence as a cultural value. Socio-cultural cumulative effects of changing norms and values would be expected to affect all five social institutions (family, polity, economics, religion, and education), but the NSB's institutional infrastructure, the AEWC, community whaling organizations, regional and tribal governments, regional and village corporations, and the Subsistence Advisory Panel work diligently to develop programs to protect these cultural values (Impact Assessment Inc. 1990a,b,c 1998; Human Relations Area Files, Inc. 1995; State of Alaska, Dept. of Fish and Game 1995b).

General Community Welfare

As a result of cumulative activities, there could be an increase in social problems, such as increased alcoholism and drug abuse, domestic violence (wife and child abuse), violent crime (rape, homicide, etc.) and suicide. The NSB already is experiencing problems in the social health and well-being of its communities, and additional development (including offshore oil development) on the North Slope would disrupt them further. Historically, increased income in these communities has been associated with increased abuse of alcohol and violence. Increased dysfunctional behavior occurred during the peak of the commercial-whaling era and then again during the height of the fur trade. Drinking and violence seem to ebb when incomes decline. Recent evidence of the effects of employment during and just after World War II also loosely supports these views. Although this evidence is not clear, the strong association of these trends makes it appropriate to assume that further oil development that results in cash flow infusion to the local economy and culture will continue to foster significant social changes. These social changes on the North Slope are likely to have influenced the extremely high rate of suicide among the Inupiat (90.8 per 100,000 for the Inupiat versus 35 per 100,000 among the Yup'ik [Travis 1989]).

In terms of cumulative effects, long-term effects will continue to threaten displacement of existing social systems; however, the NSB is vigilantly protecting the rights and culture of the Inupiat. Health and social services programs have tried to respond to alcohol and drug problems with treatment programs and shelters for wives and families of abusive spouses, in addition to providing greater emphasis on recreational programs and services and restricting the possession of alcohol. These programs, however, often have limited funding, and assistance to the NSB city governments is constrained by the limitations of funds available from the State of Alaska. Tribal, city, and borough governments in partnership seek to provide programs, services, and benefits to residents.

The relationship of oil and gas development to aberrant behavior and social pathologies might be seen more clearly in terms of social change and associations than in direct causality. Oil and gas development has affected all communities in Alaska, and, for this reason, finding control communities with no impacts as a basis to assess impacts is difficult. In general, the accumulation of effects occurs in parallel to modernization. As change happens, these alterations spread through the social fabric.

Such change can be both negative and positive and can be measured to an extent with objective indicators of the opportunity structure or the stratification system such as education, income, occupation, social networks, and social mobility (created through income, education, etc.). Positive impacts may come from higher incomes (for example, ability to purchase better equipment for subsistence), better health care, and improved educational facilities. However, some of the apparent positive impacts of oil development may have related counterveiling impacts such as increased state of apathy toward or disinterest in older cultural norms known as anomie. Certain negative effects from social change are

inescapable. As technology and opportunity develop, younger individuals readily accept these changes. This is easily seen in less developed countries where rapid change is evident or in the desertion of rural America by young people.

Both positive and negative impacts from oil and gas development exist in the NSB. Whether they are the more positive ones of increased funding for infrastructure or education or more negative ones associated with a lack of interest by younger people in traditional ways, both have added to social change. Oil and gas development has been one catalyst for such cumulative change on the North Slope; though it needs further study, it is not the single causal agent.

Another source of stress in communities in proximity to oil field development is the fear of effects from oil spills. Factors that result in fear among community members include:

Being inundated during cleanup with outsiders who could disrupt local cultural continuity

The damage that spills would do to the present and future natural environment

Drawn out oil-spill litigation

Contamination of subsistence foods

The lack of local resources to mobilize for advocacy and activism with regional, state, and federal agencies

The lack of personal and professional time to interact with regional, state, and federal agencies

Retracing the steps (and the frustrations involved) taken to oppose offshore development

Responding repeatedly to questions and information requests posed by researchers and regional, state, and federal outreach staff

The need to employ and work with lawyers in drafting litigation to attempt to stop proposed development

An ADF&G survey on social effects administered by the Division of Subsistence Management in 1994 in Nuiqsut included questions on effects from OCS development. Approximately 60 percent of the respondents did not believe a small oil spill could be contained or cleaned up, and 80 percent did not believe a large oil spill could be contained or cleaned up. An overall study on 21 Alaska communities concluded that impacts from the Exxon Valdez oil spill on subsistence use and the social and cultural system that subsistence activities support persist to this day (Fall and Utermohle 1995; Impact Assessment, Inc. 1998; Field et al. 1999).

Impacts in the first year following the spill included dramatic declines in harvest levels, reduced diversity of resources used, reduced sharing, and disruption in opportunity for young people to participate and learn the cultural values associated with subsistence. Fear of contamination of food resources was identified as a major factor in these reductions. In the following three years, harvest levels, sharing, and subsistence involvement rebounded, though not uniformly across and among communities. By 10 years after the spill, the authors conclude that subsistence uses have largely recovered to previous levels, but that some long-term changes remain, notably in fish species making up a larger portion of total subsistence, while marine mammals, marine invertebrates, and birds are a smaller part than before the spill. Resource scarcity is now cited as the reason for changes, rather than fear of contamination, as just after the spill. Hunters also reported that additional effort is required to achieve desired harvest levels, because some resources are scarcer (Fall and Utermohle 1999). The Impact Assessment, Inc., study adds additional consideration of psychological and identity impacts from the spill. These authors emphasize that for Alaska Natives, the early impacts of the spill were compounded by the sense of “fear” about resource safety, and the “alienation” from culturally valued activities this causes. These authors also note that continuing litigation contributes to continuing psychological impacts of the spill (Impact Assessment, Inc. 2001). While their review does not include new data from

the 10-year post-spill time period, some of the reported impacts will have been mitigated by the general recovery in subsistence harvest practices.

4F.7.1.2 Conclusion

Overall, both additive and synergistic impacts to the socio-cultural characteristics of North Slope communities associated with Alternative A – CPAI Development Plan and past, present, and reasonably foreseeable future development may occur. Changes to community structure, cultural values and community health and welfare predate oil and gas development on the North Slope; however change in community socio-cultural characteristics has continued during the period of oil development. As the area impacted by oil development in the future increases, especially in proximity to local communities, cumulative impacts are likely to increase. For example**,** Nuiqsut, Barrow, Atqasuk, and Anaktuvuk Pass are currently dependent on subsistence caribou harvest from the CAH and TLH; additional future development may have additive impacts to subsistence harvest from these herds leading to synergistic impacts on subsistence-harvest patterns (including disruption of community activities and traditional practices for harvesting, sharing, and processing subsistence resources), social bonds, and cultural values. Alternative A – Full-Field Development would be expected to increase the cumulative impacts described above because of the increased area dedicated to oil field development.

4F.7.2 Regional Economy

4F.7.2.1 Evaluation

Oil and gas production is the dominant economic activity in the North Slope region of Alaska. It is also a significant portion of the state's economy. In 2001, oil and gas represented 17 percent of the state's economy as measured by Gross State Product (BEA 2001 www.bea.doc.gov/bea/regional/qsp/action.cfu).

Cumulative effects have been addressed in other recent documents, including the Northwest NPR-A Draft IAP/EIS (BLM 2003b), and are herein incorporated by reference and summarized below.

Even with the past, present, and reasonably foreseeable activities considered in this cumulative effects analysis, the oil industry in and near Prudhoe Bay is anticipated to decline. An authoritative source, DOE's Energy Information Administration (U.S. Dept. of Energy 2001a), projects North Slope oil production to decline from 1.084 million barrels per day (MMbpd) in 2005 to 0.208 MMbpd in 2034. This decline would encompass oil exploration, development, and production and its associated direct employment. Associated indirect employment in South Central Alaska, Fairbanks, and the NSB and revenues to the Federal, State, and NSB governments are also anticipated to decline.

The effects below are expressed (in most cases) in annual averages over the next twenty years for the sake of simplicity. However, the effects generally would be higher in the early years and lower in latter years, corresponding to the decline in production.

CPAI's proposal would generate the following average annual revenues for the period 2007 to 2020:

$7 million revenue average annual to the NSB

$30 million average annual to the State

$13 million average annual to the Federal Government

Components of the cumulative effects scenario other than those associated with FFD could generate the following additive annual revenues (FFD revenue flows among different governments are highly dependent on the ownership of lands on which development occurs, see 4A.4.2.3):

$15 million as the State share of royalty receipts

$7 million as State income tax

$4 million as State spill and conservation tax

$41 million as the Federal share of royalty receipts

$56 million as Federal income tax

In total, the cumulative effects (excluding FFD) would generate the following additive average annual revenues:

$7 million to the North Slope Borough

$56 million to the State

$110 million to the Federal Government

This is in comparison to the year 2000 revenues for the NSB of $245 million, year 2001 State operating budget of $4.3 billion, and year 2001 Federal receipts of all types of $1.7 trillion.

The cumulative gains in direct employment would include additive jobs in petroleum exploration, development, and production, plus oil-spill cleanup activities. The direct employment would generate indirect and induced employment and associated personal income for all the workers. The cumulative effects are projected to generate additive employment and personal income increases as follows:

152 jobs annual average for NSB residents during development, declining to 28 during production. These include direct oil industry employment, indirect, and induced employment.

$11.5 million in total average annual personal income for workers residing in the NSB during development, declining to $2.2 million during production.

6,680 jobs annual average during development, declining to 3,410 during production. These jobs are for workers on the North Slope who reside in Southcentral Alaska and Fairbanks. These include direct oil industry employment and indirect and induced employment.

$479 million in total average annual personal income for workers residing in Southcentral Alaska and Fairbanks during development, declining to $213 million during production.

60 to 190 jobs for 6 months for cleanup of unlikely oil spills in the Beaufort Sea.

In addition to the North Slope workers who reside in South central Alaska and Fairbanks, additional workers commute to residences outside the State. Approximately 30 percent of current North Slope workforce in the classification of oil and gas workers commutes to locations outside the State. However, the workers commuting to residences outside the State would not generate economic effects of indirect and induced employment or expenditure of income in the State and would have a negligible effect on the economy of the rest of the U.S. Total NSB employment exclusive of oil workers in 1998 was 4,651. The projected employment for workers on the North Slope residing in Southcentral Alaska and Fairbanks is in comparison to 1998 NSB employment in mining (assumed to be all oil employment) of 4,753. Of these, 70 percent (3,329) reside in the rest of Alaska outside the NSB, primarily in Southcentral Alaska and Fairbanks. Employment projections can also be compared to the total number of workers in Southcentral Alaska and Fairbanks in 2002 (284,000). Aggregate personal income in 1999 was $200 million for the NSB and $13.2 billion for Southcentral Alaska and Fairbanks.

4F.7.3 Subsistence-Harvest Patterns

4F.7.3.1 Evaluation

Cumulative development of oil and gas production facilities on the North Slope may affect subsistence harvest patterns of the North Slope Native communities. Current development in and adjacent to the Prudhoe and Kuparuk fields is primarily to the east of North Slope communities and their associated subsistence areas, although the subsistence use area of Nuiqsut does extend into areas of existing development. Future lease sales and projected development in the NPR-A could extend development

to the west into subsistence use areas of the communities of Barrow, Wainwright, Point Lay, and Atqasuk. Because little baseline biological, habitat, or subsistence-harvest data have preceded oil development on the North Slope, it is difficult to disassociate the cumulative effects of oil development in the region from the relatively recent processes of significant local social change.

Source of Impacts to Subsistence Use

The overall impact to subsistence and subsistence harvest patterns can occur from direct impacts to the viability of the resources that the Native communities rely upon and impacts to the hunting/harvesting efforts. These potential impacts are described in detail in Section 4A.4.3 and generally include the following:

Exploration and development activities can directly affect subsistence resources because of potential oil spills; noise and traffic disturbance; or disturbance from construction activities associated with ice roads, pipelines, and landfalls. Noise and traffic disturbance might come from building, installing, and operating production facilities and from supply efforts.

Activities associated with exploration, facility construction, operation and maintenance, and oil spills have both disturbance and habitat impacts on terrestrial mammals, freshwater and marine fish, birds, bowhead whales, and beluga and other marine mammals. Direct effects include delay or deflection of movements and mortality of resource populations; indirect effects include destruction or degradation of habitat and changes in productivity.

Access to subsistence-hunting areas and subsistence resources—and the use of subsistence resources—could change if oil development were to reduce the availability of resources or alter their distribution patterns. Major factors considered in the effects analysis of subsistence-harvest patterns of the communities of Nuiqsut**,** Barrow, Atqasuk, and Anaktuvuk Pass are (1) heavy reliance on caribou, fish, birds, and bowhead whales in the annual subsistence harvest; (2) the overlap of subsistence-hunting ranges for many species harvested by these Native communities; and (3) subsistence hunting and fishing as central cultural values in the Inupiat way of life. Chronic cumulative biological effects to subsistence resources would affect their harvests. Potential effects from oil spills and noise disturbance could affect seal hunting during the winter; whale, seal, bird, and caribou hunting in spring; and whale, seal, bird, walrus, and caribou hunting during the open-water season.

Limited monitoring data limit assessment of cumulative subsistence-resource damage; resource displacement; changes in hunter access to resources; increased competition; contamination levels in subsistence resources; harvest reductions; and increased effort, risk, and cost to hunters.

Native Views Concerning Cumulative Effects on Subsistence-Harvest Patterns –

Cumulative effects from oil development have been, and continue to be, paramount concerns for North Slope residents. The concerns have been expressed in a number of different forums including scoping meetings held as part of the preparation of recent IAP/EISs and for this ASDP. There is an extensive public record of comments from members of the community concerning subsistence resources and subsistence harvest and use. A number of representative comments have be selected from this record and listed in Table 4F.7.3-1. A more comprehensive selection of comments and testimony is included in Appendix A.

TABLE 4F.7.3-1 SUMMARY OF TRADITIONAL KNOWLEDGE / LOCAL KNOWLEDGE

(1) Resource Category	(2) Summary of Effects and location	(3) Testify
Physical Characteristics		
Aquatic Environment (water resources, surface water, estuarine waters and water quality, marine water quality, flooding regime, and ice conditions)	*Comment*: As a result of past action the Itlillik River which was once clear is now a rusty color; *Effects*: decreased water quality and a lack of fish in the Itkillik River; less fish for subsistence use; *Area*: Itlillikpatt and the Itlillik River.	Bessie Ericklook, 1979, Beaufort Sea Lease Sale, public hearing in Nuiqsut
	Comment: Fresh water river levels near Nuiqsut are decreasing and rivers are getting shallower and shallower each year; *Effects*: lower fish population; less fish for subsistence use *Area*: Nuiqsut and surrounding rivers.	Flora Ipalook, 1979, Beaufort Sea Lease Sale, public hearing in Nuiqsut
	Comments: Loss of two to three feet of water in area lakes especially Shinmar Rock; level went down to 5-6 feet and therefore it cannot support any more fish; *Effects*: less fish present due to decrease in water levels and increase in noise; less fish for subsistence use; *Area*: Shinmar Rock.	Arnold Brower, Sr., 1976, Federal Energy Hearings, public hearing in Barrow
	Comment: Lakes and rivers are shallower than in past; streams and rivers that shoot off of Tsukpuk Lake use to be navigable by boat but they can't even go on them; *Effects*: decreased access; severely reduced fish populations; less fish available for subsistence use; less available area for hunting and fishing; *Area*: Tsukpuk (Teshepuk Lake).	Daniel Leavitt, 1979, Beaufort Sea Lease Sale, public hearing in Barrow
	Comment: All drilling operations consume a lot of water; the same thing will happen to the Sagavanirktok like it did to the Sagavanirktok River, it ran the completely dry twice in one year; *Effects*: less animals and fish in area; *Area*: Sagavanirktok River.	Raymond Neakok, 1982, National Petroleum Reserve-Alaska subsistence hearing in Barrow

TABLE 4F.7.3-1 SUMMARY OF TRADITIONAL KNOWLEDGE / LOCAL KNOWLEDGE (cont'd)

(1) Resource Category	(2) Summary of Effects and location	(3) Testify
	Comment: A combination of built up ice and snowdrifts and water rising with the tide causes area flooding; *Effects*: flooding to 12 miles up river causes danger for those with a dog team or on snow machine; less accessible area. *Area*: Howuerenokto and Ocean Point.	Nuiqsut Whaling Captains Meeting, 1996 Northstar EIS Project
Atmospheric Environment (climate and meteorology, air quality, and existing ambient air quality)	*Comment*: High winds and larger than average swells; *Effects*: Increase in swells which inhibited ability to travel to and from subsistence area; decrease in subsistence due to decrease in safe travel; *Area*: Cross Island.	Archie Ahkiviana, 2001 Liberty Project, public hearing in Nuiqsut
	Comments: She (former health aid and physicians assistant) has noticed an overwhelming increase in asthma patients; village makeup has not changed, still mostly Inupiaq; the most overwhelming issue was that the oil development around the gas community had increased and gotten closer; the worst nights were nights with many natural gas flares; they release particles and they travel to use; some infiltrate the ground; we are seeing changes in the caribou and fish leaving them with lesions and tumors; helicopter activity has diverted caribou away from us during hunting/subsistence gathering; *Effects*: burning of natural gas and petroleum products has increased risk for respiratory problems in local residents; increase in noise due to air traffic spooks caribou herd thus decreasing amount present in area; infiltration of particles has caused disease in animals; *Area*: Nuiqsut and immediate surrounding areas.	Rosemary Ahtuangaruak, Mayor; 2003, Alpine Slope Development Plan public hearing in Nuqisut.
Biological Resources		
Fish	*Comments*: Use of explosives has killed or damaged many fish under the ice (traditional methods of harvesting involved using a hammer to strike the ice creating a noise killing the fish); *Effects*: smaller fish population due to increase in noise; less fish for subsistence use. *Area*: Finmore rock, Sitkulik and the Tripp River area.	Arnold Brower, Sr., 1976, Federal Energy Hearings, public hearing in Barrow

TABLE 4F.7.3-1 SUMMARY OF TRADITIONAL KNOWLEDGE / LOCAL KNOWLEDGE (cont'd)

(1) Resource Category	(2) Summary of Effects and location	(3) Testify
	Comments: Use of explosives and compressors, especially in the winter months, has killed off or caused the relocation of those fish in local rivers and lakes; a method used by his father to gather fish involving pounding on ice to kill fish then drilling an opening downstream to gather the fish is no longer a feasible means of collection for him; lakes where the fish are inland freeze over in the winter and they die due to lack of water ; a compressor which sends off a very loud noise and vibrations can also kill a lot of fish; *Effects*: decreasing fish population; they are no longer able to use methods passed down through generations for harvesting fish *Area*: rivers in the area between Barrow/Nuiqsut to Anaktuvuk Pass.	Joash Tukle, 1982, National Petroleum Reserve-Alaska, subsistence hearing in Barrow
	Comment: We had some good fishing grounds up there and this fall we hardly even caught any; after the PET 4 seismograph party went through the depth of the lake is a little over 8 feet and a few blasts would clean the whole thing up; traditional methods of hitting the ice then harvesting them out of the river downstream proved ineffective; *Effects*: fish were not present following blasting and seismic activity; indirect effects-less fish available for subsistence use. *Area*: area not specified.	Charlie Edwardson, 1976, Federal Energy Hearings, public hearing in Barrow
	Comment: In an area where drilling had occurred, a net was placed in the lagoon near the ocean where my dad use to catch Arctic char; even though we had the net there overnight we did not catch any fish; *Effects*: Fish population has severely declined in areas where drilling has occurred; less fish available for subsistence use; *Area*: Prudhoe Bay.	Jenny Ahkivgak (Okkingak), 1982, NPR-A subsistence hearing in Barrow

TABLE 4F.7.3-1 SUMMARY OF TRADITIONAL KNOWLEDGE / LOCAL KNOWLEDGE (cont'd)

(1) Resource Category	(2) Summary of Effects and location	(3) Testify
	Comment: Markers of the sounders (?) that had been placed near the river; from that time on, the fishes in that river changed and are not there anymore right now; sounders are killing them or driving them to the bottom of the stream; *Effects*: Fish were not present following sounding; less fish for subsistence use; *Area*: area not specified.	Noah Itta, 1982, National Petroleum Reserve-Alaska B subsistence hearing in Barrow
	Comment: Since the use of dynamite in the river, there have been fewer and sometimes no fish found; they disturbed the garden where they live off of; *Effects*: Fish not present after blasting events (up to 3 years after); less fish available for subsistence use; *Area*: area not specified.	Noah Itta, 2001, Liberty Development and Production Plan, public meeting in Nuiqsut
	Comment: Fished in the Fish Creek area for Arctic cisco with mother (2 generations), since start of Alpine few years ago, hardly any fish to be caught in same area; *Effects*: Less fish in Fish Creek area; indirect effect-less fish available for subsistence use; Area: Fish Creek, Nuiqsut and surrounding areas.	Jimmy Nukapigak, 2003, Alpine Slope Development Plan, public hearing in Barrow
	Comment: CD-6 is close to Fish Creek area where they fish in the summer; when they can't get fish in the Nigliq Channel they slide over to the other channel; it has lots of fish and they taste better than Colville fish; *Effect*: putting in CD-6 could possibly disturb area and effect population of fish in the area historically and currently used for fishing; *Area*: around proposed CD-6; Nigliq Channel area.	Frank Long, Jr. 2003, Alpine Slope Development Plan, public hearing in Nuiqsut

TABLE 4F.7.3-1 SUMMARY OF TRADITIONAL KNOWLEDGE / LOCAL KNOWLEDGE (cont'd)

(1) Resource Category	(2) Summary of Effects and location	(3) Testify
Birds	*Comment*: In Inigok where a lot of drilling took place, bones were seen from birds that have been killed from the stuff they leave behind in the hole; wildlife and waterfowl dying from contaminants being left after having conducted drilling activity; *Effect*: contamination of waterfowl and wildlife resulting in death; steady decrease in migratory bird population; *Area*: Upulatook near Nuiqsut; Inigok.	Thomas Brower, Jr. and James Aiken, Sr., 1997, Northeast NPR-A Integrated Activity Plan/EIS, scoping meeting in Atqasuk
Mammals (terrestrial and marine mammals)	*Comment*: Seismic activity is displacing the animals; while hunting wolverines, which were being tracked, they had just been scared away from where activity (seismic) was occurring; there are no furbearers except for the foxes; did not see wolverines; *Effects*: Normal movement of animals is effected by activity making hunting and tracking is more difficult; decreasing the number of available wolves and foxes for subsistence use; *Area*: Southside of Teshekpuk up in Pikes dunes; up the Ikpikpuk River.	Harry Brower, Jr., 1997, Northeast NPR-A Integrated Activity Plan/EIS, scoping meeting in Barrow
Social Systems		
Economy	*Comment*: Being a 3rd generation since pre-contact of Western civilization, they are faced with the fact they must either subsist off the land or take a 9:00-5:00 job; can not totally exist on subsistence anymore; *Effects*: Lifestyle drastically different than the way of there forefathers; can not longer subsist off of the land; must work for the oil companies; most are not qualified and jobs are short lived; *Area*: Barrow.	Sheldon Bogenrifle, 1982, National Petroleum Reserve-Alaska, subsistence hearing in Barrow

TABLE 4F.7.3-1 SUMMARY OF TRADITIONAL KNOWLEDGE / LOCAL KNOWLEDGE (cont'd)

(1) Resource Category	(2) Summary of Effects and location	(3) Testify
	Comment: Qualifications have changed for those Natives who desire to work for oil related companies; in the beginning, the only qualification was that you pass the UA, now to get a regular labor job or driving job you need a clean UA, a driver's license or a CDL, unrestricted, and NSTC card; *Direct*: Fewer are qualified or eligible for employment through the oil industry; less available money for those living in the villages without qualifications (who are no longer able to completely subsist); *Area*: village of Nuiqsut.	Bernice Kaigelak, 2003, Alpine Slope Development Plan, public hearing in Nuiqsut
Subsistence Harvest and Uses	None	
Land Uses and Coastal Management (land ownership, land use, coastal management, and the North Slope Borough Land Management Program)	*Comment*: After catching a musk-ok he was taken to court for being inside the industry boundary; must now fight in court for harvesting in certain areas. *Effect*: Freely hunted subsistence areas are now trespassing on oil company land in order to reach the same areas restrictions on land use; less musk-ox due to land use/ownership restrictions. *Area*: Area not specified	Arnold Brower, Jr., 1998, National Petroleum Reserve-Alaska, public meeting in Atqasuk
	Comment: Open areas are now impassable due to dynamite left behind and wires scattered over the area; *Effects*: Change in use of land; less land to subsist from; smaller amounts of available animals for subsistence harvest; *Area*: Area not specified.	Ruth Nukapigak, 1979, Beaufort Sea Lease Sale BF, public hearing in Nuiqsut
	Comment: Her grandparents had a sod house and a cellar in Prudhoe Bay; now they are unable to even access the site; they have no right to it even though their ancestors were there before the oil fields were there; Effects: Loss of access and previously owned land to oil industry; Area: unspecified; Prudhoe Bay.	

TABLE 4F.7.3-1 SUMMARY OF TRADITIONAL KNOWLEDGE / LOCAL KNOWLEDGE (cont'd)

(1) Resource Category	(2) Summary of Effects and location	(3) Testify
Transportation (road systems, aviation systems, marine transportation systems, pipeline systems, iceroads and platforms, winter rolligon travel, and Alaska Railroad Corporation)	*Comment*: In order to cross the pipeline sometimes it is necessary to travel up to 10 miles off course; *Effects*: Longer travel time; indirect effect-increase in disturbed area due to having to travel off previously disturbed paths; *Area*: Nuiqsut area.	Thomas Napageak, Leonard Lampe, and Arnold Brower, 1997, Northeast NPR-A Integrated Activity Plan/EIS, scoping meeting in Nuiqsut
Hazardous Materials/Environmental Justice	*Comment*: As witnessed and experienced when working for the oil companies, toxic muds and caustic sodas are being dumped into the rivers and oceans; most of the abandoned oil rigs I have worked on, the toxic muds are put in good little cubes, approximately 5,000 square yards of toxic muds go uncovered; wastes are accumulating; *Effects:* Accumulation of toxic materials and waste; indirect effects-animals are exposed to these hazardous materials; *Area*: unspecified.	Raymond Naekok, 1982, National Petroleum Reserve-Alaska, subsistence hearing in Barrow
	Comment: When he was a boy, in his hometown during the springtime oil companies would clean out their sitla and place the oils outside; birds would stick to the oil and become unable to fly, eventually dying; *Effects*: Birds dying from inability to escape from oil exposed to the environment; less birds for hunting and subsistence; *Area*: area not specified.	Laurie Kingik, 1982, National Petroleum Reserve-Alaska, subsistence hearing in Barrow
Caribou	*Comment*: Seismic activity involving dynamite is effecting caribou who consume the blasting powder; causes rabid behavior and effects on the animals; caribou are effected by amount of waste materials; *Effect*: Poisonous powder used in blasting is being eaten by caribou thus decreasing well population and waste materials attaching to caribou (wires); indirect effect-less healthy caribou for subsistence use; *Area*: area not specified.	Raymond Neakok, 1982, National Petroleum Reserve-Alaska, subsistence hearing in Barrow

TABLE 4F.7.3-1 SUMMARY OF TRADITIONAL KNOWLEDGE / LOCAL KNOWLEDGE (cont'd)

(1) Resource Category	(2) Summary of Effects and location	(3) Testify
	Comment: The pipeline from Oliktok to Kuparuk has caused the displacement of caribou from Cross Island to Teshekpuk; few caribou have are crossing under pipelines and as a result there is displacement of caribou in the villages; *Effects*: Less caribou present following installation of pipeline; less caribou available for subsistence use; *Area*: Oliktok to Kuparuk, from Cross Island to Teshekpuk.	Frederick Tuckle, Sr., 2001, Liberty Development and Production Plan, public hearing in Barrow
Miscellaneous		
Noise	*Comment*: Not far from the Nuiqsut site they are conducting wildlife surveys by air and by foot creating an enormous amount of noise that upsets, disrupts and displaces perhaps some of their only opportunity to go get their game, especially caribou in the area are scared and may run off because of these impediments that arrive are not natural; hunters must go further to gather game *Effects*: fewer caribou present following activity and surveys thus caribou available for subsistence use; *Area*: Colville River Delta to the east side by Ulumniak	Ruth Nukapigak, 1998, National Petroleum Reserve-Alaska, public hearing in Nuiqsut
Visual/Aesthetic	*Comment:* Flames out on the project oil platforms are very close to the whaling base of Nuiqsut called Cook Island so concerns on the migration and impacts to whales exist; flames spook both the whales and crews who are harvesting whales for subsistence; *Effects*: fewer whales in the area due to excess light; increases danger for subsistence hunters; *Area*: Cross Island	Leonard Lampe, 1996, Northstar EIS Project, Nuiqsut public scoping meeting

Other notable comments concerning cumulative effects to subsistence harvest and use have been received.

In a 40-page, March 2002 letter to the USACE, Nuiqsut's Kuukpik Corporation, the Native Village of Nuiqsut, the City of Nuiqsut, and the Kuukpikmiut Subsistence Oversight Panel voiced strong opposition to Phillips Alaska's proposed development of the Fjord and Nanuq satellite fields near the Alpine development project. They called for the USACE to prepare an EIS to address the multitude of potential impacts they believe will occur from this expansion, particularly a proposed north-south connecting road in a development scenario that had been promoted as "roadless." They also want the USACE and Phillips to address broken agreements and permitting lapses with Kuukpik over: (1) exceeding employment ceilings and aircraft flights at Alpine and winter drilling activity on the Colville River Delta, (2) the proposed building of additional vertical support members (VSMs) for satellite developments when existing VSMs were supposed to be adequate, (3) yet-to-be-delivered studies on caribou in the Colville River Delta and the Alpine Socio-cultural Study report, and (4) poorly projected and analyzed drilling activity and pipeline impacts from the Tarn and Meltwater Projects. In its letter to the USACE, Nuiqsut concluded: "In essence, this whole letter is about cumulatively significant impacts, ranging from the manner in which Alpine impacts have exceeded projections..." (Kuukpik Corporation et al. 2002).

Comprehensive subsistence harvest and resource studies, monitoring, and stipulations are needed for assessing impacts on subsistence resources and hunter access to those resources. The Subsistence Advisory Panel formed under the leasing effort for the Northeast NPR-A Planning Area is one group that may resolve some of the on-going monitoring, mitigation, and enforcement concerns with subsistence.

Concern has been expressed about the potential increase in roads**,** including the proposed road interconnecting Nuiqsut and the NPR-A with the Dalton Highway. Any local or more extensive interconnecting road system could bring impacts from increased access to subsistence resources. More specifically, increased access could increase hunting pressure and increase competition for subsistence resources from both subsistence and non-subsistence hunters. Increased harvest levels could potentially make game scarcer near the road proper. Reduced abundance and distribution of caribou and other terrestrial mammals would be expected along the road corridor from hunting, trapping, recreation, and tourist traffic associated with an interconnecting road. Increased hunting pressure in areas of high goose concentration could lead to declines in bird use of these areas. As a result of increased hunting pressure and reduced abundance, hunts could take longer as hunters would have to travel farther from the road corridor to successfully reach game or be forced to hunt in nontraditional areas. Access could be diminished for subsistence hunters in developed oilfields if subsistence access has been curtailed by enforced no-fire zones.

4F.7.3.1.3 Effects of Disturbance and Oil Spills on Subsistence Resources

The following is a summary of the potential cumulative effects on subsistence resources from oil spills, disturbance, and habitat loss on resources currently exploited for subsistence by North Slope communities:

Terrestrial Mammals – Cumulative oil and gas development on the North Slope could result in a long-term displacement and/or functional loss of habitat for CAH, TLH, and WAH caribou over the life of CPAI's development. At present, cumulative oil development in the Prudhoe Bay-Kuparuk area has caused displacement of CAH caribou from a portion of the calving range, with a shift in calving distribution away from the oilfields. Future state oil-lease sales on the Arctic Slope between NPR-A and the Arctic National Wildlife Refuge and in the foothills of the Brooks Range would increase the amount of activity associated with oil exploration and development within the CAH range. Future oil and gas development in NPR-A could impact the TLH and WAH**.** Future state offshore leases in the Beaufort Sea could expose TLH and CAH caribou to additional activities related to oil and gas development through onshore facilities to support offshore leases.

The alteration of more than 8,000 acres of tundra habitat in the Prudhoe Bay area has not had any apparent effect on the distribution and abundance of other terrestrial mammals, with the possible exception of arctic foxes that apparently have increased near the oilfields. Muskoxen have continued to expand their range westward across the North Slope from an introduced population in the Arctic National Wildlife Refuge. There are no apparent effects on grizzly bears, wolves, and other terrestrial mammal populations associated with this development.

Freshwater Fish – Wide-ranging increases in impacts to arctic fish populations found on the North Slope would not be anticipated based on the cumulative analysis. Also, synergistic impacts to fish from disturbance related to oil and gas production in this plan would not be anticipated. Countervailing effects related to extraction at gravel sites would be possible in certain situations. Past reclamation of deep pits that have been mined has proved beneficial when new habitat for arctic fish species has been established.

Marine Fish – The additional effect of seismic surveys and construction-related activities above those expected from Alternative A would be anticipated to be proportional to the number of future activities. Effects on marine fish populations could be greater if there were insufficient time for full recovery between these activities. Offshore cumulative case oil spills would be expected to have mostly sublethal effects on marine fish populations. Spills that might enter coastal waters would be expected to affect a greater percentage of fish than estimated for Alternative A. Assuming sufficient recovery time between spills, the recovery from each cumulative case spill would be expected within three to five years.

Birds – Overall cumulative effects of oil industry activities on birds potentially could be substantial in the case of loon species and king eider, and significant in the case of long-tailed duck and king and common eiders—primarily as a result of mortality in the unlikely event a large oil spill were to occur. Although the chance of an oil spill happening is relatively small, the potential would be highest for contact with bird concentrations in the vicinity of primary support facilities. Also, as a result of the apparent decline in populations of some species (for example, several sea duck species), and the challenge of recovering spilled oil, particularly in broken-ice conditions, there is uncertainty as to the ultimate effect of any spills on bird populations. Disturbance could cause some small loss of productivity and lowered fitness or survival of birds occupying areas with high levels of industry activity, but these effects would not be expected to be significant. Effects resulting from oil and gas development activities likely would be additive to naturally occurring effects or those occurring as a result of other activities in the NPR-A.

Bowhead Whales – Overall, exposure of bowhead whales to noise from oil and gas operations would not be expected to kill any bowhead whales, but some could experience temporary, nonlethal effects. Whales exposed to spilled oil likely would experience temporary, nonlethal effects although prolonged exposure to freshly spilled oil could kill some whales. The incremental contribution of effects from oil and gas development in the Plan Area to the overall effects under the cumulative case would not be likely to result in an adverse effect on the bowhead whale population.

Whales exposed to increased noise could be deflected from their normal migration route and displaced from traditional hunting areas interrupting the whale harvest. Most projected reasonably foreseeable development projects would be expected to be close to shore and away from traditional bowhead whale migration and harvest areas.

Any actual or perceived disruption of the bowhead whale harvest from oil spills and any actual or perceived tainting anywhere during the bowhead's spring migration, summer feeding, and fall migration could disrupt the bowhead hunt for an entire season, even though whales still would be available.

Beluga Whales and Other Marine Mammals – In the Beaufort Sea, noise and disturbance from on-ice seismic surveys during any one year would affect breeding ringed seals in that area for no more

than one year, because only a small fraction (less than one percent) of the population would likely be exposed to and potentially disturbed by the operations. Subsequent surveys in other areas during other years have disturbed different seals and would be expected to in the future. A few pups could be lost because mothers might abandon maternity lairs or because seismic vehicles might destroy snow lairs along the shot line. Past seismic exploration on the sea ice over several years might have killed some pups and displaced some seals locally very near seismic lines (within 150 meters) during operations for that ice season. However, these additive effects probably were not significant to the seal population above changes in distribution associated with changes in sea ice.

The effects of noise and disturbance on seals, walrus, and beluga and gray whales in the Beaufort Sea from an estimated total of more than 450 helicopter round trips per month and at least 200 vessel round trips per month should last only a few minutes to less than an hour for any one disturbance event. Disturbance reactions of seals, walrus, and beluga and gray whales would be brief; they would return to normal behavior patterns and distribution shortly after the boat or aircraft had left the area. Effects would not be expected to be additive or synergistic because disturbance reactions most likely would involve different animals and occur in different areas. Seals and walrus also could get used to aircraft and vessels, if they were to encounter them routinely.

Ringed and bearded seals, walrus, and beluga and gray whales have been exposed to oil-exploration activities in the Beaufort Sea, including seismic surveying, drilling, air and vessel traffic, dredging, and gravel dumping. Activities in the Beaufort Sea—as well as barge traffic to the North Slope, and some icebreaker activity to support oil exploration—might increase in the future. These activities could affect how seals are distributed near the activity for one season (or less than one year) during high levels of activity. However, some seals would habituate to marine and air traffic, industrial noise, and human presence. Displacement from cumulative industrial activities would not likely affect the overall abundance, productivity, or distribution of ringed and bearded seals, walruses, and beluga whales in Alaska's Beaufort Sea.

Cumulative noise sources that could affect beluga and gray whales would be from seismic activities and drilling (and other noise associated with exploration, development, and production operations); vessel and aircraft traffic; construction; and oil-spill cleanup. Underwater industrial noise, including drilling noise measured from artificial gravel islands, has not been audible in the water more than a few kilometers away. Because the beluga whale's migration corridor is far offshore of the barrier islands, seismic exploration, drilling, development, and production noise from most development in the nearshore area would not be likely to reach many migrating beluga or gray whales. Noise also would be unlikely to affect the few whales that could be in lagoon entrances or inside the barrier islands because of the rapid attenuation of industrial sounds in a shallow-water environment. Because island and pipeline construction would occur during the winter and be well inside the barrier islands, it would not likely affect beluga or gray whales.

An important habitat for marine mammals is the active-ice, or ice-flow, zone. Seals, walrus, and beluga whales would be most vulnerable to spills contacting this zone; polar bears would be most vulnerable to spills contacting the flaw zone or the coast. Offshore spills would obviously pose a higher risk to marine mammals than onshore spills, but along the coast of the Planning Area, some aggregations of seals and walrus and a small number of polar bears could be contaminated by onshore spills that reach marine waters and could suffer lethal or sublethal effects. The most noticeable effects of potential oil spills from offshore oil activities would be through contamination of seals, walrus, and polar bears, with lesser effects on beluga whales. Losses from an estimated one to three oil spills of 1,000 bbls could be: fewer than 1,000 seal pups and adults, fewer than 1,000 walrus calves and adults, and fewer than 30 polar bears (out of a population of 2,272 to 2,500 bears). These losses would likely be replaced within one generation or less (with a generation of approximately five years for ringed seals and at least seven years for polar bears). Beluga whales would likely suffer low mortality (fewer than 10 whales), with population recovery expected within one year.

The Effects of Disturbance on Subsistence Resource Habitats

The continual loss of habitat associated with oil and gas development on the North Slope has been documented (Walker et al. 1986; Walker 1986; Walker et al. 1987a; Walker et al. 1987b; Walker and Walker 1991). Walker et al. (1987), in a geobotanical mapping study, concluded that by 1986 the Prudhoe Bay oilfield occupied approximately 500 square kilometers between the Kuparuk and Sagavanirktok rivers that included 359 km of roads, 21 square kilometers of tundra covered by gravel, and 14 square kilometers that had been flooded by road and gravel-pad construction. Expansion of disturbed areas since 1968 has been continual although at a reduced rate (see Figure 4F.3.1-1). Walker et al. (1987) considered these to be major landscape impacts and recommended that the implications to wetland values, wildlife corridors, and caribou calving grounds be addressed.

Development of all types has directly impacted approximately 17,770 acres (including all oil and gas activities and that portion of the Dalton Highway on the North Slope). Of this, approximately 9,640 acres are for exploration and production facilities (pads, roads, airstrips, etc.). The second largest disturbed area is for gravel mines, which cover 6,365 acres (including both tundra and riverbed mines). The total affected acreage is a small part of the Arctic Coastal Plain; the proposed CPAI alternatives will increase disturbance by approximately 1 percent of the areas currently disturbed and 1.3 percent of all areas expected to be disturbed in the future. Under FFD (Alternative A FFD) the increase in disturbance is projected to be approximately 7.9 percent (see Table 4F.5.3-1). These relatively small increases in additional disturbance are not expected to cumulatively affect the overall productivity of tundra plants on the North Slope. Further, recent, current, and expected future development will utilize technology advancements that require a much smaller acreage footprint than past projects on the North Slope.

Alterations from offshore production platform-island construction, trench dredging, and pipeline burial would be expected to affect some benthic organisms and some fish species within one kilometer for less than one year or season. These activities also could temporarily affect the availability of some local food sources for these species for up to one to three kilometers (0.62 to 1.9 miles) during island construction, but these activities would not be expected to affect food availability for seals over the long term. The effect of future onshore facilities siting—dust fallout, thermokarst, and hydrologic change—on bird populations, though additive, would be significantly less severe, because they would be restricted to much smaller areas and result in less habitat loss. Pads, gravel quarries, pipelines, pump stations, and gravel roads that cross much of the CAH calving range actually have destroyed only approximately three to four percent of the tundra grazing habitat for caribou.

An increase in abundance of deciduous shrubs (less favorable caribou forage), especially birch, and a decline in the abundance of grasses/sedges such as Eriophorum vaginatum (an especially important food of calving caribou) would be predicted if a significant increase in average temperature were to occur in the Arctic - an effect that could reduce the productivity of caribou habitats on the Arctic Slope (Anderson and Weller 1996). Over decades, warming temperatures could result in the invasion of tundra habitat by taiga woody plants (taiga forests), a less favorable habitat for tundra mammals and some bird species, thereby adversely affecting their populations and subsistence uses (Anderson and Weller 1996).

4F.7.3.2 Conclusion

Development already has caused increased regulation of subsistence hunting, reduced access to hunting and fishing areas, altered habitat, and intensified competition from non-subsistence hunters for fish and wildlife (Haynes and Pedersen 1989).

Additive impacts that could affect subsistence resources include potential oil spills, seismic noise, traffic disturbance, and disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, and supply efforts. Based on potential cumulative, long-term displacement and/or functional loss, habitat available for caribou may be reduced or unavailable or

undesirable for use. Changes in population distribution due to the presence of oil field facilities or activities may affect availability for subsistence harvest in traditional subsistence use area. The communities of Barrow, Atqasuk, Nuiqsut, and Anaktuvuk Pass would be most affected.

Overall, impacts to subsistence harvest and use may have synergistic impacts with community health, welfare, and social structure. To the extent that subsistence hunting success is reduced in traditional use areas near Nuiqsut because of the presence of oil field facilities and activities, subsistence hunters may need to travel to more distant areas to harvest sufficient resources to meet community needs. Greater reliance on more distant subsistence use areas will result in greater time spent away from the community for some household members and competition for resources with members of other communities. These changes in subsistence patterns may result in stress within households, family groups, and the community. The additive and synergistic effects of these impacts are expected to be greater under Alternative A – Full-Field Development because of the greater incursion of oil field facilities into traditional subsistence use areas.

4F.7.4 Environmental Justice

4F.7.4.1 Evaluation

Alaska Inupiat Natives, a recognized minority, are the predominant residents of the NSB, the area potentially most affected by cumulative oil and gas development on the North Slope. Disproportionate impacts from oil development could occur because of their reliance on subsistence foods, and potential effects could impact subsistence resources and harvest practices. Potential cumulative effects from noise, disturbance, and oil spills on subsistence resources and harvest practices and socio-cultural patterns would focus on the Inupiat communities of Nuiqsut, Barrow, Atqasuk, and Anaktuvuk Pass within the NSB. These impacts include: (1) effects on subsistence resources, activities, and communities and (2) other environmental justice effects.

Effects on Subsistence Resources, Activities, and Communities

Potential cumulative impacts to subsistence resources and subsistence harvest have been previously discussed (See Section 4F.7.3). Subsistence activities are important in providing dietary sustenance to North Slope residents. As a consequence, any cumulative activities that could directly impact subsistence resources and access to those resources may also have disproportionately high adverse effect on minority and low-income populations. Actions identified in the Alaska National Interest Lands Conservation Act 810 analysis as having a potentially significant impact on subsistence also would have a significant impact on minorities and low-income populations and communities. Those stipulations and other protective measures that help to mitigate impacts on Inupiat Natives are the same as identified in the subsistence and socio-cultural analyses in Section 4F.7.3 on Subsistence Harvest Patterns.

The 2000 Census counted 7,385 persons resident in the NSB; 5,050 identified themselves as American Indian and Alaska Native for a 68.4 percent indigenous population (U.S. Bureau of the Census, Census 2000). Alaska Natives comprised 88 percent of Nuiqsut's population, 56 percent of Barrows, 94 percent of Atqasuk's, and 88 percent of Anaktuvuk Pass's residents

With the North Slope Borough's largely homogenous Inupiat population, the identification of a "reference" or "control" group within the potentially affected geographic area—for the purposes of analytical comparison to determine if the Inupiat are affected disproportionately—is not possible. This is because a non-minority group does not exist in a geographically dispersed pattern along the potentially affected area of the North Slope.

North Slope Borough income figures determined an average household income of $54,645 and a per capita income of $15,218 in 1993. When figured for ethnicity, the average Inupiat household income was $44,551 and for non-Inupiat it was $74,448. The average Inupiat per capita income was $10,765 and the non-Inupiat per capita income was $29,525. Of all the households in the NSB surveyed, 23 percent qualified as very low-income households, and another 10 percent qualified as low-to-

moderate-income households. As 66 percent of the total households surveyed were Inupiat, it would appear that a large part of the households falling in the very low- to low-income range are Inupiat. Poverty-level families in the borough numbered 88, or 6 percent of all households. Poverty level thresholds used by the NSB were based on the U.S. Bureau of the Census, March 1996 Current Population Survey; low income is defined by the U.S. Census Bureau as 125 percent of poverty level (NSB 1995, 1999).

The NSB 1998/99 Economic Profile and Census Report showed household income increasing from $54,645 in 1993 to $63,884 in 1998. The average Inupiat household income increased by an average of $11,685, from $44,551 to $56,236. The average Inupiat per capita income rose from $10,765 in 1993 to $12,550 in 1998. A total of 125 households qualified as poverty level, and 37 qualified as very low income. This translates into a total of 381 individuals living below the poverty level—an increase of 12 individuals since 1993 (NSB 1999). The 2000 Census found an average per capita income of $20,540 and a median household income of $63,173. The 2000 census found 132 families (8.6 percent of a total 1,538 NSB families) in poverty status in 1999 (397 individuals 18 years and over) (U.S. Bureau of the Census, Census 2000).

Sources for cumulative effects include potential oil spills, noise and traffic disturbance, and disturbance from construction activities associated with drilling, production facilities, pipelines, and landfalls. In addition, habitat reduction, and increased local population pressure have combined as cumulative factors that continue to challenge the survival of many traditional subsistence practices.

Potential effects focus on the Inupiat communities of Atqasuk, Barrow, and Nuiqsut within the NSB. The socio-cultural and subsistence activities of these Native communities could be affected by disturbance to key subsistence species that leads to disruption, displacement, or long-term changes in species' populations. Communities could also be affected by accidental oil spills. Possible oil-spill contamination of subsistence foods is the main community concern regarding potential effects on Native health. However, as a point of reference, after the Exxon Valdez spill, testing of subsistence foods for hydrocarbon contamination from 1989 to 1994 revealed very low concentrations of petroleum hydrocarbons in most subsistence foods. In fact, the U.S. Food and Drug Administration concluded that eating food with such low levels of hydrocarbons posed no significant risk to human health (Hom et al. 1999), though they recommended avoiding shellfish, which accumulates hydrocarbons. While human health could be threatened in areas affected by oil spills, these risks can be reduced through timely warnings about spills, forecasts about which areas may be affected, and even evacuation of people and avoidance of marine and terrestrial foods that might be affected. Federal and state agencies with health-care responsibilities would have to sample the food sources and test for possible contamination.

Other Environmental Justice Effects

The BLM acknowledges the cumulative socio-cultural impacts on the North Slope and the significant change that Inupiat culture has undergone. The influx of money (from wage employment) has added many benefits and raised the standard of living, but these influences have also given rise to a number of social pathologies, including increased alcoholism and drug abuse. Although onshore and offshore cumulative effects are difficult to separate, most cumulative effects are thought to result from onshore development.

Any realistic analysis of cumulative effects on the North Slope needs to consider both onshore and offshore effects. Although no adequate monitoring or comprehensive baseline data gathering have ever been undertaken onshore by responsible federal and state agencies and industry, the most obvious cumulative effects have occurred and continue to occur onshore as oilfield development expands westward from the initial Prudhoe Bay/Deadhorse area of development. Proposed and ongoing studies that will contribute to a more comprehensive understanding of cumulative effects to the Native population of the North Slope include the following:

Based on Native stakeholder concerns about cumulative impacts, BLM and the Research Monitoring Team are considering a study proposal that would better assess the cumulative impacts of petroleum exploration and development on subsistence activities of local communities across the North Slope. The SAP would be consulted as to the variables and the process for measuring them. For further discussion of Environmental Justice effects, see the cumulative effects analyses for subsistence-harvest patterns (Sections 4F.7.3).

Ongoing and proposed MMS studies also address Environmental Justice concerns pertinent to NPR-A development and will provide valuable data for the assessment of cumulative impacts of oil and gas activities. Monitoring efforts for the Northstar and Liberty Projects (such as the 14-year aerial Monitoring of the Distribution of Arctic Whales Project) will provide long-term information on areawide and cumulative effects of oil and gas activities on the fall migration of the bowhead whale and will help in the development of mitigation measures to protect this pivotal Inupiat subsistence resource. A top priority, 5-year, $3.7 million ANIMIDA study was established in response to Inupiat requests to gather long-term monitoring data that will provide a basis for evaluating potential effects from upcoming development and production activities in the Beaufort Sea. A portion of this study will assess the historic and ongoing subsistence use of the area surrounding Cross Island by working with local whale hunters. The ongoing *Sociocultural Consequences of Alaska OCS Activities: Data Analysis/Integration* study is a cooperative agreement with ADF&G, Subsistence Division to analyze and integrate subsistence, socioeconomic, and socio-cultural time-series data from previous MMS-sponsored projects in order to assess the occurrence and implications of socio-cultural change from OCS activities.

The Exxon Valdez Oil Spill, Cleanup, and Litigation: A Community-Based Collection of Social-Impacts Information and Analysis, 1989-2001 produced an analytical tool (from a synthesis of the Exxon Valdez literature) that assists Department of the Interior (DOI) analysts in NEPA-document preparation; designing mitigation measures; facilitating the review of oil-spill-contingency plans; and paves the way for a dialogue with coastal communities regarding the DOI's offshore programs. The Quantitative Description of Potential Effects of OCS Activities on Bowhead Whale Hunting Subsistence Activities in the Beaufort Sea study was developed in response to concerns raised by the AEWC and the NSB. This study involves a systematic analysis of residents' observations and perceptions about how their lives—and especially subsistence whale hunting activities—have been (and might be in the future) affected by oil industry activities and other forces of modernity. An MMS study titled Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow: Past and Present Comparison will map geographic patterns of subsistence use near important North Slope communities. MMS will use this comparative time series information to assess cumulative socio-cultural effects in the Beaufort Sea region.

The ongoing Alaska Marine Mammal Tissue Archival Project (AMMTAP) field sampling and long-term storage of frozen tissues archive has provided a wealth of information on contaminants. Another ongoing study called *The Alaska Marine Mammal Health and Contaminants Database* will make this tissue archival information available to management agencies and subsistence villages that by necessity must make timely decisions about the safety of the environment and their subsistence foods. The *North Slope Borough Economy, 1965 to Present* study will provide a comparative basis for assessing potential economic effects of upcoming offshore oil and gas activity to better understand potential cumulative effects of offshore oil and gas development.

On April 5-6, 2001, MMS held The Bowhead Whale Subsistence Hunt and Outer Continental Shelf Oil and Gas Activities Research Design Workshop in Anchorage. This workshop was requested by NOAA Fisheries and the AEWC to focus scientific research on the cumulative effects of OCS activity

on bowhead whales and their migration, as well as the socio-cultural dimensions of the subsistence whale hunt. Recommendations from the workshop identified: 1) the need for extensive funding to effectively study the complex relationship between OCS and onshore socioeconomic effects; 2) that effective monitoring is necessary to document and analyze industry and whaling activities and the many factors of change in local communities; 3) that defining and disaggregating (on- and offshore) cumulative social effects will be a difficult process; and 4) that defining the relative causal effect of any given factor—such as OCS oil and gas activity—on social issues is problematic. Participants agreed that available resources would better be applied to researching means of prevention, intervention, and treatment of social problems in North Slope Native communities.

While these research and monitoring efforts in themselves will not resolve the larger problems of ongoing cultural challenge to Inupiat traditions from increasing development in the region—and from such powerful influences of modernity as cable television, the Internet, and an increasing dependence on a wage-based economy—they will provide processes for information sharing and opportunities for mutual decision-making and remediation of cumulative social and subsistence impacts.

Conclusion
Alaska Inupiat Natives, a recognized minority, are the predominant residents of the North Slope Borough, the area potentially most affected by ASDP development and other past, present, and reasonably foreseeable projects on the North Slope. Environmental Justice effects on Inupiat Natives could occur because of their reliance on subsistence foods, and cumulative effects may affect subsistence resources and harvest practices.

Potential effects would focus on the Inupiat communities of Nuiqsut**,** Barrow, Atqasuk, and Anaktuvuk Pass. Development as contemplated in the cumulative case could cause long-term displacement and/or functional loss of habitat to CAH, TLH, and WAH caribou over the life of CPAI's proposed development. This could result in a significant impact on access to, and perhaps the availability of, this important subsistence resource**.** Such impacts would be considered disproportionately high adverse effects on Alaskan Natives. Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources could change if oil development were to reduce the availability of resources or alter their distribution patterns.

In the unlikely event that a large spill were to occur and if it contaminated essential whaling areas, major effects could result from the combined factors of shoreline contamination, tainting concerns, cleanup disturbance, and disruption of subsistence practices. Such impacts would be considered disproportionately high adverse effects on Alaskan Natives. Oil-spill contamination of subsistence foods is the main concern regarding potential effects on Native health.

Any potential effects on subsistence resources and subsistence harvests would be expected to be mitigated substantially, though not eliminated.

4F.7.5 Cultural Resources

4F.7.5.1 Evaluation

Past, present, and future oil and gas exploration and development on the North Slope are the primary activities contributing to impacts on cultural resources because of their geographic extent. However, other activities that may contribute to cultural resource impacts, and which may in some cases have greater site-specific impact, include permitted activities such as non-oil and gas-related overland moves, scientific data gathering, recreational use by the public, and activities ancillary to the BLM's land management mission.

Cultural resources are not ubiquitous across the North Slope. Because of the circumstances associated with their creation, the presence and location of cultural deposits—the physical remains of past human activity—are predictable only to a limited degree. As a result, most of the locales where cultural re-

sources exist remain unknown. To the extent that oil and gas exploration and production and related ground disturbance increases on the North Slope, the chance that cultural resources would be affected would also be increased.

Cultural resources, because of their surface or near-surface stratigraphic contexts, are vulnerable to activities that disturb the surface or subsurface. These resources would more likely be affected by exploration than development activity because exploration activities, such as seismic surveys, ice road and pad construction, and overland travel, affect a greater surface area than does the actual construction associated with development. Although snow cover and frozen ground may offer some protection to cultural deposits, it disguises the surface, making cultural manifestations difficult to recognize and avoid. Winter operations in low light when most exploration activities occur also makes recognition and avoidance of potential cultural resource sites difficult. Thus, surveys of proposed activity areas and overland travel routes are advisable during the snow-free months preceding the initiation of winter exploration activities.

The potential cumulative effects of the three most likely sources of impacts to cultural resources are:

Effects of Gravel Extraction – A source of significant potential impact to cultural resources could be the excavation of gravel for well pads, roads, and airstrips associated with development. Most prehistoric and historic sites are on well-drained ground. On the North Slope, well-drained ground generally contains gravel deposits and is of limited extent. As a result, a gravel deposit that has some degree of surface exposure would likely be associated with cultural resource site(s). Therefore, to the extent that existing gravel deposits are extended or new gravel deposits on well-drained ground are developed, there is a high likelihood that cultural resources may be affected and such impacts could destroy or significantly degrade an individual resource. While development of oil and gas facilities on the North Slope is expected to generate the requirement for additional gravel resources (see Table 4F5.1-1), only one new gravel extraction site is expected to be developed as part of CPAI's current proposal. Instead, additional gravel resources are expected to be extracted from existing sites. To the extent that existing sites are used, the potential for impacts to cultural resources is reduced.

Effects of Natural Events – Most cultural deposits in the NPR-A are revealed as the result of natural weathering processes. For example, locales having only a thin layer (or no layer) of organic soil which results in sparse vegetation are susceptible to wind erosion. As a result of wind erosion, artifacts may be revealed. In most cases, this type of impact is viewed as positive rather than negative, as it reveals the presence of cultural sites with little or no adverse effect to the resource. The action of flowing water, seasonal freezing and thawing (cryoturbation), thermokarsting, and solifluction are other natural processes that can reveal cultural deposits. However, these processes may cause adverse impacts to the resources.

Effects of a Large Oil Spill – The effects of a large terrestrial oil spill on a cultural deposit would be directly related to the time of year and the context of the resource. If the spill were to occur during the non-snow/unfrozen surface months, then the potential level of impact would be significantly higher. In an unfrozen context, surface or near-surface cultural resources could be easily impacted, primarily by being contaminated so that radiocarbon and other elemental assays would be valueless. In this case, it is assumed that the majority of the impacts would occur as the result of the cleanup rather than the actual spill. During the frozen months, both a spill and the resulting cleanup would be considerably less impacting.

4F.7.5.2 Conclusion

The cumulative effects of the Alternative A – CPAI Development Plan and other reasonably foreseeable future development which include disturbance impacts from oil and gas exploration and the NPR-A/Nuiqsut road would be expected to impact cultural resources to some degree; these impacts would be additive. Because of the nature of cultural deposits (that is, their generally unpredictable location and context—on surface or near surface), the magnitude of the impact is difficult to estimate. How-

ever, it is expected that if current procedures for survey and inventory before exploration and development activities were to be continued, the impact to the resource would be minimal**.**

4F.7.6 Land Uses and Coastal Zone Management

4F.7.6.1 Evaluation

Land Use

As stated in Section 3A.4.6, the land use for the Plan Area and for the areas considered for future development are regulated both under the Alaska Coastal Management Program (ACMP) and the NSB Coastal Management Program (CMP). Application of these regulations is expected to reduce impacts associated with individual projects that might otherwise combine to create cumulative effects.

While few cumulative impacts are anticipated to occur, one cumulative impact that will not be avoided is the geographic expansion of oil and/or gas development into an area zoned for conservation. Under these plans, a portion of the existing area considered for the CPAI proposed plan and for the foreseeable future development is zoned as conservation and would require rezoning under development. In addition, development of CPAI's proposal , the FFD, or both would include construction of a production facility, road, and pipeline within the Fish Creek and Judy Creek buffer zones, the raptor buffer area around the Colville River Delta, areas identified for special caribou stipulations or restricted from surface developments near the Kogru River, and in the area near the Kogru River designated for no surface activities. These geographical extensions of industrial land use represent a cumulative and large scale change to the land use of this area.

Reasonably foreseeable development includes further industrial expansion into undeveloped areas requiring additional rezoning and development. The proposed Nuiqsut- to-Dalton Highway road increases the footprint of affected area by 611 acres. These geographical extensions of industrial land use represent an additive and cumulative large-scale change to the land use of the North Slope area.

Coastal Zone Management

Cumulative effects on Alaska's North Slope stem from activities occurring under the alternatives in this EIS; federal and state offshore oil development; state onshore oil development; and oil and gas transportation. The associated activities coupled with additional exploration, facility construction, operation and maintenance, and oil spills are the most important elements for the cumulative analysis because of their disturbance and habitat and subsistence impacts.

Although additive impacts could cause the overall level of effect to increase, the ACMP Statewide standards and NSB enforceable policies that are relevant to the analysis of impacts for this EIS remain relevant and would not be expected to conflict with the statewide standards or the district policies for the cumulative case. A portion of the activities associated with the proposed plan would occur on federal land within NPR-A**.** Other proposed actions, as well as most activities considered for cumulative analysis would occur on non-federal land and will not have been previously permitted. Although outside of currently permitted boundaries, this future development would occur within the NSB (including the coastal zone) and would require permitting and approval from the NSB for the activities to proceed. Additional activities in undisturbed areas would also require permitting and compliance under the ACMP. All activities would not be approved by the state or borough until it is certain they do not conflict with the enforceable policies of the coastal management programs.

Energy Facilities (6 AAC 80.78) and Transportation and Utilities (6 AAC 80.080)

Cumulative impacts from CPAI's proposal and from future development are additive and would contribute to the existing footprints from these activities. Placement, however, would occur within the boundaries of the NSB, and the ACMP thus would require NSB and state permitting and approval. Applicable standards would be addressed through an approval process and permitting would be dependent upon adherence to these policies. Stipulations and conditions placed on development would decrease overall cumulative impacts. Cumulative impacts on the North Slope from both CPAI's pro-

posal and from foreseeable future development are not anticipated to increase the potential for conflict with these statewide standards.

Habitats (6 AAC 80.130) and Subsistence (6 AAC 80.120)

Continued development of the North Slope also brings cumulative impacts to habitats and subsistence. Placement of additional roads, bridges, pipeline, and supporting facilities will affect previously undisturbed areas thus adversely affecting natural habitat. In particular, those alternatives, with the exception of Alternative B, proposing development within specific habitats identified for protection in the Northeast NPR-A IAP/EIS, have potential to disrupt species in the area. Stipulations are in place to minimize the cumulative impacts, and analyses indicate that the potential additive effects would not significantly alter or interfere with the habitats, species, and activities that these standards address.

In addition to cumulative impacts on habitats of the North Slope, future development will likely affect those areas used for subsistence. Cumulative impacts to subsistence will occur on two levels: access and disturbance. Development could change access through availability and through altering existing habitat patterns. Sources of disturbance likely to affect subsistence resources and access include noise and traffic disturbance, disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, and supply efforts. These sources create additive impacts on subsistence; however, areas of impact are likely to be isolated to those immediately surrounding development. The other impacting factors either would not be expected to have more than local, short-term impacts or could be effectively addressed through existing and proposed suite of stipulations and other protective measures required by the NSB, land management agencies, and regulatory agencies. Activities addressed for cumulative effects would not be likely to result in conflict with this statewide standard or with the district enforceable policies.

4F.7.6.2 Conclusion

While additive cumulative impacts within the North Slope would include those from energy facilities, transportation, and utilities, those impacts on habitats and to subsistence hunting resources are most likely to conflict with applicable ACMP standards and the NSB policies. The continued development of previously undisturbed areas on the North Slope causes an increase in noise and disturbance. However, most of the cumulative impacts from future development are likely to be localized, with few long-term or permanent impacts on these resources. Access restrictions and potential carryover effects of development on subsistence and habitats would be decreased effectively through stipulations, existing regulations and management practices, coordination, and through future permitting processes including federal, state, and local processes and regulations. The potential for conflicts arising from the cumulative impacts of foreseeable North Slope development would be the same, with the addition of an increase in disturbed area with development progression, as those discussed for Alternative A – CPAI Development Plan and FFD.

4F.7.7 Recreation Resources

4F.7.7.1 Evaluation

In addition to the impacts described under Alternative A – CPAI Development Plan, the construction of reasonably foreseeable developments**,** including the State's proposed road to Nuiqsut, would result in cumulative impacts to solitude, quietude, naturalness, primitive/unconfined recreation, and wilderness-type values. Short-term or transient loss of the area's naturalness and solitude from such impacts as green pads/trails and noise from aircraft and equipment would not accumulate as would impacts from permanent facilities. In that respect, their contribution to the cumulative impacts would be "momentary."

Under Alternative A, long-term impacts would be expected to affect an area of approximately 270 acres; for Alternative A FFD, disturbed area would be on the order of 1,339 acres. Considering past, present, and future development across the North Slope, total cumulative impacts could affect an area of approximately 20,510 acres (Table 4F.5.1-1). Even so, a large area of the Arctic Coastal Plain

would remain relatively untouched. However, the types of development anticipated would not be uniformly distributed across the Plan Area or the North Slope, nor would recreational and wilderness-type values be perceived to be uniformly dispersed. Cumulative impacts along popular rivers such as the Colville will be seen as far more significant than impacts elsewhere. Under the cumulative case, the Colville River Delta and its Nigliq Channel could see a pipeline and one or more road crossings, which would change its natural appearance along that stretch of the river.

4F.7.7.2 Conclusion

Short-term impacts, such as green trails and disturbance from noise and other activities, would not accumulate. Impacts from long-term or permanent facilities such as roads, pipelines, and gravel pads would accumulate and would result in the long-term loss of solitude, quietude, naturalness, or primitive/unconfined recreation, and wilderness-type values. These impacts could be locally adverse.

4F.7.8 Visual Resources

4F.7.8.1 Evaluation

Overland moves and scientific studies (with associated camps and excavation), whether or not associated with oil and gas development activities, can impact visual resources. Overland moves, which can create green trails**,** and temporary camps would increase with the need to support oil and gas development. For example, field activities associated with archaeological site clearances (such as camps, excavations, and aircraft activity) all likely would increase.

Although the amount of supplies and materials transported by winter overland moves could increase cumulatively, these moves generally follow the same routes. New trails could be developed to reach new staging areas and pump stations; however, once the route was identified, numerous trips over the route could occur without additional impacts. The natural recovery time for this type of impact would be less than the 15 to 20 years being used for the cumulative case analysis.

Seismic-survey work would continue increasing the number of operations. Green trails resulting from all future development could result in hundreds of miles of intermittent green trails visible from the air during any one-summer season. The natural recovery time for this type of impact would be less than the 15 to 20 years being used for the cumulative case analysis. As production of fields increased, seismic work would tend to decrease and green trails would decline in number and recover naturally.

Past development and production of oil and gas has, at one time or another, impacted the visual resources of approximately 10 percent of the North Slope area. Present development and production could affect less than 1 percent of the North Slope, while reasonably foreseeable future development could affect around 1 percent of the total North Slope area. However, remediation of old drill sites is ongoing, and many of the impacts have a natural recovery rate of less than the 15 to 20 years being used for this analysis. Ring effect from old well sites would also naturally recover in less than the 15 to 20 years being considered under this analysis. Exploration wells would leave behind a marker pipe expected to be no larger than a square foot on the surface and 6 feet tall. This would be essentially a permanent impact, though almost unnoticeable from several hundred feet away.

4F.7.8.2 Conclusion

Short-term impacts such as green trails would not accumulate**,** and would naturally recover. Impacts from long-term or permanent facilities such as roads, pipelines, gravel pads, and pits would accumulate and would result in the long-term loss of scenic quality.

Long-term impacts from future development with a possible life span of over 30 years would affect the visual resources for the North Slope**.** These impacts would be expected to be greatest within a half-mile radius of each developed site. Pipelines could be elevated above ground level. Except during construction and repair of pipelines, there would be no associated on-the-ground activity. Therefore,

long-term impacts to visual resources from pipelines would be expected to be minimal beyond approximately a half-mile.

4F.7.9 Transportation

Evaluation

All of the impacting activities associated with oil and gas development require the transport of personnel and materials to future development sites and would cumulatively affect North Slope transportation resources. More recent oil field developments, such as Alpine, are located farther from the central Prudhoe Bay facilities and are not connected by road to these facilities. This results in an increased reliance on air transportation during summer months supplemented with extensive use of low-pressure ground vehicles or ice roads for ground access to the remote sites during winter months. Continued oil and gas development on the North Slope will require construction of additional transportation facilities, particularly roads and airstrips to support both construction and operation activities. New developments are more likely to have roads connecting clusters of remote oil production facilities to central processing facilities, but to not have year round road access to the Prudhoe Bay area. Thus, future development is likely to result in comparatively higher levels of air traffic on the North Slope than existing facilities.

The transportation effects of the foreseeable future projects, when combined with the Alternative A – CPAI Development Plan, include continued development of oil and gas industry roads and airstrips to serve clusters of oil production facilities located across the North Slope and resultant increased road and air traffic throughout the region. Road and air transportation demands are likely to peak during construction of each new field and to decrease as construction ends and the fields become operational. In the cumulative case, however, there may be times when construction and other North Slope prospects may overlap, resulting in higher air and road traffic levels, particularly on the main oil industry transportation infrastructure in the Prudhoe Bay area. In addition, although road and air traffic for any one site is likely to drop after completion of construction, new facilities will continue to be constructed and existing facilities will continue to operate, which could result in cumulative long-term increases in road and air traffic to the North Slope and throughout the North Slope.

Future developments are likely to have local road networks, but not to be connected to Prudhoe Bay facilities by a year-round roadway. Transport of most materials to proposed future sites would occur via the Dalton Highway to the Prudhoe Bay area. Transport of materials from Prudhoe Bay to remote development areas will peak during winter periods, when overland access to these facilities is possible, by ice road or low-pressure ground vehicle. This could result in more substantial road traffic peaks on existing oil industry roadways during winter periods, as well as concentrated ground traffic peaks to remote areas during short winter access seasons.

The proposed future road from the Dalton Highway to Nuiqsut would provide a second major overland route for the oil industry to transport personnel and materials to development occurring south and west of Prudhoe Bay**,** including into the ASDP area. This would result in significantly lower road traffic levels on the existing infrastructure from Deadhorse to Kuparuk than would occur without the new Nuiqsut road. Again, the increased overland traffic activity and increased access to currently remote areas on the North Slope could result in adverse indirect effects on wildlife, subsistence and recreation resources.

4F.7.9.2 Conclusion

Development of Alternative A – CPAI Development Plan along with continued oil and gas development throughout the North Slope will result in substantial increases in both road and air traffic levels throughout the North Slope, and particularly on the central oil and gas transportation infrastructure in the Prudhoe Bay area. However, most of the transportation infrastructure on the North Slope is restricted to industry and local resident use, and is currently operated at well below capacity. Despite the substantial increase in activity levels, the existing infrastructure, combined with the proposed roads

and airstrips serving remote facilities, is expected to be sufficient to accommodate these increased demands for air and overland transportation. Therefore, there are not anticipated to be any adverse cumulative effects on transportation resources on the North Slope.

4F.8 Social Systems Cumulative Effects for Alternatives B, C, and D – CPAI Development Plan and for FFD Alternatives B, C, and D

Because CPAI's proposed development is a relatively small part of all past, present, and potential future development on the North Slope, the cumulative impacts of development of CPAI's proposal under Alternatives B, C, and D are similar to those outlined in the preceding sections for Alternative A. However, there would be subtle differences in the cumulative impacts among the alternatives. Reduction in the gravel footprint and requisite extraction of gravel under Alternatives B and D would reduce the risk of impacts to cultural resources and subsistence, while the relocation of CD-6 in Alternative B would result in a small decrease in overall North Slope oil contributions to the local and state economies. The construction of a road now under consideration by the State from the Dalton Highway to Nuiqsut, could have significantly different impacts on the social systems of Nuiqsut under Alternative C than under the other alternatives. Under that alternative there would be a continuous road network to CPAI's development, which would likely result in added traffic through the community and possible changes due to increased access to the community by outsiders, more jobs available to local residents, and more disruption of subsistence resources near the community and along the road network..

4F.9 Cumulative Social Systems Impacts of the No-Action Alternative E

Under Alternative E, no action is proposed. No overall cumulative effects to the social systems environment result from CPAI's proposed Alternative E. However, cumulative impacts on the North Slope are anticipated to occur from other foreseeable future development. While impacts from the foreseeable future development could be additive, overall effects on the social systems resources would be negligible.