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Alpine Development Project: Environmental Evaluation Document

Prepared for:
U.S. Army Corps of Engineers

Submitted by:
ARCO Alaska, Inc., Operator

Anadarko Petroleum Corporation, Co-Owner

Union Texas Petroleum Alaska Corporation, Co-Owner

September 1997
Revised

ALPINE DEVELOPMENT PROJECT
ENVIRONMENTAL EVALUATION DOCUMENT

Prepared for

U.S. ARMY CORPS OF ENGINEERS
Alaska District
P.O. Box 898
Anchorage, Alaska 99506

by

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and
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September 1997

COVER SHEET/FACT SHEET

Project Name

Alpine Development Project

Proposed Action and Alternatives

The purpose of the project is to commence safe, cost effective and environmentally responsible long term oil and gas production and transportation of sales quality oil from the Alpine Development.

The alternatives considered include:

- *Proposed Action* - The project consists of two main components (1) an in-field drilling/camp/production facility and (2) a transportation pipeline. The 97-acre in-field facility would include two gravel pads connected by a 3-mile gravel road with a 440-ft bridge and 5,900 ft gravel airstrip parallel and adjacent to the road. Alpine Pad 1 would provide the base for the production and camp facilities and operate as a drill site. Alpine Pad 2 would be a satellite drill site. In-field oil gathering lines, gas injection and waterflood pipelines would run parallel to the in-field road between the two pads. A 34-mile raised transportation pipeline would be located between Alpine Pad 1 and the Kuparuk Central Processing Facility and would carry sales quality oil to the Trans Alaskan Pipeline System.

- *ARCO Alternatives* - ARCO developed three additional alternatives based on the pipeline route. One alternative would modify the route so that the pipeline crossed the Colville River at a location downriver from the proposed action. A second alternative would construct a permanent gravel road roughly parallel to but south of the pipeline that connects Kuparuk River Unit with the in-field facility. The final alternative would be to construct a permanent gravel road and bury the pipeline in the road. All three of these alternatives utilize the proposed in-field configuration.

- *Native Alternatives* - These alternatives include the Arctic Slope Regional Corporation (ASRC), ASRC/Kuukpik, and Kuukpik (Western Initiative) alternatives. The ASRC alternative would route the pipeline farther south so it would run near Nuiqsut then north to the proposed in-field location. This alternative would also move the camp facility to Nuiqsut. The ASRC/Kuukpik alternative would move the pipeline route further south away from the delta to Nuiqsut and then follow the ASRC route. This alternative would include a permanent gravel road and use the proposed action's in-field facilities. The Kuukpik alternative would be the same as the ASRC/Kuukpik alternative except that the processing facility would be located outside of the delta to the west of the proposed location. All three Native alternatives would utilize the airstrip in Nuiqsut and include a gravel road between Nuiqsut and the in-field facilities.

Project Location

The project would be located in the Colville River delta approximately 35 miles west of the Kuparuk River Unit Central Processing Facility and 8 miles north of Nuiqsut. The in-field area would be bounded by the Nechelik (Nigliq) Channel of the Colville River to the west and the Sakoonang Channel of the Colville River to the east.

Proponent	ARCO Alaska, Inc. and co-owners Anadarko Petroleum Corporation and Union Texas Petroleum Alaska Corporation
Lead Agency	U.S. Army Corps of Engineers
Cooperating Agencies	U.S. Fish and Wildlife Service (USFWS) U.S. Environmental Protection Agency (EPA) U.S. Department of Transportation (USDOT) National Marine Fisheries Service (NMFS) Bureau of Land Management (BLM) Bureau of Indian Affairs (BIA) Alaska Department of Environmental Conservation (ADEC) Alaska Department of Natural Resources (ADNR) - Division of Oil and Gas (DO&G) - Division of Lands (DOL) - State/Federal (Joint) Pipeline Coordinator's Office (JPO) Alaska Department of Fish and Game (ADFG) Alaska Office of Management and Budget - Division of Governmental Coordination (DGC) - State/Federal (Joint) Pipeline Coordinator's Office (JPO)
Responsible Official	Lloyd Fanter U.S. Army Corps of Engineers Alaska District - Regulatory Office P.O. Box 898 Anchorage, Alaska 99506
Contact for Further Information	Mark Schindler Director, Northern Region Exploration Permits and Compliance ARCO Alaska, Inc. P.O. Box 100360 Anchorage, Alaska 99510
Licenses, Permits, and Other Required Approvals	U.S. Army Corps of Engineers Section 404 Clean Water Act Section 10 Rivers and Harbors U.S. Environmental Protection Agency Class I Injection Well, Department of Environmental Conservation Wastewater Disposal Permit U.S. Fish & Wildlife Service Marine Mammal Protection Act – Letters of Authorization/Permit Alaska Division of Governmental Coordination Coastal Zone Management Coastal Zone Consistency Determination Alaska Department of Natural Resources Lease Operations Approval LO/NS 97-07 Land Use Permit (for Colville River Boring) Water Use Permit Renewal and Amendment of LAS 18597 Land Use Permit LAS 21122 (Ice Roads and Pads)

Right-of -Way Lease for Pipeline ADL 415701
Right-of -Way Lease for Water/Gas Line and Fiber Optics Cable ADL 415857
Right-of -Way for Diesel Pipeline ADL 415932

State/Federal Joint Pipeline Office
Pipeline Right-of-Way

Alaska Department of Environmental Conservation
401 Water Quality Certification
Air Quality Control Permit to Operate (Prevention of Significant Determination/Prevention of Significant Determination Avoidance)
Notification of Temporary Storage of Drilling Wastes
Solid Waste Processing Facility Permit
Drilling Waste Disposal Permit
Air Quality Construction Permit
Oil Spill Contingency Plan

Alaska Department of Fish and Game
Title 16 Fish Habitat Permit(s)

Alaska Oil and Gas Conservation Commission
Permit to Drill
Annular Injection
Class II Disposal Well(s)

Alaska State Historical Preservation Office
Cultural and Archeological Clearance

North Slope Borough
Rezoning Approval
Coastal Zone Consistency Determination

City Council of Nuiqsut
Communicate Community Interests and Concerns

Native Village of Nuiqsut
Communicate Tribal Interests and Concerns

Kuukpik Corporation
Communicate Surface Owner Interests and Concerns

Arctic Slope Regional Corporation
Communicate Mineral Interest Owner Interests and Concerns

Arctic Slope Native Association
Communicate Native Allotment Owners Interests and Concerns

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Date of Issue

October 7, 1996
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TABLE OF CONTENTS[1]

Page

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[1] **The Table of Contents has been expanded beyond that in the original EED. New headings or changes to the headings in the text of the original EED are shown in bold.**

LIST OF APPENDICES

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF TABLES

LIST OF ACRONYMS

ACS	**Alaska Clean Seas**
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
ADGC	Alaska Division of Governmental Coordination
ADNR	Alaska Department of Natural Resources
ADP	**Alpine Development Project**
AEWC	Alaska Eskimo Whaling Commission
amsl	above mean sea level
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
ANWR	Arctic National Wildlife Refuge
ARCO	ARCO Alaska, Inc.
ASNA	Arctic Slope Native Association
ASRC	Arctic Slope Regional Corporation
BACT	best available control technology
Bbbl	billion barrels of oil
bbl	barrel(s)
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BMP	best management practices
BPXA	BP Exploration
CAA	Clean Air Act
CAH	Central Arctic Herd (caribou)
CEQ	Council on Environmental Quality
cfs	cubic feet per second
CIP	Capital Improvements Program
CO	carbon monoxide
CPF	central production facility
CPF-1	Central Production Facility-1
CPF-2	Central Production Facility-2 in KRU
CPF-3	**Central Production Facility-3 in KRU**
CWA	Clean Water Act
CZMP	Coastal Zone Management Plan
DEC	Department of Environmental Conservation
DEW	distant early warning
DNR	Department of Natural Resources
DS-1F	Drill Site-1F
EA	Environmental Assessment
EED	Environmental Evaluation Document
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EQ	Environmental Quality
ESA	Endangered Species Act
FBE	Fusion-bonded epoxy
FLIR	**forward-looking infrared**
FONSI	finding of no significant impact
fps	feet per second
ft	feet/foot
GC-1	Gather Center 1
GHX-1	**Gas Handling Expansion Program**
GIS	geographic information system
HDD	horizontal directional drilling

HDPE	**high-density polyethylene**
ICAS	Inupiat Community of the Arctic Slope
ISER	Institute of Social Economic Research
ITU	Integrated Terrain Unit
JPO	Federal/State Joint Pipeline Office
KSI	**Kilos per square inch**
KRU	Kuparuk River Unit
LOA	Letters of Authorization
MBOPD	thousand barrels of oil per day
ml	milliliter
mm	millimeter
MMbbl	million barrels
MMPA	Marine Mammals Protection Act of 1992
NAAQS	National Ambient Air Quality Standards
NDE	**Non-Destructively Examined**
NEPA	National Environmental Policy Act
NGL	natural gas liquid
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NO_x	Nitrogen oxides
NPR-A	National Petroleum Reserve-Alaska
NSB	North Slope Borough
NSPS	New Source Performance Standards
NTU	nephelometric turbidity unit
ODPCP	Oil Discharge Prevention and Contingency Plan
OSCP	Oil Spill Contingency Plan
OSRT	Oil Spill Response Team
PAH	polycyclic aromatic hydrocarbons
PBU	Prudhoe Bay Unit
PM-10	Particulate matter $\leq$ 10 micrometers in diameter
PPA	**Pressure Point Analysis**
ppb	part per billion
ppm	part per million
ppt	part per trillion
PSD	Prevention of Significant Deterioration
ROW	right-of-way
SCADA	**Supervisory Control and Data Acquisition System**
SCCP	Spill Control and Countermeasure Plan
SO_2	Sulfur dioxide
SPCO	**Spill Prevention and Containment Operations**
STP	Seawater Treatment Plant
TAPS	Trans-Alaska Pipeline System
TLH	Teshekpuk Lake Herd (caribou)
TLUI	traditional land use inventory
TSP	total suspended particulates
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USDOT	U.S. Department of Transportation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UTP	Union Texas Petroleum
VOC	Volatile Organic Compounds
VSM	vertical support member

Summary

SUMMARY

ARCO Alaska, Inc. (the applicant) has prepared this Environmental Evaluation Document (EED)[1] to assist the U.S. Army Corps of Engineers' (USACE) permit review and environmental compliance process for ARCO's proposed oil and gas production facility and associated pipeline located in the Colville River Delta on Alaska's North Slope **(Alpine Development Project [ADP])** (Figure S-1). ARCO and its partners, Anadarko Petroleum Corporation (Anadarko) and Union Texas Petroleum Alaska Corporation (UTP), have applied for two USACE permits, which **action** triggers environmental review under the National Environmental Policy Act (NEPA). The USACE must determine whether the proposed action would have a significant or insignificant effect on the natural and human environment. ARCO's goal is to have the USACE adopt, or adopt with modifications, ARCO's EED as the NEPA document for the Alpine Development Project.

ARCO has been planning the **ADP** for **six** years and has conducted environmental and technical field studies, held public meetings, and consulted with agencies. **These efforts have** allowed ARCO to **identify** the project**'s potential** environmental impacts and **to** develop design features **and other mitigation measures** that address concerns and potential impacts. Mitigation measures have been proposed. This EED describes the project, project alternatives, issues and concerns raised by the public and agencies, and results of baseline and technical studies. It also presents a description and analysis of alternative proposals and their expected impacts. **A discussion of the cumulative impacts associated with the ADP is presented.**

This EED has been revised since it was originally submitted to the USACE on October 8, 1996. The revisions reflect modifications in the proposed project design and mitigative measures, evaluation of additional design alternatives, data collected during the 1996 field season, comments received/responses provided subsequent to the original EED submittal, and an extended Public Notice of the ADP by the USACE. Virtually all of the modifications in the project design are intended to further avoid or reduce the impact of the proposed action on the environment, or they were made in response to comments by interested parties and agencies, USACE coordination and consultation, or as a result of additional engineering.

Primary modifications to the original EED, (October 8, 1996), which are in Chapter 2 of the EED include: (1) reducing the overall gravel pad footprint size (scope) by approximately 15%; (2) changing the orientation of Alpine Pad 2 to a north-south direction, in part to reduce its hydrological impact; (3) shifting Alpine Pad 1 away from the Sakoonang Channel; (4) adding a bridge and additional culverts into the gravel road in the swale immediately west of the airstrip; (5) adding culverts and increasing culvert diameters in the gravel road; (6) adding culvert armoring; (7) shifting the road northward in the swale to minimize impacts in this drainage and shifting a section of the gravel road northward to maintain cross drainage; (8) enclosing the sales oil, diesel fuel, and utilities pipelines within high-strength pipe casings at the Colville River crossing to essentially eliminate the potential for leaks into the river; (9) increasing the size of the horizontal directional drilling (HDD) to aboveground transition cellars and insulated pads; (10) replacing isolation valves with vertical expansion loops at the river crossings to reduce oil spill risks; (11) selecting the Arctic Slope Regional Corporation (ASRC) mine site as the gravel source for the project; and (12) expanding the Nuiqsut mitigation package. The EED describes in detail the currently proposed project with these modifications and other less substantial design changes, which are summarized below.

PURPOSE AND NEED FOR THE PROPOSED ACTION

The applicant's purpose is to begin safe, cost-effective and environmentally responsible long-term oil and gas production and transportation of sales quality oil from the **ADP** site. The project is needed to increase the domestic supply of oil and gas in the United States and to supplement declining oil production on the North Slope. Development of the **ADP** would economically benefit ARCO, Anadarko, UTP, the State of Alaska, the ASRC, the Kuukpik Corporation, local government (the North Slope Borough [NSB] and the City of Nuiqsut), and local residents.

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[1] Note that letters in bold type signify changes made to the original EED. An index to the EED is in Chapter 7, which was not in the original EED; this chapter is not bolded. In addition, the Table of Contents has been expanded beyond that given in the original EED.

PROPOSED ACTION AND COMPARISON OF THE MAJOR ALTERNATIVES

The ADP consists of seven main elements: field development, pipeline route, Colville River crossing method, site access, material site, freshwater source, and reservoir waterflood source to be located on the Colville River Delta (see Figure S-1). Alternatives to the proposed action were developed by ARCO and the two Native corporations (ASRC and Kuukpik) affected by the project. ARCO developed three main alternatives and each corporation submitted its own proposal, as well as a joint proposal. The Native proposals have been termed the ASRC, ASRC/Kuukpik and Kuukpik (Western Initiative) alternatives. The alternatives are discussed in this section, first in general terms and then by each of the project elements listed above. A no action alternative was also evaluated but eliminated because it precluded oil and gas development.

Proposed Action

The in-field facility will consist of two gravel pads connected by a 3-mi gravel road (Figure S-2) and comprise approximately 97 acres of the delta (the delta is approximately 164,479 acres; thus, the in-field facility would occupy 0.05 percent of the delta). The Alpine Pad 1 (facilities/drill site located towards the Sakoonang Channel), will contain a crude oil processing plant, housing for employees and maintenance facilities, as well as drill equipment. The Alpine Pad 2 will be a satellite drill site located toward the Nechelik (Nigliq) Channel. In-field oil gathering lines, gas injection and waterflood pipelines will be located 400 to 1,000 ft south of, but parallel to, the in-field road between Alpine Pad 1 and Alpine Pad 2. A 5,900-ft airstrip will be built as a widened section of the gravel road near the Alpine Pad 1 site.

A 34-mi-long transportation pipeline system will be located between Alpine Pad 1 and the Kuparuk Central Processing Facility 2 (CPF-2) site. The pipeline system will consist of a sales oil pipeline, diesel fuel pipeline, seawater pipeline, and a fiber optic cable supported by a rack elevated above ground level on 18-in-diameter vertical support members (VSMs). The pipelines will be built at minimum heights of at least 5 ft above ground level to the base of the pipes to insure passage of migrating caribou and allow unobstructed snowmachine travel in winter. Vertical expansion loops will be built at the river crossings and other appropriate locations, and they are designed to produce a liquid isolation system. This system will reduce potential spill volumes by more than 50% by eliminating flanged connections and valves from cross-country pipelines, which have traditionally been the sources of most spills. The sales oil pipeline will be approximately 14 inches in diameter and will deliver processed oil into the Trans-Alaska Pipeline System (TAPS). The seawater pipeline will transport treated seawater from the Oliktok Point Seawater Treatment Plant (STP) to the ADP in-field facility for subsurface reservoir waterflood. The seawater pipeline will be approximately 12 inches in diameter. The diesel fuel lines will be approximately 2⅜ inches in diameter and it will transport fuel from KRU to the ADP in-field facility.

The pipeline route will cross the Colville, Kachemach, and Miluveach rivers. The two smaller rivers (Kachemach and Miluveach) will be crossed on VSMs. The VSMs at these locations will be larger than those used for the rest of the route so that the pipelines can span the rivers. The Colville River will be crossed using a HDD method. This method involves drilling under the river and pulling the pipelines through the drilled holes. The HDD entry and exit locations will be set back approximately 300 ft from the river banks. At the proposed crossing point (crossing X14), the underground portion of the pipelines would be approximately 4,300 ft long and 85 ft below the bottom of the river channel.

Other major elements of the ADP include using the ASRC USACE-permitted gravel mine site on the east bank of the Colville River Main Channel, one mile south of the HDD crossing, as the source of gravel for the project. Nuiqsut Constructors, Inc. will mine and transport the gravel to the site over an ice road. Lakes containing adequate water volumes and permitted by Alaska Department of Natural Resources (ADNR) will be used as the fresh water source for building ice roads/bridges and supporting the drilling operations. The project will be constructed during winter and accessed by ice roads and air transportation.

Alternatives to the Proposed Action

ARCO developed three additional alternatives to the proposed action based on the pipeline route between

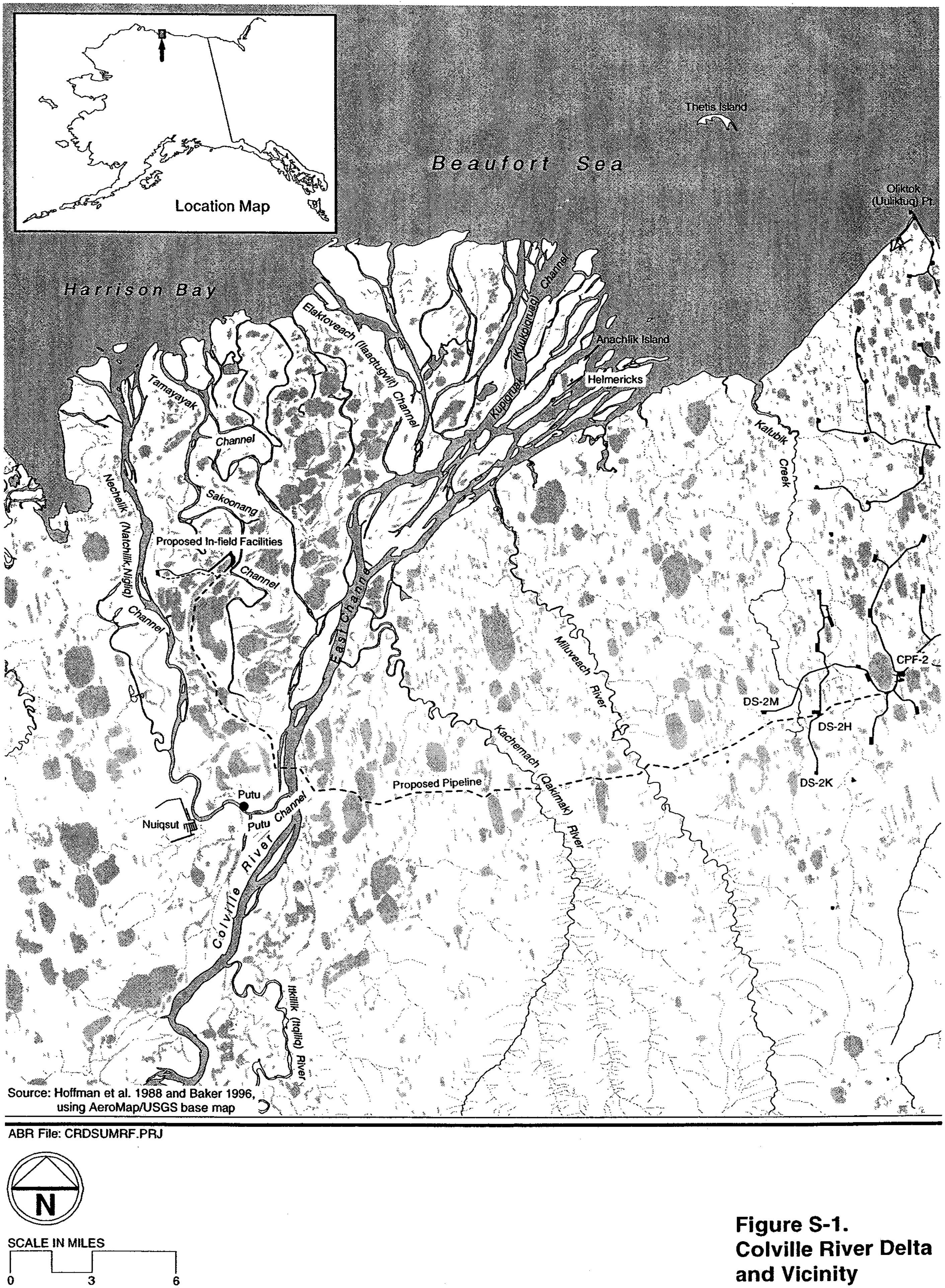

Figure S-1. Colville River Delta and Vicinity

ABR File: PRALTSRF.PRJ

SCALE IN MILES

0 1.5 3

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■— Proposed In-field Facilities

□ Proposed Kuukpik (Western Initiative) Facility

Figure S-2.
Project Alternatives

Kuparuk River Unit (KRU) and the Colville River: (1) cross the Colville River downstream from the preferred location at crossing X10; (2) construct a gravel road and run the pipeline roughly parallel to, but away from, the road on VSMs; and (3) construct a gravel road and bury the pipeline in the road bed. The route for the last two alternatives would be located south of the preferred route (see Figure S-2).

Native Alternatives

Under the ASRC alternative, the in-field facility would be similar to the proposed action, except that the camp would be in Nuiqsut, an 8-mi gravel road would be built from Nuiqsut to the ADP site, a second major river crossing would be required (the Nechelik [Nigliq] Channel), and the Nuiqsut airstrip would be used. In addition, the pipeline route and Colville River crossing would move farther upstream away from the delta and incorporate the HDD crossing method.

Under the ASRC/Kuukpik alternative, the pipeline route would move farther south, a permanent gravel road would be built from Nuiqsut to KRU, and the pipeline would be buried in the gravel road. At the Colville River crossing, a pile-supported bridge would be constructed, and the pipeline would be suspended from the bridge.

The Kuukpik alternative (Western Initiative) would be the same as the ASRC/Kuukpik alternative, except that the processing facilities would be moved west of the Nechelik (Nigliq) Channel. The only facilities in the delta would be the drill pads and connecting gravel road.

Alternatives by Project Component

This section briefly summarizes alternatives by project component.

In-field Facility (gravel pads, roads, airstrip and gathering lines)

Several configurations and locations were evaluated in the delta for the in-field facilities for the seven action alternatives: (1) southern layout, (2) ASRC and ASRC/Kuukpik alternatives, (3) the Kuukpik (Western Initiative) alternative, and (4) three variations to the arrangement of pads and the airstrip for the proposed action. The southern layout would be similar to the proposed action except that the entire in-field facility would be located about 1 mi south of the proposed location. This site was initially thought to be the best location for the in-field facility. However, subsequent delineation indicated that this is not the optimal location to tap the reservoir. The second alternative would be the same as the proposed action except that the camp would be located in Nuiqsut, and the Nuiqsut airstrip would be used for access (an airstrip would not be constructed at the ADP in-field facility). This alternative would also include an 8-mi gravel road connecting the in-field facility with Nuiqsut and a bridge crossing of the Nechelik (Nigliq) Channel. The Western Initiative would be the same as the ASRC and ASRC/Kuukpik alternatives, except that the processing facility would be located on the west side of the Nechelik (Nigliq) Channel and in-field gathering lines from the drill pads would be suspended from a bridge over the channel to the processing facility. Three variations to the proposed project layout, all of which eliminated the in-field road but were deemed not practicable, were also evaluated in the process of selecting the final layout.

Pipeline Route

Four pipeline route alternatives were considered relative to the proposed route: (1) X10 crossing route; (2) X14 crossing route (two variations with a gravel road); (3) ASRC route; and (4) ASRC/Kuukpik and Kuukpik's route (see Figure S-2). The X10 crossing route would move the entire pipeline alignment north (approximately 4.4 mi) of the proposed route (crossing X14), reduce the length of the pipeline by 3 mi, but lengthen the river crossing distance from approximately 4,300 ft to 9,000 ft.

The two ARCO road alternatives (pipeline on VSMs parallel to the road or the pipeline buried in the road) would use the X14 river crossing. However, for approximately 16 mi, the gravel road and pipeline would be located south (up to 1.5 mi) of the preferred pipeline route.

The ASRC route would be south of the ARCO road alternatives. The Colville River crossing for this alternative would be approximately 3 mi south of the preferred crossing point. This route would be located near Nuiqsut and connect to the ADP in-field facility via an 8-mi gravel road.

The ASRC/Kuukpik and Kuukpik route would be located farthest south, and outside of the delta, similar to the ASRC route. This route also runs through Nuiqsut with a road link to the proposed processing pad located out of the delta.

Colville River Crossing Method

There are four river crossing alternatives to the proposed action. These include using conventional trenching (X14 crossing only), a combination of HDD and trenching (X14 crossing only), a cable span bridge (X10 and X14 crossings) and a pile-supported bridge. All river crossing methods would be constructed during winter.

Buried pipelines using conventional trenching would be used at the X14 crossing. This technique would involve excavation and burial of the oil, diesel, and seawater pipelines at a depth approximately 10 ft below the deepest part of the channel (thalweg). The pipeline would be buried under the river channel (and a sandbar) for approximately 4,180 ft.

The combination alternative would use the HDD method at the X14 crossing to traverse under the river channel but conventional trenching to cross under the sand bar area. The HDD portion would be approximately 2,680 ft and the pipeline would be buried at least 10 ft below the deepest part of the channel for 1,380 ft.

The cable span suspension bridge could be used at either the X10 or X14 crossing locations. At the X10 crossing, the cable bridge at the main span would be approximately 2,250 ft and cables would be draped across two 245 ft towers. The remainder of the 3,300-ft crossing would include a series of 200-ft continuous steel girder spans (on the west side of the river). The pipelines would be supported on cross members. A similar-sized structure would be used at the X14 crossing.

A pile-supported bridge would be used at the ASRC/Kuukpik and Kuukpik river crossing. The pipeline would be suspended from the bridge and the bridge would accommodate vehicles.

Access

Access alternatives to the ADP include using the existing airstrip in Nuiqsut, building a permanent gravel road, and using an ice bridge, ferry, or permanent bridge to cross the Colville River. If the airstrip in Nuiqsut is used, there would be no airstrip at the ADP in-field facility. However, an 8-mi gravel road would be needed from Nuiqsut to the ADP, and there would be a second major bridge crossing at the Nechelik [Nigliq] Channel. Under several other alternatives (ARCO, ASRC/Kuukpik, and Kuukpik), a permanent gravel road would provide access from KRU to the ADP in-field facility. Once the gravel road is at the Colville River, several options could be used for crossing, including an ice bridge during winter (restricting vehicle access to winter only), constructing an ice bridge in winter and using a ferry during summer, or building a permanent bridge.

Material Site

The ASRC gravel mine site (operated and permitted by Nuiqsut Constructors) would be used as the source of gravel for all alternative proposals (see Figure S-1).

Freshwater Source

The alternative for freshwater supply would be to obtain water from existing KRU sources. KRU sources would already be filtered and treated for use. The method of water shipment was rejected because of the cost of trucking the water to the ADP area compared to the readily available water supply in the lakes in the delta and transportation corridor.

Waterflood Source

No alternative has been found to using water from the Oliktok Point Seawater Treatment Plant (STP) as the source for the volumes of water required for injection in the ADP reservoir to achieve enhanced oil and gas recovery. Surveys within the delta and the Kuparuk field have not located aquifers adequate to this task. Therefore, all alternative project proposals would use the treated seawater produced at the Oliktok Point STP for ADP enhanced recovery.

AFFECTED ENVIRONMENT, ENVIRONMENTAL CONSEQUENCES AND MITIGATION MEASURES

In summarizing the affected environment and identifying potential environmental consequences of the proposed development, as well as potential mitigation measures, the following resource categories are addressed: physical resources (geomorphology and hydrology), chemical resources (water and air quality), biological resources (fisheries, wildlife and threatened and endangered species), and human use resources (communities of the Colville region, government institutions, economic institutions and Kuukpikmiut subsistence). Basic assumptions for the effects assessment are also described below. Section 2.9 of the EED briefly summarizes impacts and mitigation measures for the proposed project.

Assumptions for Effects Assessment

Several hypothetical oil spill scenarios were developed for consideration in the effects assessment of the EED. The scenarios were chosen to represent a range of severity in impact and include a 'most likely' worst-case, a 'reasonable' worst case and an 'extreme' worst-case. The 'most likely' worst-case scenario is an oil leak caused by corrosion in a 20-inch in-field gathering line during winter. The 'reasonable' worst case scenario is a well blowout during break-up. The 'extreme' worst-case scenario is a rupture of the 14-inch pipeline that transports sales oil to KRU. **Although these scenarios provide a framework for analyzing conceivable effects of the project, there have been no major spills from leaks in sales oil pipelines or uncontrolled releases of oil from wells in the history of North Slope oil and gas operations.**

Physical Resources

Geomorphology and Hydrology

The landforms, waterbodies, and hydrologic regimes of the Colville River delta and adjacent areas have been surveyed and studied frequently over the past fifty years. For the past six years, focused surveying, detailed mapping, and analysis of these features have been conducted in areas proposed for the ADP and its associated pipeline linkage across a transportation corridor to KRU CPF-2. Three potential impacts that could result from construction and operation of the ADP include: alteration of watercourse flow patterns caused by gravel placement for road and in-field facility pads; erosion and sedimentation from alteration of surface water flow; and thermokarst (thaw/freeze subsidence) ground disturbance. Ice-rich soils permeate virtually every area of the proposed development and will be adequately protected against thermal degradation. These impacts will be mitigated by (1) conducting most construction activities on the protective snow and ice cover of the winter season; (2) ensuring adequate culverting for cross-field drainage; (3) **constructing a bridged section across the swale area which intersects the gravel road linking Alpine Pads 1 and 2 to ensure waterflow from the south to the north side of the road, to preserve a fish passage channel, and to maintain the wetland habitat qualities of the downslope side of the road;** (4) avoiding areas where erosion and sedimentation of watercourses might pose problems; and (5) employing techniques that minimize thermokarst (insulation, where appropriate, to preserve permafrost substrates).

Impacts from the three potential oil spill scenarios could be disturbance from thaw and refreezing of the permafrost layer resulting from potential spillage of hot oil and spill cleanup activities. Thermokarst impacts under all scenarios would be minimized by employing best management practices (BMPs).

The alternatives to the proposed ADP would significantly enlarge the area of impact, to the extent that gravel roads are components. For example, approximately 40 mi of gravel road—beyond that proposed for the preferred alternative—would be required for either the ASRC/Kuukpik or Kuukpik (Western Initiative) alternatives. Since most historic problems with drainage impediments and associated thermokarsting occur along gravel roads, the project alternatives substantially increase the potential for widespread thermokarsting impacts.

Chemical Resources

Water Quality

Water quality in the rivers, lakes, and groundwater in and near the ADP area is good. Fish populations, as environmental indicators, flourish under the natural regimes of water temperature, dissolved oxygen, turbidity, salinity, and other natural water quality characteristics (including naturally high levels of heavy metals). Concerns for deterioration of water quality arise from possible releases of oil, fuel, drilling muds, wastewater, or seawater into fresh waterbodies, rivers and streams, and possibly the nearshore marine waters of Harrison Bay. Impacts caused by erosion or sedimentation from drainage alterations and dust fallout from travel on gravel roads, could increase turbidity or suspended solids in waterbodies. Such impacts are likely to be minor relative to the naturally occurring high sediment levels in the Colville River and associated watercourses.

Major mitigative actions proposed to meet these potential impacts include: spill prevention, detection, and control plans and technologies; reinjection of drilling fluids, cuttings, and produced water; backhauling wastes to approved disposal sites; provision of drainage structures to minimize flow alteration; and scheduling construction activities in winter.

Direct impacts of spilled oil on water would include contamination, which might produce lethal and sub-lethal effects on fish and wildlife. Indirect impacts would include tundra damage caused by cleanup activities and associated thermal and hydraulic erosion potentially increasing turbidity and suspended solids in water. **The isolation of fluids provided by the vertical expansion loop system is** meant to prevent or minimize potential quantities of spilled oil in the unlikely event of a rupture. Other measures involve the establishment of an effective response mechanism under the currently approved KRU Oil Discharge Prevention and Contingency Plan (ODPCP) **during the construction phase of the project, and as part of a regional oil spill contingency plan when that plan is fully developed. Two major elements of both the Kuparuk ODPCP and the planned ADP component of the regional oil spill contingency plan will be inclusion of** the Nuiqsut village Oil Spill Response Team (OSRT) and the pre-staging **and pre-deployment** of response equipment **at appropriate areas in the delta and along the pipeline right-of-way (ROW).**

All project alternatives have the potential to increase impacts to water quality beyond those discussed for the **proposed project** alternative. For example, the magnitude of the potential impacts would be greater for alternatives that include construction of gravel roads, adding a bridge to the Nechelik (Nigliq) Channel crossing, using the trenching method to cross the main channel, and building either cable span or pile-supported bridges or a ferry dock.

Air Quality

The existing air quality in the ADP area and the North Slope is good due to few pollution sources and good dispersion conditions. It meets the national ambient air quality standards (NAAQS) for all regulated pollutants. However, since it is within a containment area, the ADP will be subject to the Prevention of Significant Deterioration (PSD) regulations. The construction phase of the project will generate temporary and localized impacts, such as fugitive dust emissions and exhaust from heavy construction equipment. During operation, gas or diesel-fired production and drilling equipment will generate nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter (PM10), and volatile organic compounds (VOCs). The largest volume of emissions will be in the form of NO_x produced by gas turbines and diesel engines. However, the increased emissions will not exceed the applicable PSD increment limits and the NAAQS in the project area.

Best available control technologies (BACT) will be applied to reduce NO_x emissions from gas turbines and heaters. The ambient concentrations and increments of air pollutants resulting from the ADP, as well as BACT, will be analyzed in the PSD permit application to demonstrate compliance with applicable standards. **Air quality within the City of Nuiqsut will be monitored prior to construction to obtain information on existing conditions within the city. ARCO will fund the air quality monitoring device, and recommends that a Native-owned entity manage the placement, operation, and maintenance of the device to ensure an objective evaluation.**

Under any of the oil spill scenarios, volatile gases from spilled oil and exhaust emissions from cleanup equipment would increase air quality impacts. However, oil vapors and exhaust would rapidly disperse because of typical arctic weather conditions and they are not expected to exceed federal and state air quality standards. The effect of an oil spill on air quality would, therefore, be minimal.

In-field facility alternatives would have impacts on air quality similar to the preferred alternative. Alternatives that include the construction of a gravel road from Nuiqsut to the in-field facility site and to KRU would have higher levels of dust generation. Dust emissions would be negligible under all alternatives during the construction phase, as it would occur during winter. However, dust levels and vehicle emissions would increase during travel over roads.

Biological Resources

Fisheries

The Colville River Delta and transportation corridor contain a variety of habitats that support an abundance of fish (at least 20 species). Habitats range from lakes, small streams, and the major river channels to the saltwater and brackish estuaries, as well as outer reaches of the river. Critical factors necessary to maintain fish populations include adequate under-ice over-wintering areas, suitable feeding and spawning areas, and access to such locations. Both the subsistence and commercial fisheries of the Colville River Delta are very important to the culture and livelihoods of local residents.

Elements of the ADP potentially affecting fish habitats include water withdrawal, alteration of flow patterns, and water quality deterioration caused by release of contaminants. During both construction and operational phases, water would be needed from lakes for building ice roads, drilling and camp operations. Water withdrawals would be closely monitored to ensure that removal does not exceed amounts allowed by state regulations.

Alteration of flow patterns, particularly through wetlands, can affect the ability of fish to migrate in and out of lakes during breakup and seasonal flooding. Flow patterns could be altered by gravel placement for pads and roads. Impacts will be avoided or minimized by locating in-field facilities to avoid lakes, wetlands, and critical fish habitat, where feasible and practicable, and by using fish-passable structures (i.e., culverts, bridge). Frequent, small-volume spills of contaminants are mostly contained within the gravel pads. However, if contaminants migrate off the gravel fill, they could create build-ups affecting the productivity of the receiving environment—if such contamination becomes incorporated in the food web. Impacts from this source will be mitigated by emphasizing a strong commitment to spill control, pre-staging response and containment equipment, use of rapid clean-up techniques, and education.

Under the most likely worst case hypothetical oil spill scenario, impacts to fish would be negligible because most of the oil would be cleaned up before entering waterbodies. The reasonable worst case or extreme worst case hypothetical scenarios would result in oil entering adjacent lakes, the Sakoonang Channel and Harrison Bay. This could cause some fish mortality, reduced growth rates or lower fish production. These impacts typically are short-term and should be confined to the year of the spill.

The impacts of alternatives would be similar to those of the proposed action. The potential disruption of flow patterns would be greater for alternatives that include gravel roads along the pipeline route and those linking Nuiqsut to the in-field facility that cross either wetlands or streams providing fish habitat. The alternatives for crossing the Colville River by trenching, bridge, or ferry may also slightly increase the impact on fish because of disturbance to the river channel during construction of support structures.

Wildlife and Habitats

Twenty-four wildlife habitat types, supporting a wide range of bird and mammal species, occur in the Colville River Delta and transportation corridor. The delta is dominated by wet sedge–willow meadows associated with low-relief ice-wedge polygons, river channels and streams, barrens, tide flats, and nonpatterned wet meadows. The transportation corridor outside the delta is characterized by moist tussock tundra, moist sedge–shrub meadows, old basin wetland complexes, and deep open lakes without islands. More than 100 species of birds representing three main categories (waterbirds, tundra-nesting birds, and predatory birds) differentially use these varied habitat types. Most birds use the project area during spring and summer, with few birds remaining year-round. At least 34 species of mammals inhabit the delta and adjacent territory: 25 are terrestrial species; 8, including spotted seals which also use the river channels, inhabit the Harrison Bay offshore waters; and one, the polar bear, uses both the sea ice (its principal habitat) and land. Major mammal species include caribou, grizzly bears, muskoxen, Arctic foxes, ground squirrels, lemmings, and voles.

Potential impacts of the proposed action on wildlife habitats include: (1) loss from gravel fill or excavation, and (2) alteration from compaction, contamination, sedimentation, dust fallout, or water withdrawal. Habitat losses due to these impacts will be 97 acres covered by gravel fill, and up to 400 acres affected by temporary loss or disturbance and other indirect impacts. Overall, the affected landscape will amount to less than 1 percent of the total available delta habitat. Impacts arising from soil and vegetation compaction would be mitigated by conducting construction and major materials movement during winter and by varying the ice road routes from year to year. Implementation of appropriate oil spill prevention plans will minimize habitat degradation caused by contaminants. Dust impacts will be reduced by conducting most operations during winter, including gravel placement, and restricting traffic volume and speed. Water withdrawals will be governed by state regulatory allowances, and the principle of always maintaining sufficient water quality for winter fish survival.

Potential impacts on wildlife include altered patterns of habitat use, behavioral disturbances, changes in predator-prey relationships, mortality arising from injury (vehicle collisions, bird strikes on elevated structures). Impacts can also positively impact certain species: temporary water impoundments attract (by making aquatic habitat available earlier than normal) or displace birds, depending on species; early snowmelt can result in impoundments and early green-up of plant species. Noise disturbance caused by vehicles and aircraft or by facility operations will affect wildlife behavioral patterns, particularly for those individuals within close proximity (about 1,000 to 1,500 ft) of loud noise sources (> 85 decibels). Mitigation measures will be designed to control and limit noise disturbance, such as restricting large-aircraft flights during the waterfowl nesting and early brood-rearing seasons and strictly regulating vehicle traffic on the 3-mi road linking the drilling pads. Management and disposal of garbage at construction and facility locations will be key to minimizing increases in predator populations. Access to habitats by caribou will be maintained by elevating the pipeline at least 5 ft above the tundra and separating it, where possible, at least 400 ft from the in-field facility.

The effect of the most likely worst-case hypothetical oil spill scenario would be minimal, owing to winter conditions and ease of cleanup. The reasonable worst case hypothetical scenario could have serious impacts on bird populations using the in-field facility and areas downstream. These could include mortality from contact with contaminants and depressed breeding production for two to three years. Cleanup activities conducted during summer could induce nest abandonment and lower production. The effect on marine mammals could include direct oiling (particularly of seals) if the spill reached Harrison Bay. The extreme worst case hypothetical scenario would have similar impacts, but the magnitude would increase during the year of the spill (especially in sensitive salt-affected habitat on the outer delta), although the long-term duration of impact may not increase.

Alternatives that include a permanent road and bridge over the main channel and the Nechelik (Nigliq) Channel of the Colville River would significantly increase the loss of habitat area from gravel fill and structure placement. The area affected could range from approximately 217 acres to 365 acres depending on the length of the road and bridge construction. Wildlife disturbance from increased vehicle traffic would also occur. Impacts to wildlife and their habitats would substantially increase under all project alternatives with a permanent gravel road for access to the in-field facility.

Threatened and Endangered Species

Three species listed as threatened or endangered (T&E) occur within the ADP area: the bowhead whale (endangered), spectacled eider (threatened), and Steller's eider (threatened). Bowhead whales are uncommon near shore in Harrison Bay and along the barrier islands east of the Colville River Delta, approaching the project most closely during fall migration from Canada to the Bering Sea (bowheads have rarely been sighted inside the barrier islands and more commonly are found considerably offshore from the coast of the delta in water depths greater than 60 ft). The spectacled eider breeds in the project area during summer (June-September). Although spectacled eiders occur throughout the project area, they are four to six times more abundant on the delta than in the ADP transportation corridor. The outer coastal habitats of the delta north of the ADP are the prime nesting areas. No nests have been found in the vicinity of the in-field facility. Steller's eider is seen rarely on the Colville River Delta, and nesting has not been confirmed on the delta.

The potential impacts of the proposed project on birds in general also apply to the spectacled eider. These include long-term loss of habitats used for pre-nesting, nesting, brood-rearing, and fall staging; behavioral disturbance near roads and pads from equipment noise, human activity, and vehicle and air traffic; and mortality from collisions with vehicles or structures, fouling, or ingestion of contaminants. The magnitude of these impacts would be negligible for spectacled eiders at current population levels, because few eiders occur near the proposed in-field facility or pipeline. Project construction and operation would have no impact on bowhead whales.

Under the oil spill scenarios, there would be little impact to T&E species from the most likely worst case hypothetical scenario because eiders would not be in the area during winter, and oil would not spread to the ocean. Under the other two hypothetical scenarios, severe impacts to eiders could occur. Their coastal distribution pattern makes spectacled eiders vulnerable to oil spills that enter river channels and spread to the outer delta. Impacts could include mortality through oiling or ingestion, oiling of eggs and nest failure, degradation of habitat and disturbance of nests during cleanup. Any impacts to bowhead whales would be unlikely, because whales migrate far from shore during the time of the hypothetical oil spill events. Mitigation measures for T&E species would involve standard spill prevention and control precautions to minimize wildlife exposure to oil spills.

The project alternatives would have impacts on eiders similar to those described above in the wildlife section. Use of the airstrip in Nuiqsut, or locating the camp facilities in Nuiqsut (Native alternatives), would reduce noise disturbance on the central delta by locating these activities further from nesting areas. Under the cable bridge span of the vehicular pile-supported bridge alternatives, there would be some potential for creating a collision hazard for eiders flying in low-visibility conditions. Project alternatives would have no impact on bowhead whales.

Human Use Resources

Communities of the Colville River Region

The principal residents of the Colville River Delta region are the Kuukpikmiut (Inupiat) Eskimos. Archaeological, historical, and cultural sites of great antiquity (c. 11,000 years) are located in and adjacent to the delta. A modern village community was founded at the present site of Nuiqsut in 1973. Its approximately 450 residents, 90 percent of whom are Inupiat, have crafted a contemporary society based on the subsistence lifestyle underwritten by participation in a modern wage and cash economy. The only other delta residents are in the Helmericks family which, since the late 1940s, has resided on Anachlik Island in the northeastern outer delta. The nearest neighbors to the delta residents are the base camps of the KRU oil field occupied by shift workers whose permanent residences are not on the North Slope.

The ADP will not likely impact the residential composition of Nuiqsut, the social cohesion underlying Kuukpikmiut subsistence lifestyle, or other cultural resources of the region. The project will not produce an immigrant, non-Inupiat residential population nor would it place demands on local community services (such as schools, health services, police and fire protection, public facilities, and utilities) since the ADP would consist of a self-contained camp and production facility whose workforce will be housed on-site.

The main impact of an oil spill will be the immediate call-up and in-field response of the Nuiqsut OSRT. This may involve the lease of local equipment and the absence of the spill response team members from their regular jobs in the village—depending on the nature, extent, and duration of the spill.

Project alternatives would have impacts similar to the proposed project except for those that include a permanent road, use of the existing Nuiqsut airstrip, and the location of project camp facilities in the village. The use of the airstrip would move non-local members of the ADP workforce through the village and likely increase demand for local services. If camp facilities are located in Nuiqsut, there would also be an increase in social interactions between non-local personnel and the majority Inupiat population. An all weather road would lower the cost of transporting people and goods to Nuiqsut. It might also make local access to some subsistence use areas easier.

Government Institutions

The only project impacts on the City and Native Village of Nuiqsut, the NSB, State of Alaska and federal governments will be the cost of providing services such as planning, permitting, regulation, and compliance. Net earnings from enhanced tax revenues, royalties, and fees generated by the ADP will exceed costs of services rendered.

Impacts of alternatives would be similar to the proposed action, except for those that include a permanent road. Any involvement by the NSB, where its public bonding authority is used to support or underwrite construction, would represent a major commitment of NSB public spending authority.

Economic Institutions

As land and mineral rights owners in the proposed project area, ASRC and Kuukpik Corporation will receive major financial benefits from production royalty earnings, rents, and fees. These Native corporations and their for-profit subsidiaries will also benefit from increased earnings opportunities as contractors supplying services and gravel (e.g., gravel from ASRC mine) to the operator. Similarly, employment opportunities for the local resident workforce will increase. Nuiqsut might also benefit by receiving natural gas or electricity from the ADP to be used for heating and energy generation in the village.

A major adverse impact from the reasonable and extreme worst case hypothetical oil spill scenarios would be on the subsistence fishery and the commercial fishery at Colville Village (Helmericks). Both the commercial and subsistence catches could be rendered unfit for consumption and sale during the year in which the spill occurred.

The economic impacts of alternatives that include construction of a permanent road to KRU and/or use of Nuiqsut's airstrip or camp facilities located there would be significant. Airstrip and village land use would generate fee and rent income. The road to KRU would lower costs of freight and travel.

Kuukpikmiut Subsistence

The ADP is planned for a small part of the Colville River Delta that is used for subsistence hunting and fishing. Subsistence users are concerned facilities may impact access to wildlife resources, and habitat might be impacted by in-field facility placement, oil spills, or noise disruption. Since Nuiqsut relies heavily on subsistence for both nutritional and cultural needs, a disruption of access to subsistence resources would constitute a serious adverse impact.

The operator proposes to address these concerns through a Subsistence Oversight Panel (SOP) staffed mainly by local residents. This panel would advise the operator about sensitive subsistence use areas and incorporate detailed local knowledge in both planning and operational phases of the project. Detailed procedures would be established to minimize restrictions on access by hunters and fishers to subsistence use areas in the vicinity of project facilities. Non-local project employees would be prohibited from hunting during periods of active shift work.

Under the hypothetical oil spill scenarios, the most likely worst case would have minimal impact on subsistence because less than 1 acre out of a total of 164,479 acres of delta lands would be affected in winter conditions. Under the reasonable worst-case scenario, 1% of those lands might become unsuitable for hunting and fishing for one year. Under the extreme worst-case scenario, the magnitude of the impact would be similar to the previous scenario, except that commercial fishing and seal hunting would be impacted for one year.

Project alternatives would have similar impacts to those of the proposed action. Alternatives that include a gravel road would increase the magnitude of impacts affecting wildlife habitat and might also increase access for non-local hunters.

Cumulative Impacts Assessments

The region-wide discussion of cumulative effects addresses the ADP with reference to existing, planned, and reasonably foreseeable oil, gas, and other developments (e.g., Bureau of Indian Affairs (BIA) road at Nuiqsut) both within a 30-mi radius of the ADP and across the wider mid-Beaufort region of the North Slope. These developments could occur within the foreseeable time-frame of the next 10-17 years.

Chapter 1

1. PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1 ENVIRONMENTAL EVALUATION DOCUMENT PURPOSE AND HISTORY

This Environmental Evaluation Document (EED) has been prepared to assist the permitting process for ARCO Alaska, Inc.'s **(ARCO)** proposed Alpine Development **Project (the** proposed action **or ADP)**, a new oil and gas production facility and associated pipeline corridor located in the Colville River Delta, North Slope Alaska (Figure **1.1-1**).

This document has been revised since it was originally submitted to the U.S. Army Corps of Engineers (USACE) on October 8, 1996. The revisions reflect (1) modifications in the proposed project design and mitigative measures, (2) evaluation of additional design alternatives, (3) data collected during the 1996 field season, (4) comments received/responses given subsequent to the original EED submittal, and (5) an extended Public Notice of the ADP by the USACE. The modifications in the project design were developed to further avoid or reduce the impact of the proposed action on the environment, or to respond to comments by interested parties and agencies, and USACE coordination and consultation, or evolved as a result of additional engineering. Please note that changes in this EED are shown in bold

An Environmental Assessment (EA) will be prepared by USACE to determine whether the proposed action may significantly affect the human and natural environment. This follows the procedures required by the Council on Environmental Quality (CEQ) implementing regulations, and other applicable requirements. ARCO's goal is to have the USACE use **the** EED and the results of **six** years of environmental studies in preparing the **National Environmental Policy Act** (NEPA) Permit Evaluation and Decision Documents. ARCO requests that mitigation measures identified and incorporated in the pre-application phase and in this EED receive appropriate consideration and credit.

On October **8**, 1996, ARCO Alaska, Inc., as operator, and its co-owners Anadarko Petroleum Corporation (Anadarko) and Union Texas Petroleum Alaska Corporation (UTP), applied to the USACE for permit authorization **(Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act), to construct and operate the ADP** and related facilities. The USACE District Engineer must determine whether issuance of **this** permit would constitute a major federal action having a significant effect on the human and natural environment requiring preparation of an environmental impact statement (EIS). A finding that the permit issuance would not create a significant impact (finding of no significant impact [FONSI]) could alternatively be made on the basis of an **EA**.

ARCO has been planning for potential development in the Colville River Delta for **six** years. Focused environmental and technical baseline studies conducted during this period have allowed ARCO to develop predictive environmental assessments of the **proposed action and other** project alternatives identified in this EED. Over the past **27** months, these assessments have been coordinated with federal, state, and local resource agencies, local governments, and Native communities (see Section 5). In addition, in May 1996, two USACE pre-application public workshops were held, with cooperation from the state of Alaska, in Anchorage and Nuiqsut, Alaska. ARCO has also engaged two affected Native entities, Arctic Slope Regional Corporation (ASRC) and Kuukpik Corporation, in development planning, contracting, and summer field studies. **Other entities, such as the Native Village of Nuiqsut, the City of Nuiqsut, and the Arctic Slope Native Association, have been engaged in planning meetings. Interested government agencies were given the opportunity to visit the project site with ARCO, its consultants, and Native leaders and elders.**

ARCO responded to comments received **on the EED,** during **two** pre-application **public workshops, other pre-application meetings, and the extended USACE Public Notice period,** by documenting concerns, issues, and the major studies' findings. **These concerns, issues, and findings were communicated** to interested parties in correspondence dated March and April 1996 (Appendix A), **and February (Appendix K), May (Appendix K), and July 1997 (Appendix L), as well as** in meetings, and by telephone. **ARCO considered all comments received in designing the project to avoid or minimize impacts.** ARCO's assistance in the planning/permitting process has created a unique opportunity for the company to propose mitigation measures in the initial permit application submittal **and** prior to permit issuance. The existing pre-development baseline data will serve as a benchmark to illustrate and evaluate the effectiveness of mitigation measures.

1.2 STATUS OF PROPOSED ACTION

Since the proposed action relates to permit issuance, no construction activity has been undertaken. ARCO has conducted six years of planning and conceptual/preliminary design work on the proposed project. Extensive engineering design has been conducted.

1.3 PURPOSE AND NEED FOR THE PROPOSED ACTION

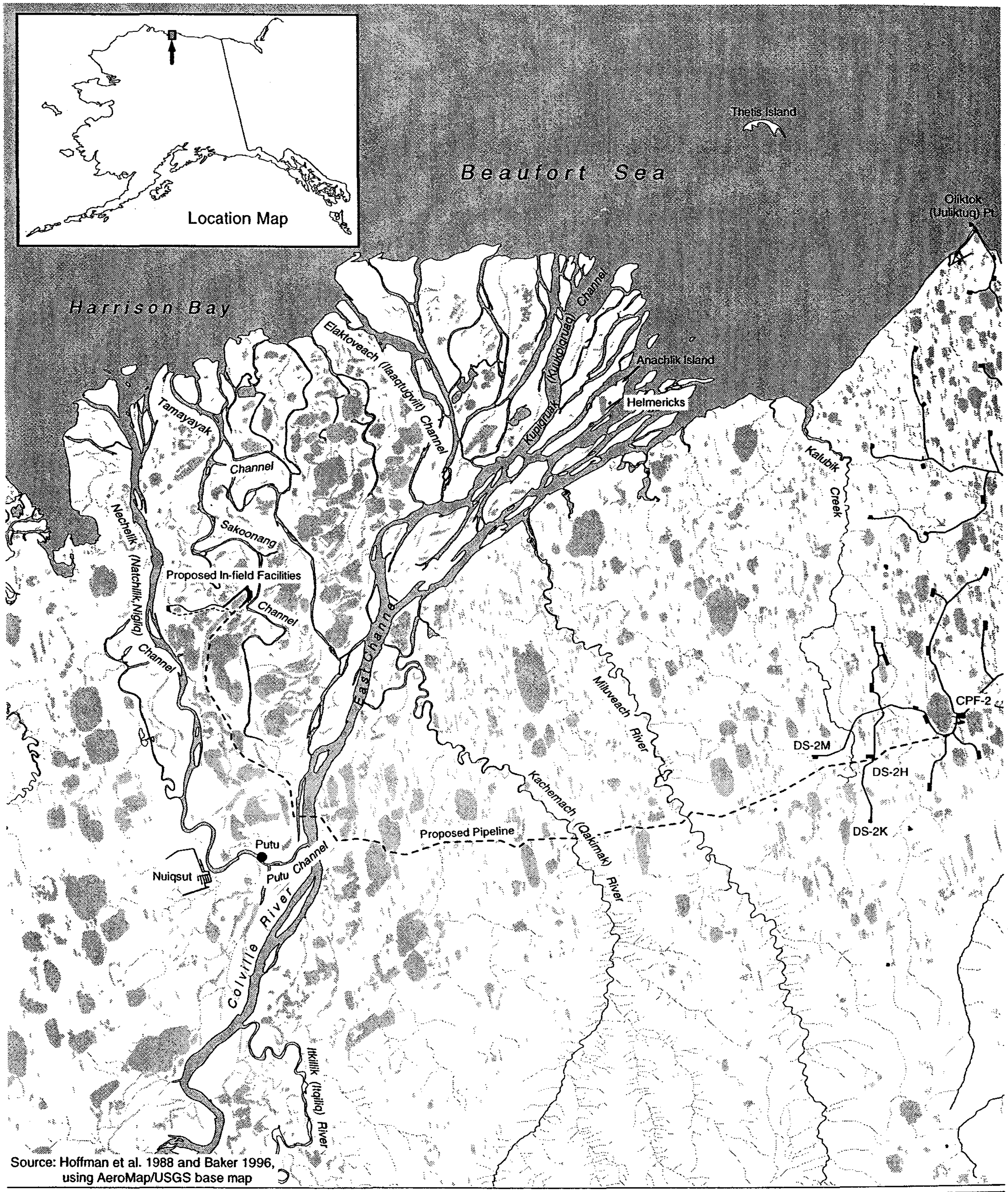
The need for the proposed action is multi-fold. ARCO's purpose for placement of fill material is to: construct access to the commercial deposit of oil and gas; provide gravel pads for drilling, logistical support and processing facilities; and transport sales quality oil associated with oil and gas recovery from the Alpine reserve to and through the Trans-Alaskan Pipeline System (TAPS) and ultimately to market. ARCO's gravel airstrip construction proposal would allow for development and operation of the ADP without the need to build a permanent gravel road connecting to the Kuparuk River Unit's (KRU) road system. Further, this project will generate additional revenues to federal, state, and local units of government from oil royalties; provide economic benefits to the applicant, ASRC, The Kuukpik Corporation, private organizations and individuals; and contribute to the nation's recovery of domestic oil supplies.

The applicant's primary purposes are to begin safe, cost-effective and environmentally responsible long-term oil and gas production and to provide transportation of sales quality oil from the ADP. The USACE decision on the proposed action will be based on applicable statutory and regulatory authority, including the CWA, the Rivers and Harbors Act, NEPA, implementing regulations, and other laws and executive policies. The proposed action would facilitate the availability of low-cost energy, which is a need identified in the Performance Agreement between President Clinton and Energy Secretary Hazel R. O'Leary, Fiscal Year 1996 (Appendix B). Goals of the Agreement are to "Develop and promote energy efficient and renewable technologies; advance the efficient and environmentally responsible production, transportation, and use of domestic fossil fuels and other conventional energy sources; promote an equitable system of energy supply and end use; and reduce U.S. vulnerability to energy supply disruptions." A specific commitment of the Agreement is to "Improve the capability of the nation's petroleum industry to produce additional supplies of secure, domestic natural gas and oil, increasing U.S. gas and oil production by an average 1 million barrels per day (oil equivalent) during the 2001-2010 period."

Total U.S. domestic crude oil production for the first six months of 1996, as reported by the American Petroleum Institute, averaged approximately 6,438,000 barrels of oil per day (a decline of 3.1% from same 1995 period). Of this amount, the producing fields of the North Slope of Alaska contributed approximately 1,300,000 barrels of oil per day, or about 21% of the total amount. U.S. demand for petroleum products (as measured by deliveries) for the first six months of 1996 is estimated at 18,025,000 barrels of oil per day (a 2.5% increase from the same period in 1995). The producing fields of the North Slope contributed approximately 1,300,000 barrels of oil per day, or about 7% of this total. Production from the North Slope has been declining since 1988 (Figure 1.3.0-1). Production from the ADP, estimated to range between 50,000 and 80,000 barrels of oil per day, would significantly contribute to reducing this decline. It is in the public interest to have an environment that is put to productive use, while at the same time the land, rivers, and marine ecosystems that characterize the Arctic region of Alaska are being protected.

The ADP will economically benefit both private and public interests and entities. The ASRC and the Kuukpik Corporation, also known as Alaska Native for-profit business corporations, are owners of various surface and subsurface rights included in the proposed development area. They will earn income from hydrocarbon production, various income from use of their property, and receive other consideration through the permit process or by separate agreement. In addition, ASRC and Kuukpik will earn substantial revenues from oil field contracting services provided to the developer. Their shareholders will also have employment opportunities associated directly with these services.

The North Slope Borough (NSB) regional government will receive important property tax revenues from the



Source: Hoffman et al. 1988 and Baker 1996, using AeroMap/USGS base map

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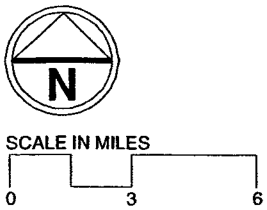
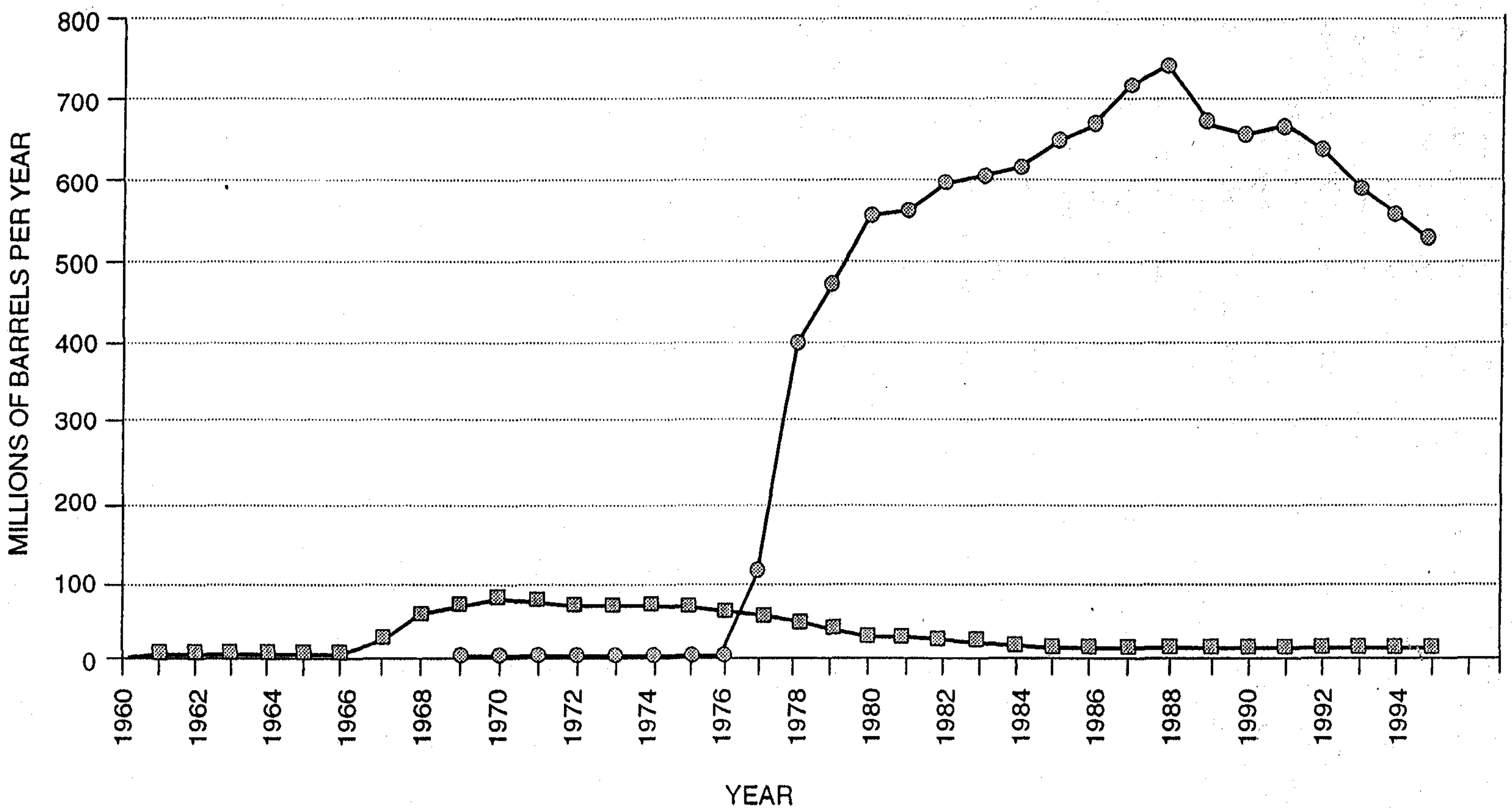


Figure 1.1-1. Colville River Delta and Vicinity



Source: Historical and Projected Oil and Gas Consumption,
Alaska Dept. of Natural Resources, Division of Oil & Gas

ARCO Alpine Development/55-2042-04(01) 8/97

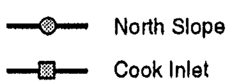


Figure 1.3.0-1.
Alaska Oil Production
1960-1995

ADP at a time when their overall tax base is decreasing. It is from these oil and gas property tax revenues (approximately $220 million/year North Slope-wide) that the major services (schools, health care, public facilities, social services) are provided to NSB villages, such as Nuiqsut, which lies within the immediate project vicinity. Nuiqsut may also acquire the benefits of a cheaper local energy source, natural gas or electricity.

The State of Alaska is an important owner of subsurface rights in the Colville River Delta. It will receive production royalty earnings, severance, and corporate taxes from this development. A recent study of the economics of North Slope marginal oil fields, conducted by the Institute of Social and Economic Research (ISER) of the University of Alaska, predicted that net economic benefits would accrue to the state in amounts substantially exceeding the costs of providing additional public services (Goldsmith 1995). In addition to increased state earnings, other economic benefits to the state economy would come in the form of new jobs and in-state value added to project materials and services purchased.

The federal government would benefit from the addition to the nation's dwindling domestic energy supplies and production rates. It would also profit from corporate and personal taxes generated by the ADP.

ARCO, Anadarko, and UTP, as the subsurface lessees of record and pipeline owners, will derive income from oil and gas production, transportation, and sales.

1.4 STATUS OF LICENSES, PERMITS AND APPROVALS

The current status of the proposed action, in relation to major legislative and regulatory actions governing its implementation, is summarized in Table 1.4-1. Permits, approvals, and policy compliance reviews, other than those listed, may be necessary before and during construction, under state and local statutes and regulations. In addition, other agencies have policy implementation responsibilities that could relate to the proposed action.

1.5 EED FORMAT

The EED is organized into the following seven sections: (1) Purpose and Need for the Proposed Action; (2) Description of the Applicant's Proposed Project; (3) Alternatives; (4) Affected Environment, Environmental Consequences, and Mitigation Measures; (5) Consultation and Coordination; (6) References, and (7) Index. Chapter 2 describes the proposed project and summarizes proposed mitigation measures relative to the project design features, construction, and operation, and Native concerns. Chapter 3 describes additional alternatives to the proposed project, including alternatives developed by ARCO and interested parties, and three Native proposal alternatives. This chapter also has a tabular summary of the impacts of the proposed action and alternatives. Chapter 4 addresses the primary elements of the natural and human environment including hydrology, geology, and geomorphology for the physical resources; water quality and air quality for the chemical resources; fish, wildlife, and threatened and endangered species for the biological resources; and communities of the Colville River region, government institutions, economic institutions, and Kuukpikmiut subsistence for human use resources. This chapter also analyzes impacts for three hypothetical oil spill scenarios and the cumulative impact scenarios developed with the USACE. Chapter 5 lists the meetings held and contacts made with agencies, local residents, Native entities, and other interested parties concerning the ADP. Issues and concerns raised during these meetings, as well as in comments made subsequent to the filing of the initial draft EED, are described in this chapter, with references to where the concerns or issues are addressed in the EED. Complementing these chapters are appendices, containing supporting information for subjects referenced in the text.

Table 1.4-1 Status of permits required, statutory/regulatory review, and Native interests.

Administering Agency or Entity	Review/Permit	Status
U.S. Army Corps of Engineers (USACE)	Section 404 Clean Water Act	Permit application and Environmental Evaluation Document submitted October 8, 1996
U.S. Environmental Protection Agency (EPA)	Class I Injection Well, DEC Wastewater Disposal Permit	Permit application to be submitted in August 1997
U.S. Fish and Wildlife Service (USFWS)	Marine Mammal Protection Act—Letters of Authorization (LOA)/Permit	Permit application to be submitted in 1997
Alaska Department of Natural Resources (ADNR)	Land Operations Approval LO/NS 97-07 Land Use Permit (for Colville River Boring) Land Use Permit LAS 21122 (ice roads and pads) Water Use Permit Renewal and Amendment of LAS 18597 ROW Lease for Pipeline ADL 415701 ROW for Water/Gas Line and Fiber Optics Cable ADL 415857 ROW for Diesel Pipeline ADL 415932	Permits have been submitted to agency for review
Alaska Department of Environmental Conservation (ADEC)	Section 401 Water Quality Certification Air Quality Construction Permit Oil Spill Contingency Plan (OSCP) Air Quality Control Permit to Operate (PSD/PSD Avoidance) Notification for Temporary Storage of Drilling Wastes Solid Waste Processing Facility Permit Drilling Waste Disposal Permit	Permit has been submitted to agency for review Permit application to be submitted in October 1997 Application to amend Kuparuk OSCP to be submitted in October 1997 for appraisal well drilling and testing operations Applications will be submitted in March 1998 for hydrocarbon production facilities, in-field and sales oil pipelines, and major development well drilling activities One or more of these permit applications will be submitted in August 1997 Permit to be submitted by July 1, 1998 Permit to be submitted in August, 1997
State/Federal/Joint Pipeline Office (JPO)	Pipeline ROW	Application submitted in September 1996
Alaska Division of Governmental Coordination (ADGC)	Coastal Zone Management Coastal Zone Consistency Review	Application has been submitted for review Pending
Alaska State Historical Preservation Office	Cultural and Archaeological Clearance	Archeological and cultural resources report submitted in 1996

Table 1.4-1 Status of permits required, statutory/regulatory review, and Native interests (continued).

Administering Agency or Entity	Review/Permit	Status
Alaska Department of Fish and Game	Title 16 Fish Habitat permit(s)	Permit has been submitted to agency for review
Alaska Oil and Gas Conservation Commission	Permit to Drill Annular Injection Class II Disposal Well(s)	Permit applications to be submitted September/October 1997 and subsequently as more wells are proposed to cover drilling of appraisal/production test wells and development of future disposal well(s)
North Slope Borough (NSB)	Rezoning Approval Coastal Zone Consistency Review	Application has been submitted Pending
City Council of Nuiqsut	Communicate Community Interests and Concerns	Coordination ongoing for 26 months
Native Village of Nuiqsut	Communicate Tribal Interests and Concerns	Coordination ongoing for 26 months
Kuukpik Corporation	Communicate Surface Owner Interests and Concerns	Surface Use Agreement reached, August 1997
Arctic Slope Regional Corporation (ASRC)	Communicate Mineral Owner Interests and Concerns	Coordination ongoing for 26 months
Arctic Slope Natives Association (ASNA)	Communicate Native Allotment Owners Interests and Concerns	Coordination ongoing for 26 months

Chapter 2

2. DESCRIPTION OF THE APPLICANT'S PROPOSED PROJECT

The in-field facilities of the ADP site (see Figure 1.1-1) are located in the Colville River Delta approximately 35 mi west of the KRU Central Processing Facility (CPF-2). It is bounded by the Nechelik (Nigliq) Channel of the Colville River to the west and the Sakoonang Channel of the Colville River to the east. The Village of Nuiqsut, population 450, lies approximately 8 mi south of the in-field facility. The Colville River Delta front is located approximately 8 mi north of in-field facility. The legal description of the in-field facility production location is Sections 5, 6, and 32, Township 11 North, Range 5 East, and Sections 1, 2, and 4, Township 11 North, Range 4 East, Umiat Meridian.

The primary features of the in-field facility's roughly 97-acre footprint (Figure 2.0-1) will consist of two basic facilities pads connected by a 3-mi-long gravel road: the eastern pad (Alpine Pad 1) includes a processing facility/camp drilling site, and the western pad (Alpine Pad 2), a satellite drilling site. A 5,900 ft (5,500 ft landing area plus two 200-ft safety overrun areas) airstrip will be built as a wide spot in the road adjacent to the gravel road nearest Alpine Pad 1. A 440-ft bridge with a 402-ft opening at the abutment toes will be built into the gravel road just west of the airstrip to maintain drainage patterns at a swale. Culverts in the gravel road will also maintain drainage. A total of approximately 100 to 150 wells will be drilled at the in-field facility. A sales oil pipeline, a diesel fuel pipeline, a fiber optic cable, and a utility pipeline will extend aboveground from the in-field facility for 34.2 mi, on vertical support members (VSMs), to KRU CPF-2 (Figure 2.0-2). At CPF-2, the sales oil pipeline will connect with the Kuparuk Pipeline system and the utility pipeline will connect with the appropriate Kuparuk process system (gas or water). The sales oil pipeline, diesel fuel pipeline, fiber optic cable, and utility pipeline will cross the main channel beneath the Colville River through bored holes. Other minor river and stream crossings will use VSMs.

To further mitigate impacts and respond to comments and USACE coordination, the proposed project has been modified from the description given in the Public Notice issued by the USACE in April 7, 1997. Primary modifications include: (1) reducing the overall gravel pad footprint size (scope) by approximately 15%, (2) changing the orientation of Alpine Pad 2 to a north-south direction in part to reduce its hydrological impact, (3) shifting Alpine Pad 1 away from the Sakoonang Channel; (4) adding a bridge and additional culverts into the gravel road in the swale immediately west of the airstrip; (5) adding culverts and increasing culvert diameters in the gravel road; (6) adding culvert armoring; (7) shifting the road northward in the swale to minimize impacts in this drainage and shifting a section of the gravel road northward to maintain cross drainage; (8) enclosing the sales oil, diesel fuel, and utilities pipelines within high-strength pipe casings at the Colville River crossing to essentially eliminate the potential for leaks into the river; (9) increasing the size of the Horizontal Directional Drilling (HDD) to aboveground transition cellars and insulated pads; (10) replacing isolation valves with vertical expansion loops at the river crossings to reduce oil spill risks; (11) adding a small helipad at the Colville River Channel crossing; (12) selecting the ASRC mine site as the gravel source for the project; and (13) expanding the Nuiqsut mitigation package. The following chapter describes the currently proposed project with these modifications and other less substantial design changes.

2.1 HISTORY AND SCHEDULE

Since 1991, ARCO, as operator, has been conducting exploratory oil and gas operations in the Colville River Delta area. Other than summer geological field work conducted by helicopter and on foot, exploratory operations have occurred exclusively during winter through the use of ice roads and pads. Wastes were backhauled to the KRU. These operations resulted in insignificant impacts to the human and natural environments. The resulting 19 well penetrations revealed subsurface conditions that shifted ARCO's area of interest from the northeastern portion of the Colville River Delta to the southwest. The most recent exploratory and delineation results, a stand-alone production test and 3-dimensional seismic data model, indicate that commercial development is possible on existing oil and gas leases. Table 2.1.0-1 lists the major identified project milestones.

The ADP is located approximately 35 mi west of the KRU oilfield infrastructure, the second largest oilfield in North America. KRU has been producing oil since 1981 (Figure 2.1.0-1). Current production is approximately 300,000 barrels of oil per day. The ADP is 70 mi west of the Prudhoe Bay Unit (PBU) which, as the largest oilfield in North America, has been producing oil since 1977. Current production is approximately 900,000 barrels of oil per day. By comparison, the ADP is much smaller; its expected peak production is 50,000-80,000 barrels of oil per day. Production could start as early as the year 2000.

The Prudhoe Bay oilfield is the 18th largest ever discovered. The geologic formation in which it occurs, composed primarily of porous sandstone and gravel, made the oil relatively accessible. The estimated 22 billion barrels of oil originally in place at Prudhoe Bay warranted the enormous infrastructure investment necessary to produce oil and gas and transport the product using the TAPS.

Oilfields developed after Prudhoe Bay (for example, Kuparuk and Endicott) have also had relatively significant and accessible reserves. However, almost 20 years after Prudhoe Bay was brought on line, production rates from these large fields are declining and the oil industry is diligently exploring the North Slope for new domestic oil and gas reserves.

New oil and gas reserves presently being evaluated for development (such as Alpine, Tarn, Northstar, and Badami), lie in different geologic formations and, more importantly, have much smaller oil and gas accumulations than the above-mentioned producing fields. These new low-producing fields tend to have poorer quality rock, making oil production more difficult and costly. The relatively small deposits found and higher costs necessary to retrieve the oil have created new, more economically sensitive thresholds for investment.

These new potential oil and gas reserves would not be proposed for development without Kuparuk, Prudhoe, and TAPS infrastructures already in place. If the ADP is to meet its economic threshold for investment, high-cost project components, such as an approximately 30-mi permanent gravel road to Kuparuk and a rig-capable vehicular bridge across the Colville River, must be eliminated. Accordingly, technological advances, innovative designs, and lessons learned during ARCO's 20 years of North Slope operating experience have been incorporated in the proposed project alternative. ARCO is confident that the ADP can be prudently operated as a remote facility.

2.1.1 Development Schedule

Alpine facility development will occur in three phases: (1) construction/pre-start-up development drilling; (2) start-up/development drilling; and (3) long-term operation. Figure 2.1.1-1 is the optimal project schedule leading to development drilling in 2000.

Phase 1 could start as early as the 1997/98 winter and finish in 1999 or 2000. The major construction activities will include: Colville River pipeline crossing, gravel pads/road, bridge, VSMs and facilities/ infrastructure. Work will be done almost exclusively in the winter. Several delineation wells and possibly several pre-development wells will be drilled in the 1997/98 winter. Pre-start-up development drilling of 15 to 20 wells could start as soon as the 1998/1999 winter and may occur year-round henceforth.

Phase 2 will begin at facility start-up and will run for 5 years, from 1999 or 2000 to approximately 2005. Development drilling will be the major activity and may occur year-round. Ice roads and ice bridges will be constructed each winter season to support the year-round drilling operations. Oil production will begin during Phase 2, mid-2000.

Phase 3 will be the long-term ADP operation. Production activities will run from 2005 to the end of the development's field life, which is estimated to be 2020 or 2025. No major additional activities are envisioned during this period. Occasional minor construction projects or downhole well repair work may occur every three to five years. Ice roads and bridges will accommodate equipment movement to the ADP during these projects.

2.1.2 Well Pads And Facilities

The proposed in-field facilities consist of two basic gravel pads (see Figure 2.0-1). Each pad will support drilling, and one pad will also support a processing facility and camp site. The processing facility will be capable of processing 50,000 to 80,000 barrels of oil per day. Table 2.1.2-1 lists each major facility element, its approximate size, and the gravel needed for development. Gravel will be mined, hauled, and placed at the in-field facility site using an ice road during the winter.

The pads will be connected by a 3-mi-long gravel road containing an airstrip (built as a wide spot in the road) adjacent to the vehicular portion of the road. Access to the in-field facility will be by air or seasonal ice road. Section 2.3 discusses the proposed construction and

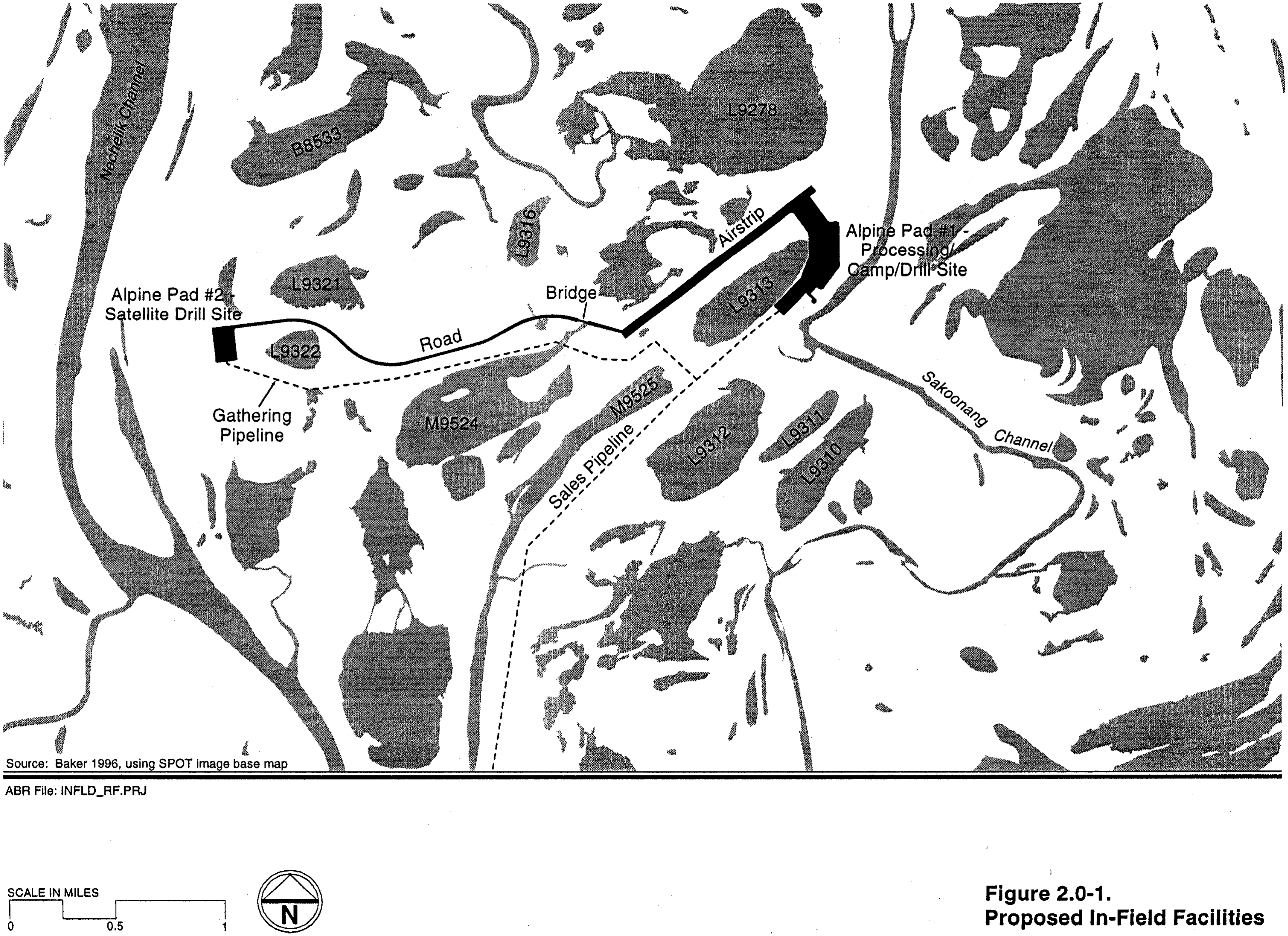


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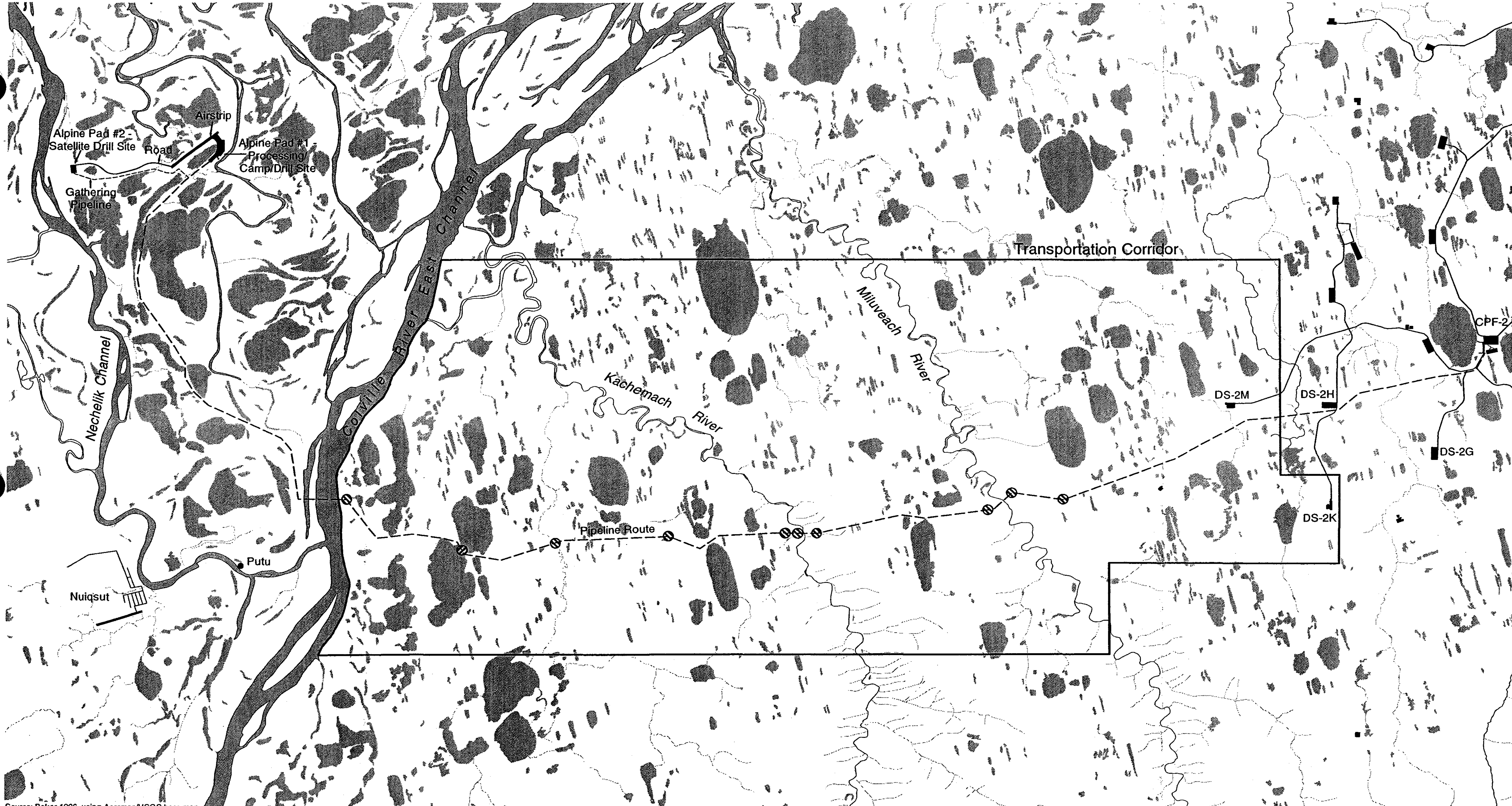
Figure 2.0-1.
Proposed In-Field Facilities



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SCALE IN MILES

0 1.5 3

N

Higher-than-normal (>5 ft above tundra) pipeline elevations:

⊘ Vertical Expansion Loop

⊘ Caribou Crossing

Figure 2.0-2.
Proposed Project

Table 2.1.0-1. Alpine development project milestones.

Milestone	Time Frame	Description
Exploration Drilling	Winter 1991-1994	Twelve exploration well penetrations were made in the Colville River Delta area.
Environmental, Facilities, and Pipeline ROW Studies	Spring/Summer 1992-1997	Studies produce an EED that specifically addresses Native concerns and state, local, and federal regulations regarding the development facilities and oil and water pipelines. Engineering studies aid project planning.
Delineation Drilling, Production Test, 3D Seismic	Winter 1995-1996	During the 1995/1996 winter season, ARCO drilled seven well penetrations and conducted a stand-alone production test to further delineate the oil reservoir under the Colville River Delta and analyze the reservoir's producability. Further geophysical surveying was also conducted.
Alpine Commerciality Announced (Appendix W)	October 1996	ARCO and its partners publicly announce development plans.
Additional Environmental Studies	Summer 1996, 1997, then as needed	Wildlife, fishery, and subsistence baseline studies continue (see Section 2.9, Mitigation Measures).
Design-Level Engineering	1996-1998	Design-level engineering supports permit applications and construction specifications.
Gravel Pad Construction	Winter 1997/98, placement Summer 1998, compaction	Pad placement in this winter allows overall construction to be phased over two winter seasons, thereby optimizing costs, maximizing startup production rates, and minimizing impact to the environment and Native cultural and subsistence activities. Ice roads and ice bridges support construction.
Bridge Construction	Winter 1997/98 Summer 1998 Winter 1998/99 Summer 1999	A 440-ft bridge with a 402-ft opening at the abutment toe in the gravel road swale area will be constructed and will include bridge pilings, deck and abutments. Abutment and roadside slopes and certain areas under the bridge will be permanently armored.
Delineation Drilling	Winter 1997/98	Ice pads will be built contiguous to permanent drill sites to support delineation drilling.

Table 2.1.0-1. Alpine development project milestones (continued).

Milestone	Time Frame	Description
Pipeline Construction	Winters 1997/98; 1998/99	Because a Colville River crossing is critical, the bored HDD river crossing construction will begin during the first winter and VSM/ pipeline construction will be completed in the second winter. Ice roads and ice bridges will support construction.
Development Well Drilling	Winter 1998/99 -2005	A development well drilling rig will be moved onsite to commence pre-start-up and post start-up drilling. Ice roads and ice bridges will be constructed each winter season to support the year-round drilling operation.
Facilities Installation	Winter 1990/2000 Summer 2000	Installation of pre-fabricated processing modules, camp facilities, inter-connects, and pipeline connections will be completed.
Production	Mid 2000-2020 to 2025	Production at ADP starts in 2000 and continues through the end of the life of the field, now estimated to be 2020 to 2025.

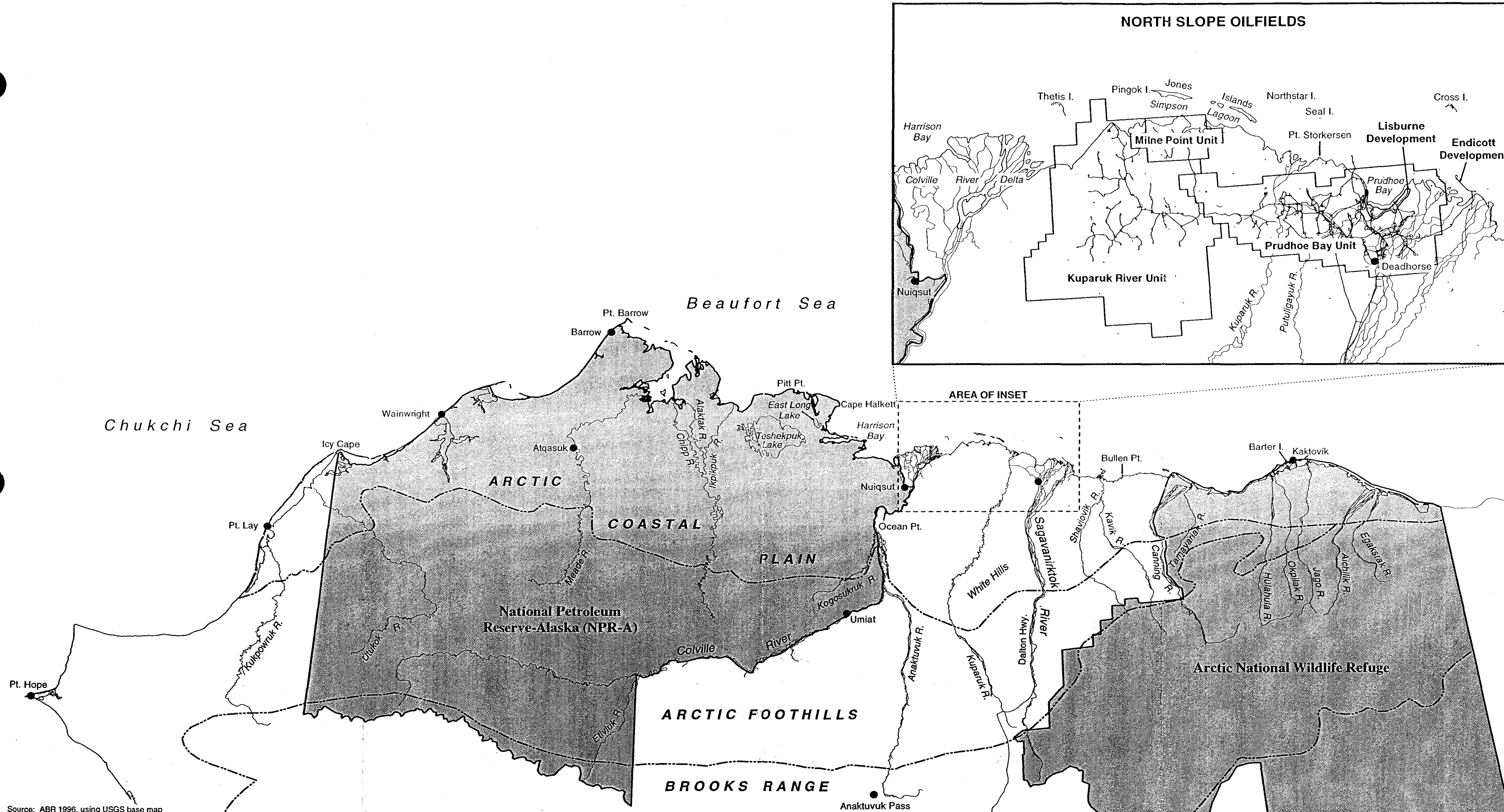
operation access. All wells will be located on the two basic gravel pads (not the road). The drillrig(s), approximately 120-ft high, will be on location during (1) winter 1997/98 for delineation and pre-development well drilling, and (2) almost entirely during Phase 2 and moved to the in-field facility in 1998/1999 from KRU along a nearshore sea/ice road originating from Oliktok Point.

The gravel road connecting Alpine Pad 1 to Alpine Pad 2 will have a 402-ft opening at the swale area located just west of the west end of the airstrip. The opening, which is measured at the spill-through-type abutment toes, will be spanned by a 440-ft long bridge. See Figure 2.1.2-1 for details. The bridge/opening is only one component of the many drainage structures planned for the Alpine development to maintain cross drainage (see the Alpine Development Hydrology and Drainage Plan and Final Drainage Proposal).

Bank full flow was originally considered as a hydraulic criterion. This flow is a common "benchmark" criterion for streams in equilibrium since it is frequent enough (two to three year return period on average) and large enough to affect stream characteristics. However, the swale area is neither a stream (water only flows through the swale for few days most years, but is standing for longer periods), nor is it in hydraulic equilibrium. After analysis of ecosystem patterns, vegetation and habitat types, and processes on the delta, it was judged (see Final Drainage Proposal) that passing 80% of the five year return period flood (Q_5) through the bridge opening will provide the flooding and sedimentation rates necessary to maintain the habitats upstream and downstream of the road near the swale area.

The bridge will be designed to support movement of all required equipment including drillrigs (e.g., development and emergency relief well drillrigs). The bridge concept being evaluated is steel beams on steel piles with a concrete deck. The bottom of the bridge girders will be at least 2 feet above the Q_{50} water surface elevation to provide clearance for wind waves and floating ice.

Scour protection will be installed on the bridge approach road sideslopes (e.g., to a point approx. 50 ft back from toe of abutment under bridge, and keyed at toe bottom), abutment faces (e.g., 2:1 gravel



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SCALE IN MILES 0 50 100

N

Boundary of physiographic province (Arctic Coastal Plain, Arctic Foothills, Brooks Range)

Figure 2.1.0-1. North Slope Region and Existing Oilfields

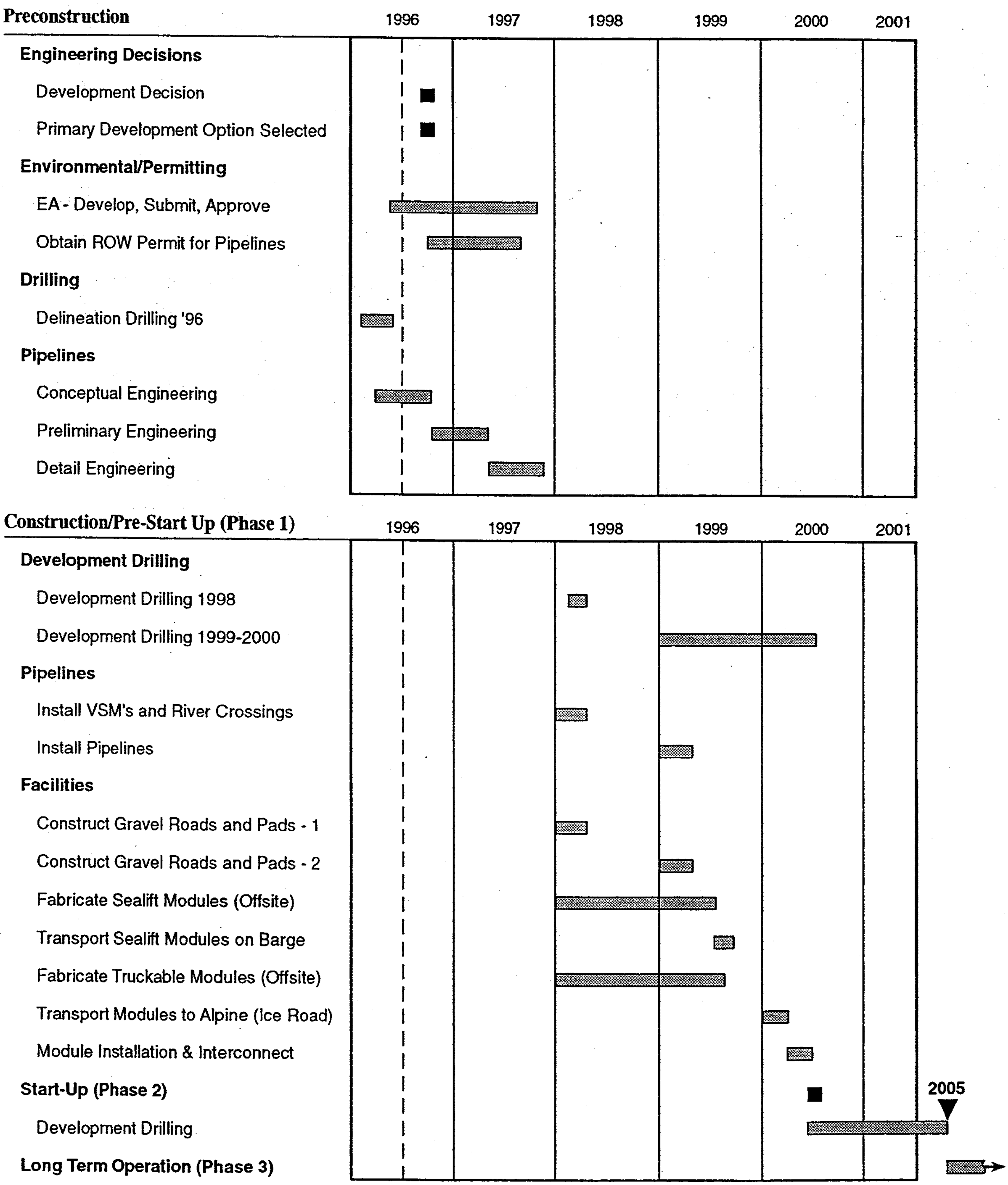
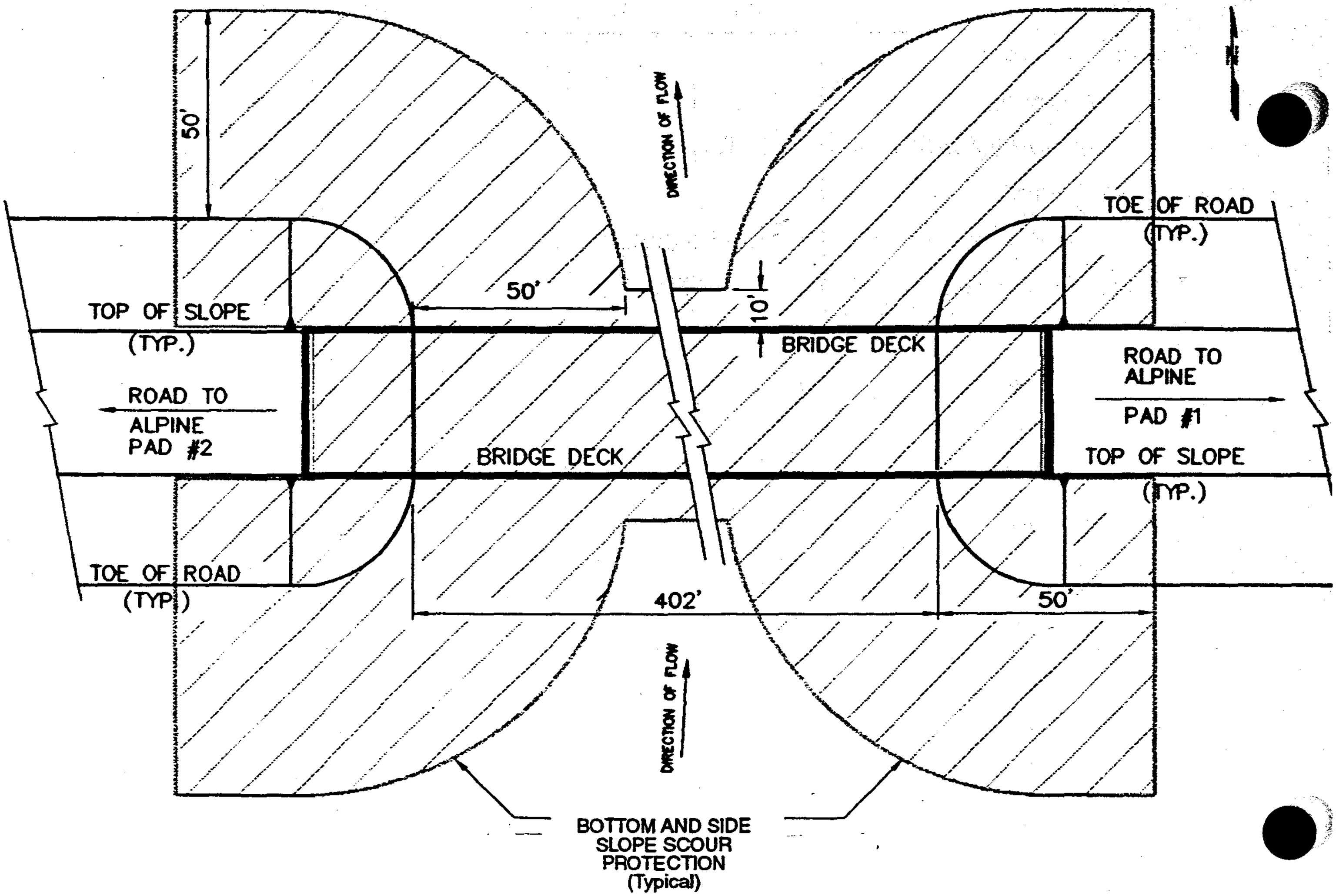
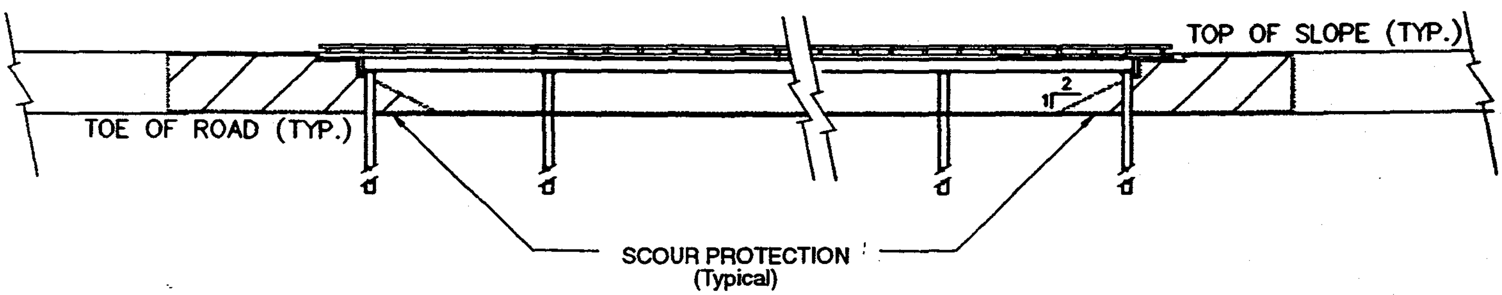


Figure 2.1.1-1.
Alpine Development
Project ConstructionSchedule



PLAN



ELEVATION

Source: Baker 1997

Figure 2.1.2-1
Scour Protection

sideslopes keyed at bottom), ground surfaces extending out from the toes of abutments and road sideslopes (e.g. up to 50 ft horizontally out from toes), and on the swale bottom (e.g., an area approx. 402 ft by 52 ft, including ground surface areas extending from toe of abutments).

Swale bottom protection will protect the bridge pilings and the swale bottom. The bridge pilings scour protection system will be designed for events exceeding the Q_5 events, however, the swale bottom scour protection system will be a design intended to prevent scour during the Q_5 events and smaller. All swale bottom areas having velocities greater than 4.0 fps at the Q_5 event will be protected from scour. The abutments, road sideslopes, and their ground surface area extensions scour protection systems will be a design intended to prevent scour during the Q_{50} events and smaller.

Scour protection system design concepts range from articulated concrete mat for the abutments, road sideslopes, and ground surfaces extending out from the road sideslopes and abutments to a similar mat concept on geosynthetic overlay for the swale bottom or a design in certain swale bottom areas that allows natural vegetation to grow through. The primary considerations for selection of designs are reliability, performance, expected velocities and their duration, and minimizing impact to tundra. A multi-mode scour protection system that takes into account the water velocity profile through the opening may provide the most protection with the least impact.

The bridge road approaches, abutments, and pier piles will be designed to withstand catastrophic floods with the Q_{100} flood being the design event for scour. In addition, the pier piles will be designed to withstand impacts from ice floating downstream.

ARCO will monitor for scour and implement remediation measures as appropriate (see Section 4.2.3.3).

2.1.3 In-Field Pipelines

The separate gathering, gas injection, and utility (most likely waterflood) pipelines required from Alpine Pad 1 to Alpine Pad 2 will run along the permanent road (see Figure 2.0-1) with a nominal 400-ft road/pipeline separation where possible and a 1,000-ft maximum separation. NSB permitting criteria will be followed. The in-field pipelines will include two 8-inch diameter lines (gas and water) and one 20-inch-diameter line (multi-phase production line). The in-field pipelines will be supported on VSMs spaced approximately 35 to 55 ft apart for approximately 3 mi; up to 450 VSMs may be needed to support in-field pipelines. To ensure free passage for migrating caribou, the in-field pipelines will have at least a 5-ft clearance between the bottom of the pipeline and the tundra.

2.2 PIPELINE, ROUTE, AND RIVER CROSSINGS

2.2.1 Sales Oil Pipeline

The sales oil pipeline from the in-field facility to KRU CPF-2, a distance of approximately 34.2 mi, will be elevated on VSMs as is typical of North Slope oilfield development, including a large part of the TAPS. The applicant has over 20 years of experience in building and operating elevated pipelines.

The pipeline support system has several components including VSMs, crossmembers, connectors, and pipe saddles (Figure 2.2.1-1). VSM spacing at a distance of approximately 55 to 70 ft apart will safely support the pipelines. Approximately 2,760 VSMs would be placed in the transportation corridor. The VSM design is controlled by seasonal changes in the tundra's active layer (i.e., frost jacking forces), which is conservatively estimated to be 1.5 to 4.5 ft deep in the Colville River Delta and 1 to 4 ft deep in the transportation corridor. Based on these estimates, the VSMs will be embedded at depths between 20 to 25 ft (see Figure 2.2.1-1).

Topographic features enroute would be accommodated by changes to the support system. For example, to accommodate elevation changes, the standard 5-ft minimum VSM height may be gradually increased in certain areas to accommodate undulating terrain, thus minimizing vertical bends in the pipeline. The entire sales oil pipeline will also maintain a minimum 5-ft clearance between the bottom of the pipe and the tundra to accommodate caribou passage. To further enhance caribou and human crossings, selected portions of the elevated pipeline will exceed the 5-ft minimum (7 to 8 ft average) near streams and lake complexes where caribou and human use is high (see Section 2.9 Mitigation), and nine vertical expansion loops will be installed in the pipeline at heights ranging from 15 to 25 ft (see Section 2.7.1.1 for description of vertical expansion loop design). River bank setbacks of approximately 300 ft will be established for bored hole entry and exit locations at the Colville River crossing.

Table 2.1.2-1. Facility elements and estimated gravel requirements.

Element	Approximate Top of Pad Dimension	Acreage[1]	Gravel Volume (yd^3)[2]
Alpine Pad 1			
Drill Site Section	790 ft x 340 Irregular shape 760 ft x 1500 ft Irregular shape		
Processing/Camp Section	300 ft x 315 ft		
Storage Area			
Total		36.3	375,015
Alpine Pad 2	500 ft x 800 ft	10.1	128,290
In-field Roads	32 ft x 10,080 ft	14.6	141,225
Airstrip			
Airstrip (in road)	180 ft x 5,900 ft	31.4	276,077
Apron Area	450 ft x 650 ft	4.3	40,303
HDD Transition (East)	56 ft x 172 ft (Irregular Shape)	0.2	2,560
HDD Transition (West)	56 ft x 176 ft (Irregular Shape)	0.2	3,830
Helipad	30 ft x 30 ft	0.10	500
TOTAL		97.2	967,800

1 Acreage includes area covered by gravel pad side slopes.
2 Pad depths would vary to accommodate expected flood levels. Minimum pad depth would be 5 ft. Total gravel volume estimate based on a 7-ft average pad depth.

These setbacks will likewise enhance caribou and human use crossings and achieve channel migration setback allowances.

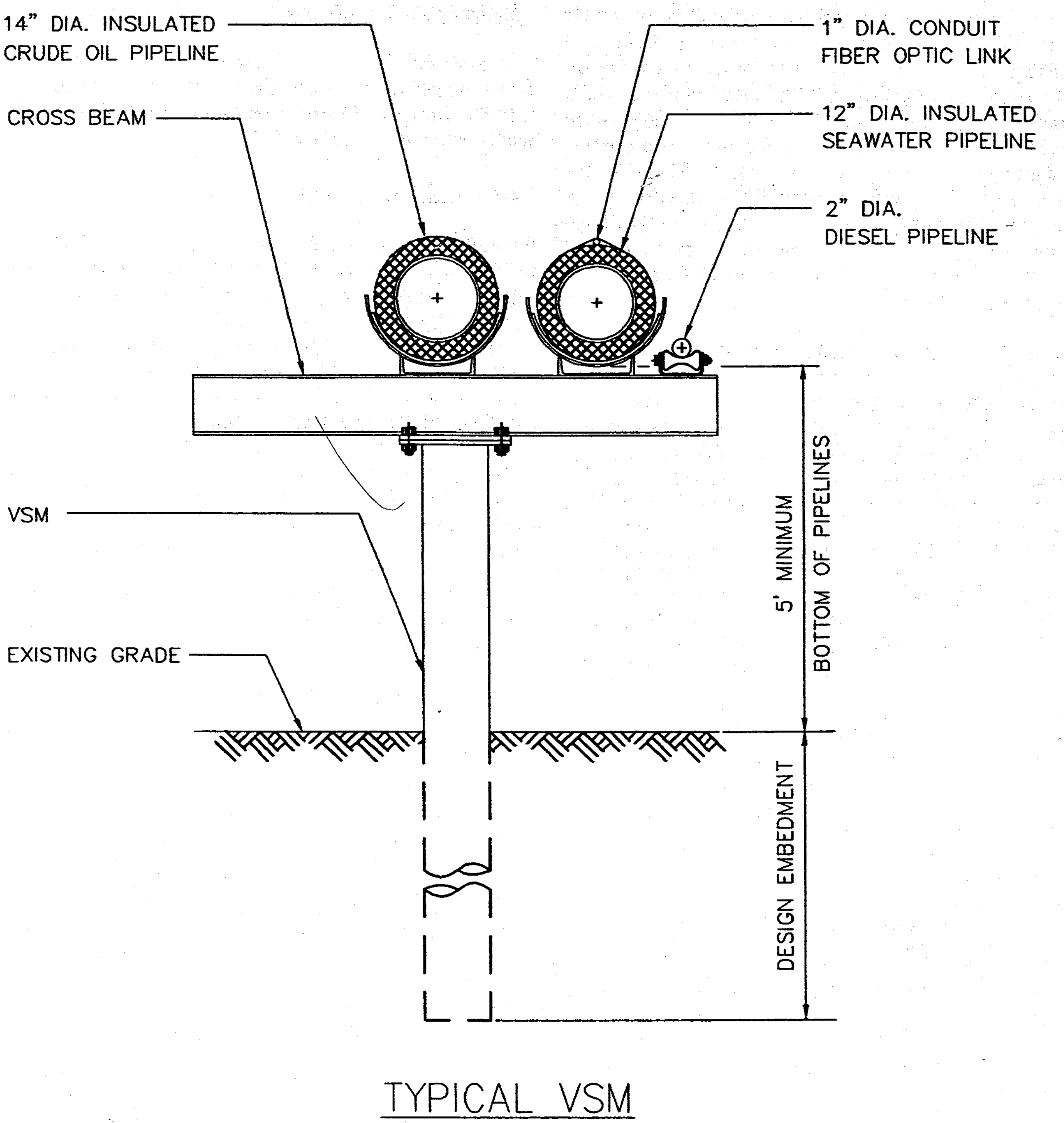
The sales oil pipeline will be constructed of steel and have a nominal diameter of 14 inches. The pipeline, which will transport hot crude oil with a maximum design temperature of 180° F, will be covered with insulation. The pipeline will have a minimum wall thickness of 0.312 inches, a yield strength of 65,000 psi (pounds per square inch), and a maximum allowable operating pressure of 2,064 psi. The pipeline will be designed to U.S. Department of Transportation (USDOT) standards for crude oil pipelines. The pipeline design is being evaluated during the right-of-way (ROW) leasing process coordinated by ADNR and the JPO (Appendix V). See Alpine Pipeline Overland Hydraulics Report, June 1997 for more details on pipeline features.

The sales oil pipeline will be encased in a second pipeline in the section of the line crossing underneath the Colville River for added protection from an oil spill and redundant structural integrity. Detailed plans have been included in the permit application submitted to the JPO with the pipeline ROW process.

2.2.1.1 Construction

<u>Ice-Roads/Bridges</u>

Access for building the sales oil pipeline between the ADP and KRU will be by ice road (Figure 2.2.1-2). Such roads are typically constructed using compacted snow and water. Approved deepwater lakes (see Figure 2.2.1-2) will provide water during the temporary construction access period. The actual road widths and thicknesses will depend on the size and weight of vehicles using the road. A typical ice road is 8 inches thick at the centerline and 40 ft wide at the base.



Source: Baker 1997

ARCO Alpine Development/55-2042-04(02) 9/97

NOT TO SCALE

Figure 2.2.1-1. Vertical Support Member Detail

The start and closure dates for construction of winter ice roads are determined by weather conditions and freezing or thawing of the tundra surface. Evaluation of weather data for the Colville River Delta suggests a start date as early as mid-November or as late as the end of December. For planning and analysis purposes, a December 1 start date is assumed. The date for closing the ice roads is normally estimated as the average start date of the thaw. This date ranges from mid-April to May 10. This analysis assumes a closure date of April 20. Heavy equipment will be moved on the ice road during the winter.

Ice roads will be constructed over rivers and channels by thickening the existing ice. Water will be applied and allowed to freeze in multiple layers. In the case of the main channel of the Colville River, ice will be built into a floating ice bridge to maintain fish passage and water quality. The non-grounded ice bridge will be approximately 11 ft thick, and water depths at this location are 13-16 ft. Culverts or other flow maintenance methods will not be required because the non-grounded design will allow adequate flow underneath the bridge. Cut banks will likewise not be required. The non-grounded ice bridge will be required during the first construction season (i.e., 1997/1998 Winter) to support gravel hauling trucks, equipment, and materials. During the same season, a river ice crossing will be required to haul muds and cuttings, equipment, and manpower between the HDD east and west entry/exit point operations. This crossing will be a non-thickened river ice crossing accomplished by merely blading snow off river ice. The grounded ice bridge proposed in the original draft EED has been eliminated from consideration to mitigate potential water quality impacts.

ARCO is now evaluating the alternative of using a sea ice road running from Oliktok Point to a landfall point between the mouth of the Sakoonang Channel and Nechelik (Nigliq) Channel and then transitioning to an on-land ice road route to Alpine Pad 2. This sea ice road would be used to move a heavy development drillrig in the 1998/1999 winter and move production modules weighing up to 2,000 tons in the 1998/1999 and 1999/2000 winters. Once moved to the in-field facility, the development drillrig would remain there for a period of 4-5 years. Therefore, another sea ice road would be required in the 2002-2005 time frame to move the rig back to the KRU.

The ice bridges at the Kachemach and Miluveach rivers will be bottomfast, which is a normal condition during winter.

Pipeline/VSM Installation

The holes for the VSM installation will be drilled by dry auger from the ice road that serves as a work pad. Cuttings from the drilling operation will be handled in accordance with existing USACE guidelines.

2.2.2 Utility Pipelines

An insulated utility pipeline (12-inch nominal diameter) will be placed on the same pipeline support system as the sales oil pipeline to bring water, gas, or natural gas liquids (NGLs) from KRU to the ADP processing/drilling facility. The pipeline will have a wall thickness of 0.330 in, yield strength of 65,000 psi, and a maximum allowable operating pressure of 1,440 psi. This pipeline will most likely carry treated seawater originating at the existing Seawater Treatment Plant (STP) at Oliktok Point (north of KRU). The water will be used for subsurface reservoir waterflood (a method used to extract more oil and gas from the reservoir) and possibly for drilling water.

At the Oliktok STP, the suspended solids and oxygen will be removed from the seawater and biocides (glutaraldehyde and occasionally sodium hypochlorite) added. The temperature of the water in the pipeline will be between 40° and 100° F.

An insulated diesel pipeline (2⅜-inch nominal diameter coiled tubing) will also be placed on the same pipeline support system as the sales oil pipeline. The pipeline will have a 0.156-inch wall thickness, 52 psi yield strength, and a maximum allowable operating pressure of 2,160 psi. The wall thickness of this pipeline will be several times greater than the wall thickness required to withstand the loads expected during construction and operation. The integrity of the line should not be affected by corrosion, since diesel fuel does not have significant corrosive tendencies and the fluids will be transported at a low ambient temperature. The diesel fuel line and the utility line construction methods will be the same as those described for the sales oil pipeline.

A fiber optic cable will also be placed on the same pipeline support system as the sales oil pipeline. This cable will be inside a 1.25-inch-diameter high-density polyethylene (HDPE) conduit.

2.2.3 Pipeline Route

Figure 2.0-1 shows the proposed centerline alignment of the applicant's proposed pipeline route. The proposed (1) route, (2) Colville River crossing location, and (3) crossing method are based on a comparison of the

Source: Baker 1996, using SPOT image base map

ABR File: ICERD_RF.PRJ

Figure 2.2.1-2. Proposed Ice Road and Potential Water Sources

economic, environmental, engineering, and socio-cultural factors and statutory requirements specific to each alternative route and crossing method. The proposed pipeline route is approximately 34.2 mi long. It originates at the Alpine Pad 1 and proceeds in a general southeasterly direction to the Colville River. East of the Colville River the pipeline proceeds, in as direct a route as prudent, to Kuparuk's CPF-2.

2.2.3.1 Colville River Crossing

In selecting the pipeline crossing location and installation method for the main channel of the Colville River, the following criteria were used:

- Minimize impacts to fish and wildlife.
- Minimize the crossing length.
- Avoid areas of potential bank erosion and channel instability.
- Avoid, if possible, multiple crossings.
- Balance overall pipeline route length with crossing length.
- Avoid soils/substrates unsuitable for using HDD technology.
- Maximize installation success.
- Avoid and minimize leak potential underneath the river.
- Provide redundant structural integrity for hydrocarbon carrying pipelines.
- Minimize likelihood of an oil spill.

The optimum balance between these criteria is the proposed pipeline crossing 14, near the Putu Channel (see Figure 2.0-1). This 4,300-ft-long crossing is oriented east-west, at right angles to the river banks. The preferred crossing installation method is HDD. Four borings will be drilled under the river using HDD technology, and cased pipeline assemblies will be pulled through these bores to accommodate the required services (Table 2.2.3-1). The pipelines will be cased under the river to contain fluids in the remote event of a spill and to provide redundant structural integrity.

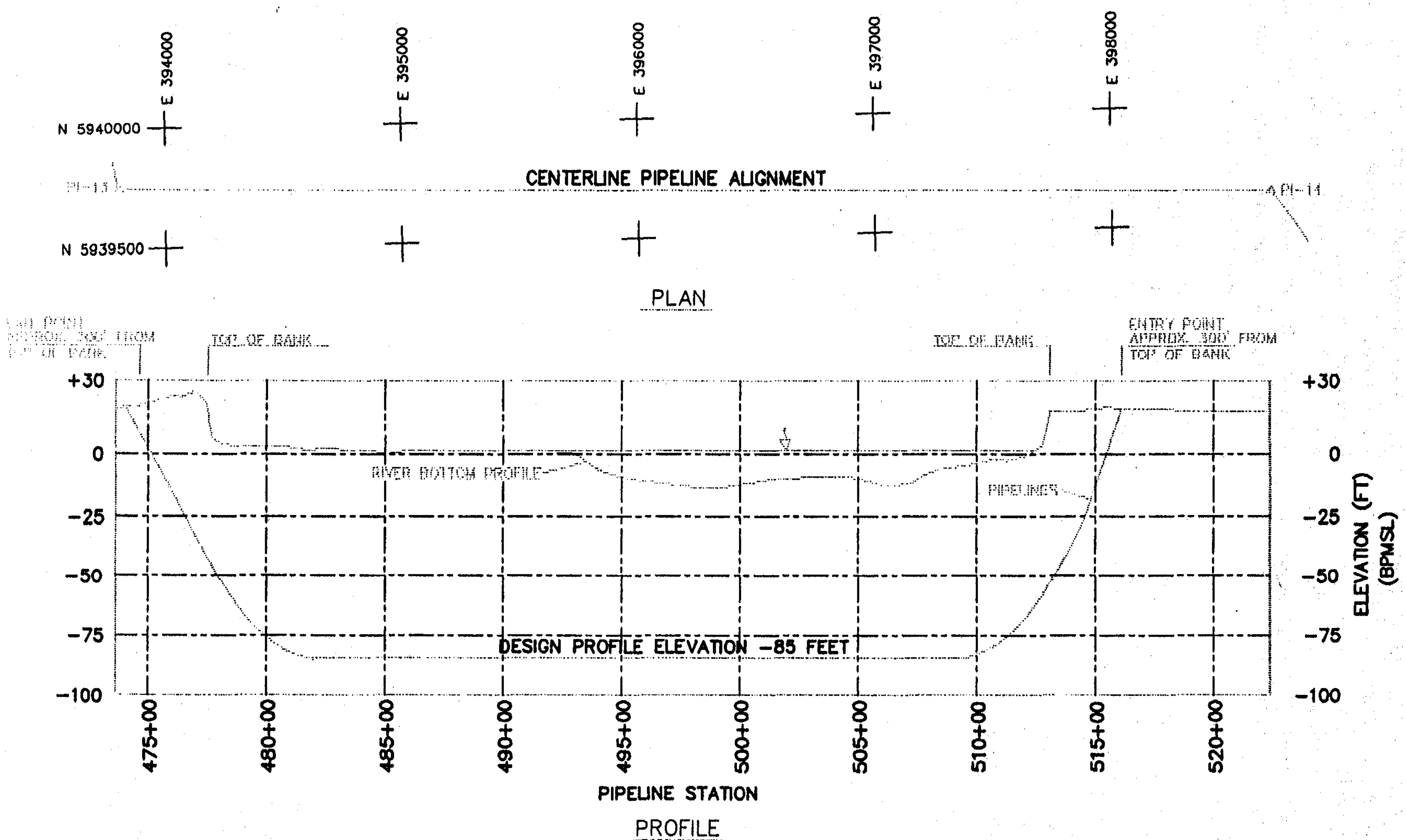
HDD technology is an effective pipeline installation method in locations where more conventional methods are not environmentally or socially/culturally prudent. The Colville River is a particularly suitable candidate for an HDD-installed pipeline because of its use by fish and wildlife, and by humans for subsistence; its high water flow during break-up; and the potential for ice, erosion, and scour that could damage either an above-ground or trenched pipeline crossing.

HDD eliminates in-water construction impacts associated with installation; allows river bank setbacks before pipelines emerge (thereby allowing unimpeded movement of wildlife and humans parallel to the river [see Section 2.9 Mitigation Measures]); provides protection to the pipeline from human traffic; and provides overall excellent leak containment (enhanced by casings design). One of the major objectives of bored pipeline crossing designs is to ensure that the pipeline is not exposed to the hydraulic and abrasive forces of water flow and sediment movement. HDD crossings also eliminate temporary and permanent impacts to fish and wildlife habitat.

The HDD drilling profile would compensate for river channel movement. The channel shows evidence of general long-term eastward migration that appears to average 1.5 ft per year over 30 years. Based on these data and a hypothetical one-time migration event of 36 ft, the design bank migration for the east bank is 90 ft. This is considerably less than the HDD pipe entry location, which is approximately 300 ft from both the east and west river banks (Figure 2.2.3-1 and Section 2.9, Mitigation Measures). Based on historical evidence, the west bank will be stable. The exit and entry locations are considerably beyond the erosional influence of ice jams.

History of HDD Technology Application to the Colville River

HDD technology was developed in late 1970s by construction contractors seeking to develop improved methods for completing pipeline crossings impeded by large natural and man-made obstacles. The concept of using an inclined drillrig, together with a "wet drill" system (utilizing slurry to move or remain suspend augured materials), was developed and applied to crossing situations involving rivers, large highway systems, or other situations where conventional trench excavating methods caused significant temporary impacts and long-term maintenance concerns.



Source: Baker 1997

HORIZONTAL SCALE IN FEET : 1 1/2" INCHES = 1000 FEET
VERTICAL SCALE IN FEET : 1 INCH = 20 FEET

Figure 2.2.3-1.
HDD River Crossing Plan and Profile

Table 2.2.3-1. **HDD bore hole and casing information.**

Bore No.	Casing Diameter	Service Lines in Casing
1	20 inch	14-inch oil sales line
2	18 inch	12-inch utility line
3	8 inch	2 3/8-inch diesel fuel line
		24-strand ducted fiber optic cable
4	8 inch	Casing serves as cathodic protection anode.

As with any emerging technology, HDD has endured its share of failures during the developmental stages. As experience with the technology has matured, an understanding has been developed as to the factors that limit success for HDD. Additionally, improvements in technology have enabled HDD to be used in conditions previously considered infeasible. Failures in initial HDD efforts were primarily the result of attempting to use HDD in non-conducive soil conditions. Subsurface conditions with cobbles, boulders, and significant amounts of sands or coarse gravels presented problems for HDD. These materials are dense and would not move or suspend within the slurry. This would cause obstacles in the drilled borehole and prohibit pulling the pipe through. To improve the odds of success, soil investigations are now completed well in advance of construction, and are reviewed by experienced HDD personnel, to determine feasibility. In addition, improvements in slurry mixtures, using environmentally safe polymers and other additives, have radically improved the ability of HDD to work successfully in difficult soil conditions, including rock. However, it is still not possible for HDD technology to be applied to all soil conditions.

Subsurface fracturing or faulting contributed to another early problem of HDD: inadvertent returns. Any fluid will attempt to move in the path of least resistance. Slurry is under pressure due to the elevation change, and if an HDD bore crosses a significant fault or fracture, slurry will flow to it and possibly escape at the ground surface if resistance to flow is low. This could cause degradation of earthen foundations and entry of slurry (although non-toxic) into undesirable areas such as streams, lakes, or places of public convenience and necessity, such as parks or highways. Again, investigation of subsurface conditions by knowledgeable personnel (geologists, civil engineers and experienced HDD personnel) is required to avoid this situation, ensuring the subsurface does not contain features which could cause inadvertent returns to occur. If it is deemed possible that inadvertent returns could occur, but HDD is still the desired method of installation, additional precautions can be taken to prevent damage. These precautions include drilling supplementary bores to direct slurry away from sensitive structures, and monitoring underground pressures to guard against higher pressures which exacerbate inadvertent returns.

Controlling the actual drill path was another problem encountered in the development stage of HDD. The drill bit and pipe were originally directed by applying force to rotate the drillrig, causing the drill pipe and bit to react and push in the opposite direction. "Flying blind" was the acronym, and enabling the drill bit to come up on the opposite side of the obstacle was initially considered a substantial feat. Today's construction technologies employ magnetic tracking systems, gyroscopes in the drill bit and mud motors directly behind the drill bit to actually "steer" the drill bit, and track it from the surface. Today's technology advances allow HDD contractors to hit a circle the size of a hula hoop at distances of 4,000 to 5,500 ft.

In summary, today's HDD technology is a combination of improved understanding of subsurface limitations, and improved accuracy.

HDD Technology Application to the Colville River

The decision to use HDD technology is based on an extensive study of the technology's present status and its application in an arctic environment. The selection of HDD technology for installation of the pipelines across the Colville River-East Channel was based upon the following HDD issues and subsequent follow-up investigations:

- Subsurface Conditions – knowledge of subsurface conditions at the crossing location is critical to successful HDD installation. Experience has shown that cobbles, boulders, coarse gravel, and highly fractured rock prohibits the successful use of HDD technology. To investigate subsurface conditions, 21 boreholes were drilled at two crossing locations on the Colville River, East Channel, as deep as 200 ft. Soil conditions were studied and the ground thermal regime identified. The soil evaluation identified a highly consolidated silty-clay layer at depth. Silts and clays are extremely conducive to HDD because they consist of fine-grained material with good cohesion properties. These conditions were compared to previously successful HDD crossings with similar soil conditions. This soil strata is a highly consolidated formation, well below the fluvial deposits in the upper riverbed strata. Material fractures are highly unlikely. This reduces to almost zero the potential for inadvertent returns.

- Application of HDD to arctic conditions – The use of HDD in arctic conditions affects two primary areas: that of working in cold weather and thermal effects of drilling in permafrost. HDD-installed pipeline crossings have been previously completed in cold regions of southern Alaska and northern Canada. Use of ice pads and roads, and enclosing HDD activities at the entry and exit locations in shelters minimizes the effect of cold weather on HDD installation productivity and minimizes construction impacts. These same conditions will be employed for the Colville River crossing.

- Evaluation of the HDD technology for drilling through permafrost has shown that slurry circulation can be maintained with conventional bentonite/water mixtures without substantial freezeback or plugging of the borehole. In addition, numerous additives, polymers and more effective slurry mixtures can be employed that have the freeze point depressed below-ground temperatures at the Colville River. These alternative slurry mixtures consist of compounds known as xantha gums (the primary ingredient in chewing gum), hydroxides, salts, and other mixtures which, by previous experience are proven to be environmentally benign and/or already present in the native soils at the crossing location.

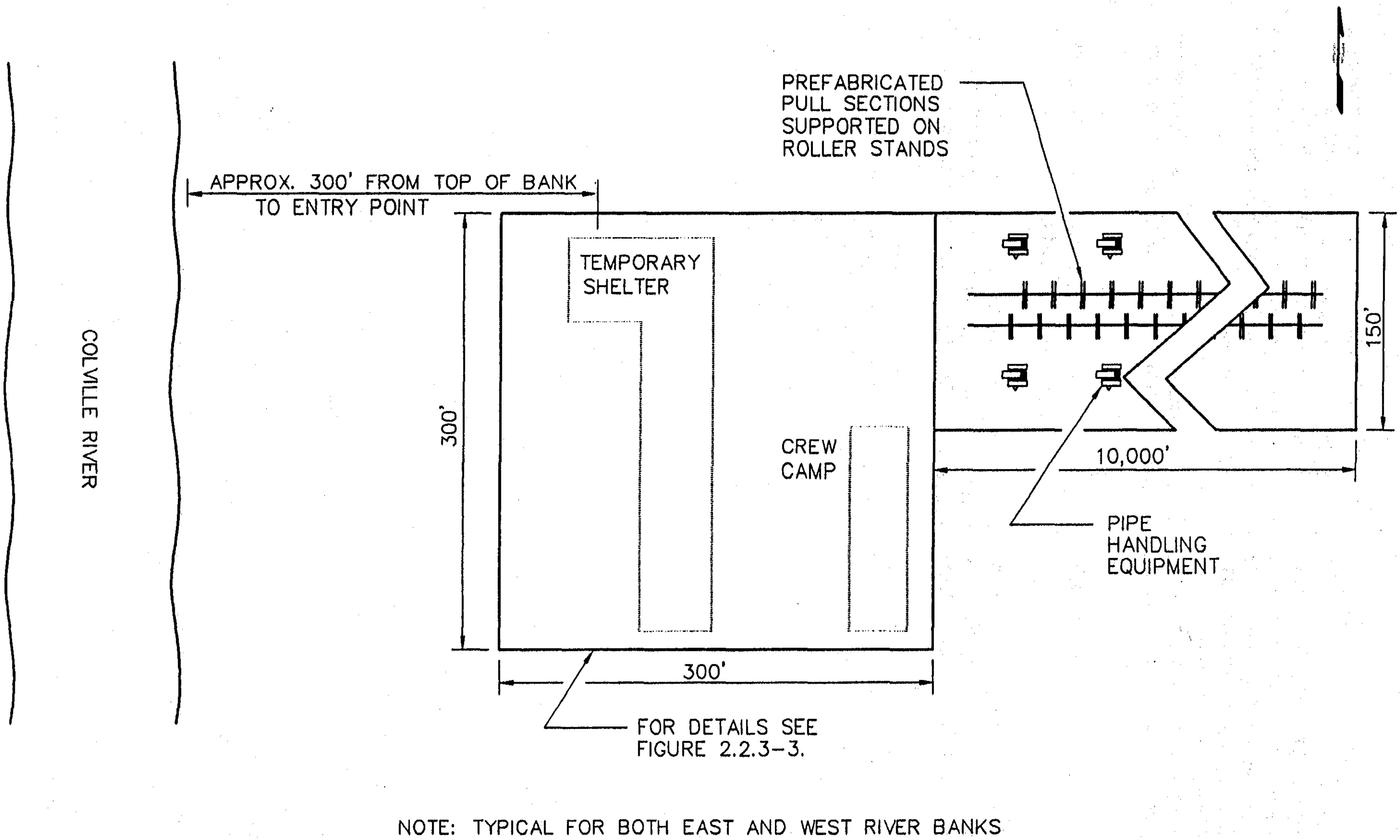
- Schedule – to be successful, it is imperative that the HDD installation effort be mobilized, completed, and demobilized within one winter construction season. A schedule analysis was completed using conservative estimates for: tundra travel allowance, HDD productivity, and typical construction execution inefficiencies. The analysis concluded that the HDD effort can be completed using 60% of the available construction days in a winter construction season.

Construction

HDD Operation. Operations begin by drilling a small pilot hole. Next, the cuttings (material removed from the penetrated subsurface during drilling) are carried out of the pilot hole by slurry (a suspension of fine, solid material in liquid, which is used to facilitate drilling). The cuttings are separated from the slurry and then the slurry is recycled and/or separately contained, depending on the volume of excess solids that remain in suspension after separation. Once the pilot hole is completed, it is enlarged (by making multiple passes with a reamer) to achieve a maximum bore hole diameter of 36 inches. The reamer does not remove all of the cuttings it creates, but suspends them in the slurry circulated through the bore hole. After the hole is reamed out, the pipe is pulled through the hole, using the lubricity of the slurry to pull the pipe through the native material with little friction. Four holes will be bored and reamed; one for the sales oil pipeline, one for the utility pipeline, one for the diesel fuel pipeline and fiber optic cable, and one for the cathodic protection system. The centerline of the holes will be approximately 10 ft apart at the entry and exit holes.

Slurry handling and disposal practices for the HDD drilling will be as follows: (1) bentonite/water drilling mud without additives will be used unless conditions determined at the time of drilling require additives to maintain a safe and effective mud weight and viscosity; (2) drilling mud will be continuously circulated during drilling; (3) coarse drill cuttings will be removed from the mud at the surface before the mud is recirculated; (4) with regulatory approval, drill cuttings removed from the mud may be recycled into gravel used to construct ADP gravel facilities or may be disposed of as overburden at the gravel mine site (or may be transported back to KRU or PBU for disposal); and (5) drilling mud will be transported back to KRU or PBU for disposal by subsurface injection.

Pipe Stringing/Pulling. Two temporary ice/snow pads will be constructed in alignment with the bore hole path on each side of the river, beginning at the pipe exit and entry locations and continuing away from the river for the length of the pipe casing and internal carrier pipelines (Figure 2.2.3-2). These pads will be approximately 10,000 ft long and 150 ft wide. In addition, a 300 by 300-ft pad will be required on the entry and exit sides. These pads will be in work areas and include drilling shelters that house drilling rigs and mud recycling equipment to process excess slurry. A detailed description of the HDD process is provided in the ADP Colville River Design Report, June 1997.



Source: Baker 1997

ARCO Alpine Development/55-2042-04(02) 9/97

**Figure 2.2.3-2.
Colville River Crossing
Temporary Work Pads**

Prior to completion of the bored holes, the pipe strings will be fabricated. The pipes will be welded, non-destructively examined (NDE) with radiographic and/or ultrasonic techniques, hydrotested, and the pipe joints coated. The prepared pipe strings will then be pulled into the bore holes. The end of the pipe will be equipped with a pulling head and swivel attached to the drill stem. Sidebooms will lift and guide the pipes into the bored hole as the drillrig on the other side of the river pulls the pipe string.

After the pipes are installed, the work area will be cleaned and left clear.

Temporary Shelter. To minimize the effect of winter weather, temporary shelters will be constructed on the 300 - by 300-ft ice pads to house the construction personnel, drilling equipment, and supplies (Figure 2.2.3-3). The floor of the heated shelter will be covered with a waterproof membrane and timber mats to prevent possible melting and damage to the tundra. Other activities, such as pipe string welding, will be completed outdoors on snow pads.

Construction Season. The HDD installation will be completed in winter. Summer construction was evaluated but rejected for the following reasons:

- Winter construction avoids/minimizes impacts to wildlife and fish habitats and human use patterns.
- Work pads and access roads for summer construction would have to be constructed of gravel, as compared to seasonal ice pads for winter construction.
- The strings of pipe pulled into the bored holes would require special handling if constructed during the summer. With winter construction, ice pads can be built on the frozen tundra and lakes, to line up the long pipe strings, without damaging the tundra.
- Winter construction minimizes impacts from temporary storage of muds and cuttings on ice pads prior to disposal. Summer construction would require extended storage of mud and cuttings on-site until winter conditions allowed access for hauling.
- Summer construction would require heavy equipment to be moved on-site during winter because of the relative ease of winter travel. The equipment would stay at the site on temporary, insulated ice pads or mats, unused, until the summer construction season started. This mode of operation would be prohibitively expensive, and would not avoid/minimize impacts to wildlife and fish habitats and human use patterns.

In conclusion, the environmental, socio-cultural, and economic costs/impacts overwhelmingly favor winter construction.

2.2.3.2 Kachemach and Miluveach River and Smaller Stream Crossings

The cross-country pipelines will be elevated on VSMs to more than 5 ft (see Section 2.9, Mitigation Measures) above the Kachemach and Miluveach rivers and small streams (see Figure 2.0-2) as dictated by local topography. The hydrology of smaller rivers and streams will determine the appropriate location to place VSMs away from scour or active channel locations. If local conditions warrant, the VSMs will be strengthened (i.e., larger diameter and thicker walls) to withstand the force of high flows. These streams are typically dry before freeze-up and do not produce thick ice. The JPO pipeline ROW process will determine and verify these design criteria.

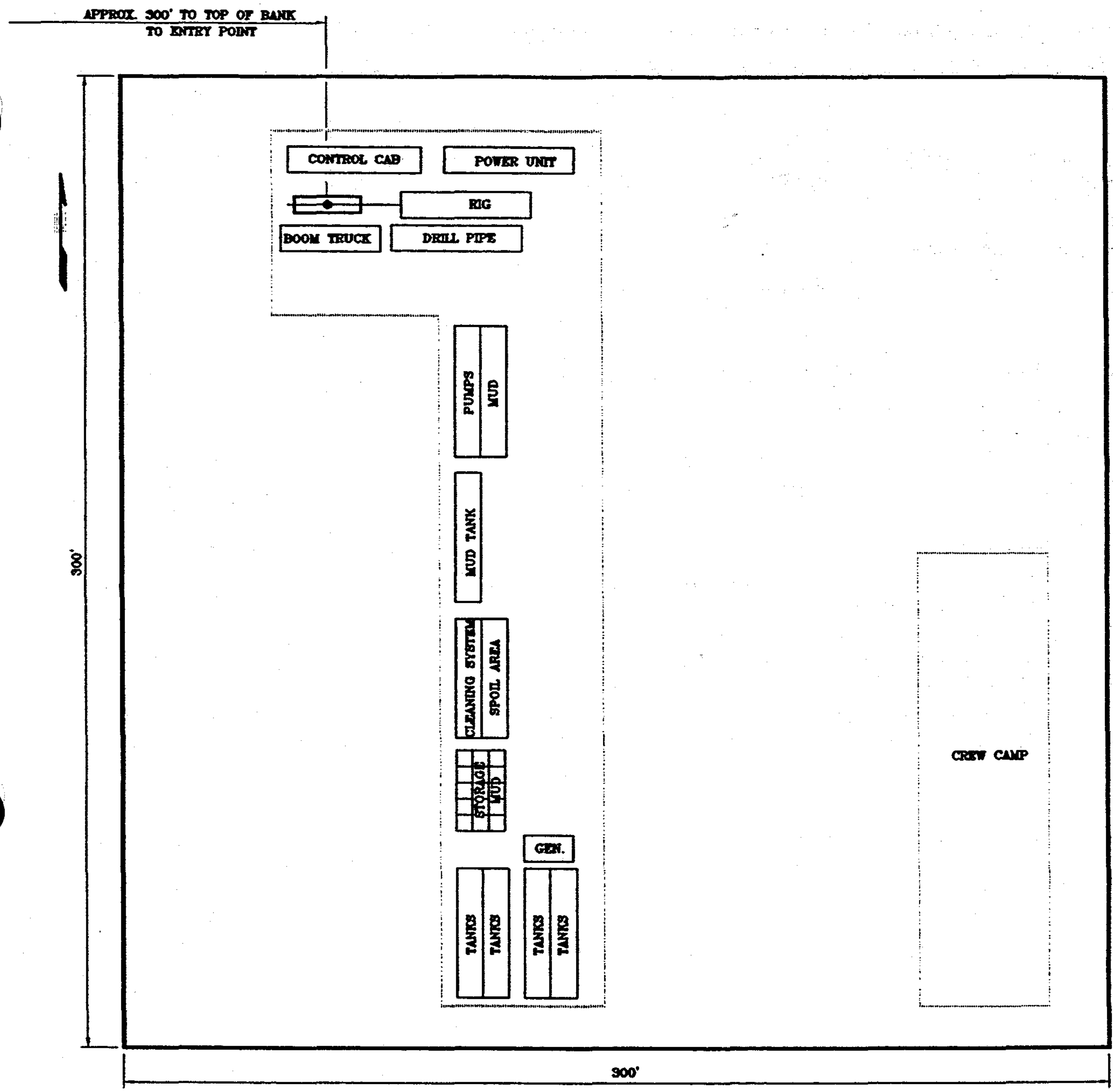
2.3 ACCESS

Construction and drilling access during winter will be by temporary ice roads, ice bridges, and aircraft. Summer access will be by boat or aircraft. A 5,900 ft-long, 180-ft -wide, and 5- to 8-ft-high airstrip will be built during the first year of construction, essentially as a wide spot in the gravel road at the in-field facility. The airstrip will be oriented in a southwest/northeast direction.

Access during long-term operation (Phase III) of the ADP will primarily be by small airplanes and helicopters (see Section 2.9, Mitigation Measures). Ice roads and ice bridges built during this phase will be constructed only every three to five years when a drilling rig(s) or maintenance project warrants the activity. Table 2.3.1-1 lists the transportation modes and their frequency of use for construction and operation of the ADP (Also see Section 2.9, Mitigation Measures).

2.4 MATERIAL SITES

The gravel source will be the Nuiqsut Constructors, Inc., permitted gravel mine (also shown on the EED



Source: Baker 1997

ARCO Alpine Development/55-2042-04(02) 9/97

Figure 2.2.3-3.
Temporary Construction
Pad and Shelter Layuot

Table 2.3.1 **General seasonal access needs for construction and operation of the ADP.**

	Construction		Operation	
	Summer[1]	Winter[1]	Summer	Winter
Personnel[2]	**50-100**	**300-400**	**20-40**	**30**
Air Trips[3] (Aircraft shown or equivalents)				
Boeing 737	2-3 per month	2-3 per month	1 per month	1 per month
Otter	1-2 per month	1 per day	3 per week	3 per week
Hercules or DC-6	1-2 per week	1-2 per week	As needed, but infrequent	As needed, but infrequent
Vehicle Trips				
Pad-to-Pad	Frequent	Frequent	Daily	Daily
Ice Road	NA	Frequent	NA	Daily

1 Seasons defined by ability to use ice road for access. For this analysis, summer is defined as April 20 to November 30. Winter is December 1 to April 19.

2 Peak personnel needed during most intensive winter construction season.

3 Restrict airstrip use from June 1-July 15 to aircraft weighing less than 105,000 lbs take-off weight (i.e., Boeing 737 prohibited) unless excepted by FAR PART 36-Stage 3 (noise level category), safety emergency, or by Subsistence Oversight Panel (see Nuiqsut mitigation). Minimize aircraft use during June 1-July 15, and maintain 500-ft minimum altitude except for take-off and landing patterns. Maximize aircraft use during winter. Also see Section 2.9, Mitigation Measures.

maps as the ASRC mine site) located just east of the Colville River main channel and approximately 1 mi south of the HDD crossing (X14). Nuiqsut Constructors, Inc., a Native joint business venture, has obtained a permit from the State of Alaska to mine the gravel.

2.5 WATER SITES AND USE

2.5.1 Phase I: Construction/Pre-Start-up Development Drilling

Approximately 42 to 65 million gallons of water will be used during winter for ice road construction each year during Phase I and Phase II, but only every three to five years during Phase III, and 10 million gallons will be used during the 1997/98 winter for the HDD crossing of the Colville River. In the 1995 winter exploratory program, 42 million gallons were used for ice roads and pads; in the 1996 program, 65 million gallons were used. Sources of water will be deepwater lakes that will be re-authorized for use by the State of Alaska. These sources were previously used to support 1995 and 1996 exploratory operations (see Figure 2.2.1-2). These lakes were authorized for use by the ADNR (permit LAS 18597) for 435.5 acre-ft of water per year at 1 million gallons per day, and by the Alaska Department of Fish and Game (ADFG) (Fish Habitat Permits, FG95-III-0239, dated November 8, 1995) for withdrawal from 52 lakes within the transportation corridor and Colville River Delta. All re-authorized lakes will be greater than 7 ft deep, and have a combined volume of approximately 6.5 billion gallons. The ADNR and ADFG restrict use of water in these lakes to 15 percent of a given lake's water volume under typical ice cover conditions, or approximately 447 million gallons; this represents six times more water than the projected water requirements for any year. Water use will be monitored by using metered pumps and recording the number of truck loads of known water volume, as is done at KRU. ADFG may require additional monitoring of use.

The proposed water source at ADP (Lake 9313) is a perched lake with infrequent flooding; it has a permittable volume of 4.0 million gallons. ADFG has indicated that recharge of this lake may be possible from the Sakoonang Channel, however, a separate proposal for this activity will be submitted to ADFG.

Other lakes are available in the in-field facility area as potable water sources capable of providing 30 million gallons. In the vicinity of the HDD crossing, approximately 53.7 million gallons of water are available from nearby lakes (L9334 and M9603). There are many lakes along the route of the ice road from which water could be withdrawn, thereby lessening the impact to any single lake. For example, lake L9123 near KRU contains 31.8 million gallons of permittable water; Lake MC7903 between KRU and the Colville River contains 42.4 million gallons; moving across the river toward the ADP in-field facility, Lake AMC7911 contains 34.3 million gallons, and moving north towards the in-field facility, Lake B8534 east of Sakoonang contains 41.4 million gallons.

During the winter construction seasons, potable water requirements will be 100 gallons/day/person x 350 people or 35,000 gallons/day. The potable water will be trucked to the construction field camp from KRU. During the summer of 1998, ARCO plans to blade and compact the gravel laid the previous winter and install drainage structures at the in-field facility. This will require 6-12 people temporarily based at Nuiqsut. During the summer of 1999, ARCO will be conducting site preparation. A fully self-contained, permitted construction camp with potable water and sewage disposal facilities will be operational at this time.

Pre-start-up development drilling water will be obtained either from (1) approved deepwater lakes, (2) the Nechelik (Nigliq) (if authorized) or Sakoonang channels of the Colville River (if authorized), (3) a dedicated source water well, or (4) the waterflood supply pipeline. Total drilling water demand will be 21,000-63,000 gallons per day.

2.5.2 Phase II: Start-Up/Development Drilling

Start-up/development drilling water will be obtained either from approved deepwater lakes or from the Nechelik (Nigliq) or Sakoonang channels of the Colville River, (if authorized), from a dedicated source well, or from the waterflood supply pipeline. Total drilling water demand will be 42,000-63,000 gallons per day. Potable water will be trucked to Alpine from the KRU.

2.5.3 Phase III: Long Term Operation

During operation, fresh water will be used at the in-field facility for maintenance drilling, potable water, and firefighting. A pumphouse will be located at Lake L9313, (see Figure 2.0-1). The pumphouse will provide untreated water to the in-field facility where it will be processed before use. The water in the lake will be accessed by pipeline from Alpine Pad 1.

2.6 SUPPORT FACILITIES

2.6.1 Construction Facilities

The number of construction personnel will peak when installing both the sales oil pipeline and the utility pipeline in a single winter season. Up to 300-400 people will be employed during the winter construction phase of this project; they will be housed in camp facilities on location and/or at KRU. Potable water will be trucked via ice road to the site from KRU; sewage and solid waste will be hauled to KRU for treatment and disposal.

2.6.2 Operation Facilities

Approximately 20-40 people will be housed at the facility during operation. Solid waste and sewage solids may be incinerated at the site or ground- transported to KRU or PBU for disposal. Organic wastes may be composted at the site, depending on the success of a pilot program currently being conducted at PBU. Gray water will be injected into a permitted disposal well. Non-combustible solid and oily waste will be ground-transported to KRU for disposal.

2.7 SPILL PREVENTION, DETECTION, AND RESPONSE

ARCO will implement the following spill prevention, detection and response program, which will be further developed into an oil spill plan before the start of operations.

2.7.1 Spill Prevention Measures

ARCO has designed the project facilities, the aboveground pipelines and the underground Colville River crossing to minimize the possibility of spills. ARCO will also implement a pipeline maintenance and inspection program, an employee spill prevention training program, and a Pollution Prevention Program to further reduce the likelihood of spills occurring.

2.7.1.1 Aboveground Pipeline Design Features

ARCO will design and construct the pipeline to comply with all state, federal, and local regulations, and will go beyond those minimum requirements, as described below. As explained above, the sales oil, utility and diesel pipelines will be constructed of high-strength steel and will have wall thicknesses equal to or in excess of regulatory requirements. Welds will be non-destructively examined (NDE) (i.e., radiography and ultrasonic) during pipeline construction to ensure their integrity, and the pipelines will be tested hydrostatically prior to operation.

ARCO will incorporate vertical expansion loops into the pipeline design to reduce the potential for oil spills and to reduce the potential spill volumes (Figure 2.7.1-1). The expansion loops will be constructed at an upward angle to prevent backflow of oil where topographic gradients exist (e.g., river crossings). In an idealized vertical loop, the pipeline takes a 90 degree upward turn, followed by a 90 degree horizontal turn which causes the pipe to continue horizontally at an elevation for 45-65 ft, and then it returns to normal elevation through two more 90 degree bends. This elevated segment, the height of which is dependent upon the topography (slope) along the line (as much as 20-25 ft), provides a constant valveless spill limitation device. This design, which has been approved by the USDOT (Appendix X), will reduce potential spill volumes by as much as 50-55% as compared to a valved pipeline design. Five of the nine vertical expansion loops will be located at the Colville River (one on the east side), Miluveach River (one per side), and Kacheamach River (one per side).

2.7.1.2 Underground River Crossing Design Features

To further prevent a pipeline leak under the Colville River, the sales oil pipeline will be installed inside a high-strength casing pipe. This "pipeline-within-a-pipeline" approach is fairly unique for HDD pipeline river crossings. Simultaneous failure of both the sales oil pipeline and the casing pipe is highly unlikely. If oil leaked from the sales oil pipeline, it would be captured within the space between the outer wall of the sales oil pipeline and the inner wall of the high-strength casing pipe, rather than reaching the subsurface river environment. This design is analogous to secondary containment provided as a spill prevention technique for storage tanks. The same encasement design will be used for the utility (most likely sea water) pipeline and the diesel fuel line, each of which is separately encased, with similar benefits. The casing performs a second function in that it is designed to accommodate the external loads that would normally be carried by the carrier pipe. The casing and carrier pipe do not distribute loads between each other, due to the spacer design included, which means that a deformation of the casing pipe would not cause deformation of the pipeline carrying crude oil effectively provides double integrity against external loads.

To prevent external corrosion, all of the casing pipes and carrier pipes are protected by a mechanically tough state-of-the-art fusion-bonded epoxy coating. In addition, and in response to comments regarding additional prevention, another 8-inch pipe parallel to and near all of the casing pipes provides the anode portion of a cathodic protection system to prevent corrosion of the casing pipes. Cathodic protection is designed to detect and counteract electrolytic differences in the metalurgical chemical and soil characteristics of the pipes and the materials that surround them to inhibit corrosion (this is comparable to devices placed on the hulls of boats and specialized paints and coatings that prevent seawater corrosion).

Careful technical review and selection of materials, coatings, and protections have been conducted and included in the design and were reported in the technical summary transmitted to the JPO on June 2, 1997.

2.7.1.3 Facility Design

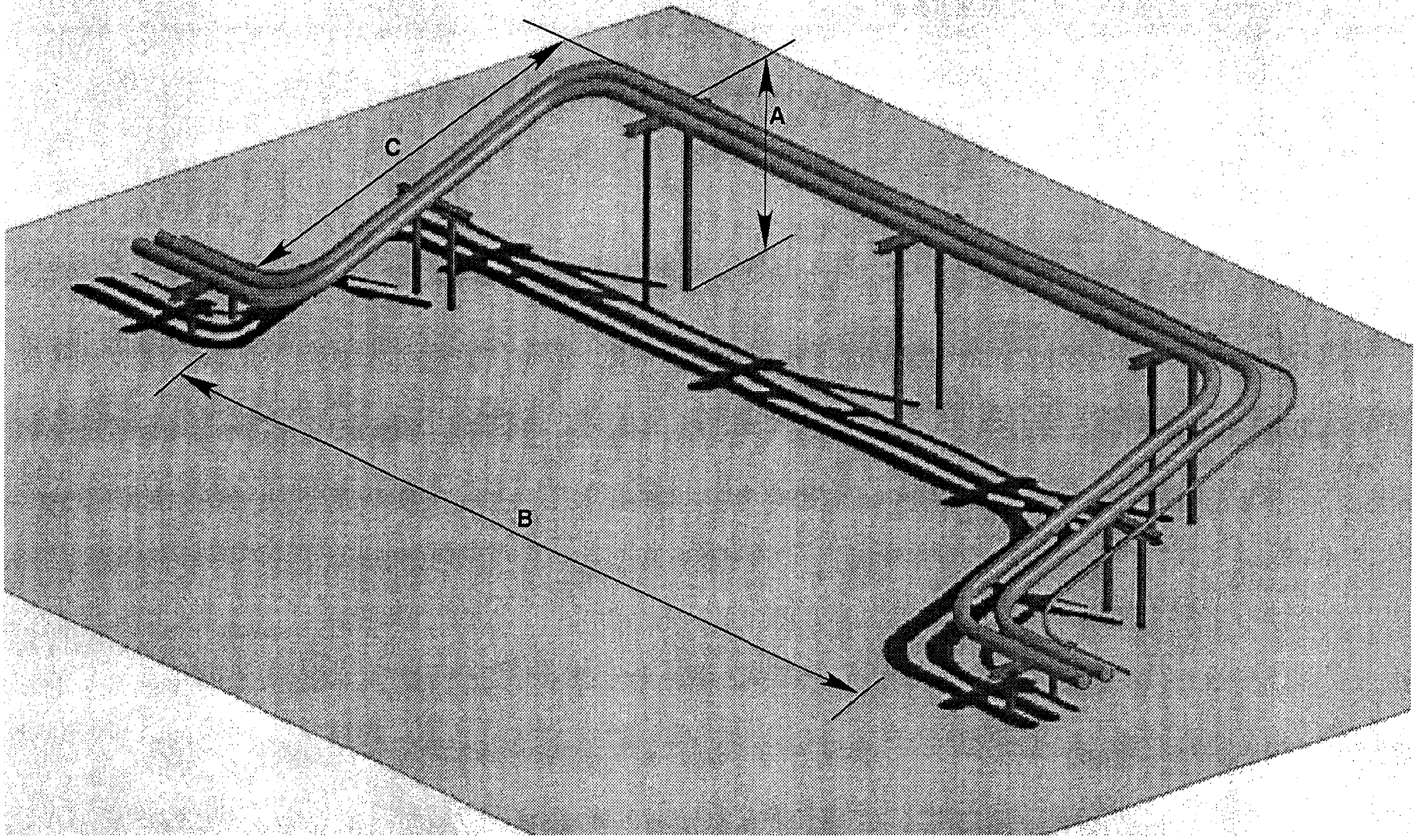
ARCO's production facilities will include secondary containment structures for fuels and hazardous materials, as required by state and federal regulatory requirements. Storage tanks and processing facilities will be located away from the Nechelik (Nigliq) Channel to avoid and minimize any potential spill impact. The Nechelik (Nigliq) Channel is comparably more dynamic and receives the greatest human and subsistence use.

2.7.1.4 Employee Spill Prevention Training

ARCO will provide regular training to its employees on the importance of avoiding oil or hazardous material spills, and spill response. ARCO will provide new-employee orientation, annual environmental training seminars, and appropriate certification classes about issues, including spill This prevention and response. ARCO employees will participate in frequent safety meetings, which will address spill prevention and response issues, as appropriate. ARCO's Incident Management Team will also participate in regularly scheduled training programs and will conduct spill response drills in coordination with federal and state agencies.

2.7.1.5 Pipeline Inspection And Maintenance Program

An important component of ARCO's spill prevention program is its pipeline inspection and maintenance program. At regular intervals, ARCO will inspect the pipelines using "smart pig" technology that involves inserting a mechanical device, called a "pig," which is fitted with sensing and telemetry devices, into the



Source: Baker 1997

ARCO Alpine Development/55-2042-04(02) 9/97

Purpose: - Replaces pipeline valves to reduce the risk of oil spills.
- Minimizes potential oil spill volumes.
- Enhance wildlife/human crossings.

There will be nine vertical expansion loops at various locations between the east bank of the Colville River and CPF-2.

A 15-25 Feet High
B 100-120 Feet Long
C 40-50 Feet Wide
(Approximate and Typical)

Figure 2.7.1-1
Typical Vertical Expansion Loop

pipeline. The pig data identifies anomalies in the pipeline that require closer investigation. The inspection data will be used to perform appropriate maintenance to correct problems before they result in a spill.

2.7.2 Spill Detection Methods

Although the special design features referred to above will avoid or minimize the likelihood of a spill, ARCO will also employ spill detection techniques that give early warning of potential problems. The spill detection program has two key elements: a computerized leak detection system and visual inspections.

ARCO will use computerized pressure point analysis (PPA) and mass balance leak detection systems. The state-of-the-art PPA system detects leaks by comparing instantaneous pressure data to trended pressure data (using a computer algorithm) and compares the data set used to define the current operations with the data set used to define the current trend and characteristic leak profiles. The PPA system determines the probability that it has found a leak and checks to determine whether the anomaly could be from known events in progress. If the anomaly cannot be explained, the system notifies the operator. ARCO will also use a computerized mass balance system and Supervisory Control And Data Acquisition System (SCADA) for leak detection. Both systems will use a fiber optic communications network for data transmission, because it is more reliable and has more data capacity than microwave systems.

ARCO will also conduct frequent visual examinations of the pipeline and the project facilities. ARCO will visually monitor the pipelines by conducting aerial overflights more than 26 times per year. Inspection aircraft will fly at a maximum elevation of 500 ft, and most overflights will allow inspection both visually and with the aid of forward-looking-infrared (FLIR) technology. Infrared technology permits identification of potential spills based on the temperature "signature" resulting when warm crude oil leaks onto the ground. The FLIR technology is capable of detecting warm spots even when it is dark, or when other circumstances limit visibility. FLIR technology has the ability to identify trouble spots, such as damaged or wet insulation, before a problem occurs. ARCO will also conduct regular ground-based visual inspections of infield facilities and accessible portions of the pipelines.

ARCO is also evaluating the possibility of using pressure sensors, flow sensors, vapor detectors, or hydrocarbon liquid detectors to monitor below-threshold leaks from the portion of the pipeline crossing under the Colville River. There is concern about the reliability of these devices, especially considering the low ambient temperature and the remote site. The decision to install any mechanism will require a feasibility and practicality evaluation. Final selection of any system will be based on its accuracy, reliability, and sensitivity.

2.7.3 Alpine Spill Response Plan

The protection of waters and landforms of the ADP and all areas potentially affected by it, including the pipeline ROW, will be accomplished through implementation of an OSCP designed to meet impacts produced as a consequence of accidental oil spills. During the construction phase of the project, the existing ADEC approved Kuparuk Field ODPCP will be used. Through the ODPCP, the vast, readily accessible inventories of appropriate oil spill response equipment and personnel that are part of the Kuparuk and Prudhoe infrastructures will be available for use in the ADP. In addition, the spill response cooperative, ACS, will provide trained personnel to manage all stages of any spill from detection to containment to clean-up. The Nuiqsut Village OSRT is also a major element of oil spill preparedness.

Planning is already underway for creation of an ADP ODPCP when the production facilities begin to operate. The ADP ODPCP will complement the larger, slope-wide technical manuals being developed by the North Slope Spill Response Project Team, whose membership includes the NSB and its villages, regulatory agencies, response organizations (ACS for example), and oilfield operators.

The Colville River Delta and its channels and distributaries, the waterbodies and lakes in the ADP area, and the watercourses lying along the pipeline ROW were systematically surveyed in the summer of 1995-96 and again in August 1997 by Dr. Ed Owens, oil spill specialist, with the object of identifying key potential oil spill control points where pre-staged and pre-deployed response, containment, recovery and clean-up equipment effectively could be located. Each of these control points has been identified for specific reasons that include environmental resource protection or effective access by boats where channel water depths are sufficient to accommodate them throughout the entire open-water season.

Equipment at these locations would be tailored to meet the needs of spill response required at the individual pre-identified potential oil spill control points. The equipment pre-staging would also be designed with the concept to access it by air (helicopter), boat in the open-water season, or all-terrain vehicles (ATV) after hard freeze-up if tundra travel is necessary since there is no gravel road access along the major portion of the pipeline ROW.

Although further surveying and future experience may indicate that not all the pre-identified potential oil spill control points surveyed to date by Dr. Owens will require equipment pre-staging and boom pre-deployment in the open-water season, the following locations have been selected to insure that protection from potential spill impacts can be achieved prior to start-up and during all phases of the ADP (Figure 2.7.3-1). Six locations have been identified as appropriate for pre-deploying boom in stream and watercourses during the open-water season: (1) the Miluveach and Kachemach rivers immediately downstream from the point where they are to be crossed by the pipeline; the Sakoonang Channel at one location north from Pad 1, and two locations south from Pad 1 along the pipeline route within the Delta; at the exit channel from the Nanuk Lake complex (located just south of Alpine Pad 2) to the Nechelik (Nigliq) Channel. Pre-staging of response equipment could occur at up to eight potential control points: on the Nechelik (Nigliq) Channel north from Pad 2; at a large bend in the Sakoonang Channel downstream from the projected pre-deployed boom location; on the Tamayayak Channel; on the Kupigruak Channel; at the northerly mouth of the Kachemach and the mouth of the Miluveach Rivers where they join the Colville River Main Channel; and on both the east and west banks of the main channel at the HDD crossing (see Figure 2.7.3-1).

2.8 OPERATIONS AND MAINTENANCE

On-site personnel will perform most operation and maintenance. During operation of the ADP, there will be 20-40 personnel per weekly shift.

Operation and maintenance of the pipeline system will include routine operation and maintenance, initial spill response, and monitoring of the pumping and metering units and the pipeline itself.

Only crucial remote site services will be performed at the in-field facility. Major warehousing and repair shops will be located offsite, either at KRU, PBU, or at a private vendor's facility.

2.9 MITIGATION MEASURES

ARCO's front-end loading of the permitting process has created the following mitigation measures plan for the ADP. As stated below, this plan is the result of interaction with interested parties; expert contractors; state, federal, and local agencies; Native entities; Colville River delta residents; and consultation of historical databases.

Since 1992, ARCO has made 19 well penetrations in the Colville River Delta. These well and testing data have been correlated with extensive seismic data to accurately size and site the proposed production facilities with respect to the subsurface reservoir. ARCO has spent approximately $10 million on focused environmental and technical studies and has integrated agency and interested party input into study scope designs.

Broad environmental, social, and technical studies of the Colville River Delta area dating back approximately 50 years were thoroughly reviewed to assist in design of ARCO's six years of subject-specific studies. Input was sought from Native entities; Colville residents; state, federal, and local agencies as well as from other interested parties, and was incorporated into the scope of ARCO's focused studies. These programs are summarized in Appendix C.

Over the past 28 months, ARCO has conducted pre-application workshops, town meetings, individual coordination discussions and meetings, and on-site field trips (see Section 5). Public pre-application workshops were held in Anchorage and Nuiqsut. In March and April 1996, ARCO distributed two information packages (see Appendix A) that presented (1) key findings (graphics included) of the focused environmental and technical studies (excluding 1996 study findings which were not yet available), (2) executive summaries of potential impacts identified by qualified experts, (3) a report of significant comments received to date, and (4) a record of major meetings (minus phone calls) to date. Replies to this information have been integrated into the applicant's mitigation plan. The scope of studies planned for 1997 are included in Appendix R.

Since submitting the EED to the USACE on October 8, 1996, the state, federal and local agencies, (including NSB), and interested parties have provided two rounds of comments. One round was provided after ARCO submitted the EED to the USACE, and the second round was provided after the Public Notice of the EED. The comments, responses, (including ARCO responses to comments dated February 27, 1997, May 21, 1997, and July 28, 1997) and associated letters are provided in Appendices K and L.

This process has allowed ARCO to take a hard look at potential environmental consequences and make predictive assessments of impacts. Consequently, ARCO hereby offers the mitigation measures identified in Tables 2.9.0-1 and 2.9.0-2, which are based on (1) substantial scientific fact bound data; (2) preparation of adequate biological opinion; (3) consideration of best available scientific and technical data on the status of human, wildlife, fisheries, natural resources, and potential impacts; (4) gathering of traditional knowledge; and (5) a careful review of the administrative record resulting in reasoned evaluation of relevant factors. These mitigation measures have been designed to avoid potential impacts or render any potential impact insignificant.

Where appropriate, ARCO has integrated its 20-plus years of experience at operating the neighboring Prudhoe and Kuparuk oilfields into the mitigation measures. Selective mitigation (monitoring) actions will provide opportunities to modify, optimize, and select post-development data. The ADP is unique because substantial pre-development baseline data exist that can be used in post-development comparative studies. Section 4 provides a more detailed discussion of mitigation measures as they relate to specific environmental consequences.

2.10 OTHER MITIGATION

2.10.1 Polar Bear

Measures taken to ensure there will be a minimum of interference with polar bear populations have been described in great detail in the Polar Bear/Personnel Interaction and Monitoring Plans implemented for each of the five exploration seasons at the ADP. These plans are also incorporated in the letters of authorization (LOAs) obtained from the USFWS as core elements of those project permits.

A plan will be established for the ADP that encompasses the following two essential areas of concern:

1. Adopting procedures intended to minimize human/bear interactions. These include (a) providing all project personnel with a training program on how to respond to bear encounters; (b) conducting reconnaissance monitoring for the presence of bears or bear signs and continuing on-site monitoring throughout the project (especially important for seismic winter work), keeping camp and work areas well lighted, and minimizing potential bear hiding locations; and (c) eliminating bear attractants from work and camp areas (food and garbage, use of bear-proof dumpsters). Food waste will either be incinerated on-site or hauled daily for disposal in a certified waste facility. Chemicals or other materials that might prove harmful or fatal to bears if ingested will be securely stored. The key principle will be early detection and avoidance of bears. Human intervention will happen only if bears are a threat to human safety. These occasions have been rare, even in the established oilfields.

2. Identification and avoidance of maternal polar bear dens, if any, will be located within the project area. This will require a fall reconnaissance survey, which will normally be conducted by surface vehicles (snow machines, seismic survey units), before work such as ice road and pad construction and deployment of seismic camps, cable, etc. If an occupied den is located, work in the immediate vicinity will be suspended until normal den-leaving time (March-early April). Note that with polar bears, only pregnant females occupy dens. The balance of the bear population will continue to range freely, mainly on the offshore pack ice, for its principal food source, seals.

In addition to the above measures, a plan of cooperation will be developed between any local subsistence user groups and ARCO. These plans will guarantee that the operator places no impediment in the way of legitimate subsistence uses. They will also be used to acquire expert local knowledge on bear presence or habitat use that may help ARCO provide the best possible bear/personnel interaction plan.

2.10.2 Rehabilitation of Land Affected by the Alpine Development

Upon abandonment (as defined in oil and gas leases) of the ADP facilities, ARCO will rehabilitate and restore the affected habitat areas by using various gravel removal and plant cultivation techniques. ARCO will remove gravel from lower portions of the floodplain (including delta thaw basins, active- and inactive-floodplain cover deposits) to eliminate impedance of floodwater. Complete gravel removal in these areas will be appropriate because the cover deposits have low-to-moderate ice content and are not, therefore, particularly susceptible to thermokarsting. Figure 2.7.3-1 Alpine Development Project Oil Spill Response Control Points

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SCALE IN MILES
0 3 6

Potential, pre-identified oil spill control points (equipment pre-staging)

Potential pre-deployment of boom in rivers and watercourses during open-water season

Figure 2.7.3-1.
Alpine Development Project Oil Spill Response Control Points

Table 2.9.0-1. Alpine Develop Project mitigation measures plan.

Action	Benefit
PIPELINE: DESIGN	
Evaluated two river crossing locations (X10 and X14) and three crossing designs at each crossing. Elected to cross Colville River at X14 using HDD technology to bore pipelines underground beneath river bed.	Avoids impacts to fish, wildlife, and water quality because pipeline would be at least 85 ft below the river bed, thereby avoiding in-water work or structures. Potential oil leak containment underneath the river bed is provided by the bored hole and cased design.
X14 HDD pipeline entry and exit locations to be approximately 300 ft from each river bank.	Avoids visual barrier of pipeline to caribou moving parallel to the river seeking a crossing. Allows on-land vehicular/human crossing. Reduces chance of oil spill entering the Colville River by locating pipeline transitions farther away from the Colville River. Responds to NSB government request for setbacks.
Elevate pipelines to heights greater than 5 ft at river/stream crossings (as dictated by local topography), at vertical pipeline loop locations, and a special use area between lakes located 2 mi east of the Colville River.	Avoids impacts to fish and wildlife habitat, and water quality. Enhances free passage for caribou movement.
Install pipelines inside high-strength casings at Colville River crossing.	Minimizes potential for oil spill under river by isolating pipeline from any possible soil stress, and providing secondary containment under river through annular flow space to redirect any spill away from river.
Prepare a pipeline isolation strategy based on CFR 195 (USDOT regulation for common carrier pipelines) and the California State Fire Marshall's Guide. The latter guide outlines the analysis to determine spill volumes under contingency leak scenarios. Developed concept of vertical loops. Substitute the valve plan with an isolation strategy (e.g., vertical loop).	Provides for a pipeline design that will minimize the worst case oil spill scenario volume to accepted and comparable pipeline practices. This analysis is based on leak rate, detection time, response time, and draindown between topography breaks (see Section 2.2.1). This analysis will be prepared and reviewed as part of the State of Alaska and federal pipeline ROW process. ADOT has approved the isolation strategy using vertical loops.
Elevate pipeline to nominal 5 ft aboveground on VSMs across tundra (exceptions noted above).	Avoids obstruction of caribou passage and minimizes impact on fish and wildlife habitat, and subsistence use.
Re-route pipeline in in-field facility areas (using ARCO's habitat mapping and interested parties' comments) to minimize contact with sensitive habitats and use areas.	Minimizes impact to fish, wildlife, habitat, and subsistence use areas.
Re-route pipeline to maximize its distance from the airstrip.	Enhances safety.
Ensure overall pipeline integrity through compliance with USDOT design standards.	Minimizes probability of pipeline failure.
Install pipeline isolation block valves at Alpine Processing Facility and at termination point in CPF-2. Install vertical loops in lieu of isolation block valves along the pipeline ROW.	Minimizes probability of oil spill and minimizes potential spill volume by isolating damaged sections of the pipeline and mitigating back flow of oil.
Connect sales oil pipeline into KRU at point nearest to ADP.	Minimizes amount of fish and wildlife habitat crossed by pipeline.

Table 2.9.0-1. Alpine Development Project mitigation measures plan (continued).

Action	Benefit
Space gathering lines at least 400 ft and up to 1,000 ft maximum from the 3 mi gravel road, where practicable.	Enhances crossing success for caribou. Incorporates NSB management standard for visual spill detection.
Adequately size the diameter of sales oil pipeline from ADP to KRU to account for future throughput potential. Designate Alpine Sales oil pipeline as "Common Carrier."	Avoid or minimize future duplication of facilities and cumulative impacts (i.e., additional sales oil pipelines traversing Colville River Delta) by designing and classifying pipeline to be capable of transporting potential non-Alpine oil.
Transport large quantities of water for subsurface reservoir waterflood process via pipeline from KRU (if required).	Avoids impact to local Colville River Delta water sources, associated fish and wildlife populations, and subsistence users.
PIPELINE: CONSTRUCTION AND OPERATION	
Eliminate permanent gravel road/construction pad from KRU along sales oil pipeline route to ADP in-field facilities.	Avoids up to 35 mi of construction pad, 217 acres of permanent gravel footprint to wetlands, year-round vehicular traffic, wildlife and subsistence disturbance, dust, and cross-drainage impairment. Minimizes pressure on subsistence and social structure of residents on Colville River Delta by limiting access.
Construct pipelines over two winter seasons.	Avoids summer construction surface impact, wildlife and subsistence disturbance. Reduces intensity of single winter construction and also reduces wildlife and subsistence disturbance.
For the most part, coordinate logistics out of KRU instead of Nuiqsut.	Avoids adding pressure to Nuiqsut social institutions and public facilities/services.
Backhaul slurry and cuttings from HDD boring operation to KRU or Prudhoe Bay for disposal, exception would be beneficial use of cuttings.	Avoids discharge to Colville River or surrounding lands.
Employ construction and operation technological advances and lessons learned through ARCO's 20-plus years of experience on the North Slope.	Minimizes overall impact, reduces probabilities of human, equipment, and design failure.
Employ state-of-the-art leak detection systems, including sensitive pressure change metering, visual surveillance (ground/air), FLIR remote sensing system operated from aircraft as thermal imagery; remote methods of detection (smart pigs, computerized system [SCADA]) for real time monitoring, and alarm systems.	Increases likelihood of detecting low-threshold oil spill and potential oil spill volumes.
Adopt procedures regarding human/polar bear interactions. Conduct survey to identify maternal polar bear dens. See Other Mitigation for details.	Minimizes project impact upon polar bear population.
ROAD: DESIGN	
Eliminate permanent gravel access road from KRU to ADP in-field facilities and vehicular bridge across Colville River.	Avoids 35 mi of gravel road, 217 acres of permanent gravel footprint to wetlands, year-round vehicular traffic, wildlife and subsistence disturbance, dust, and cross-drainage impairment. Minimizes pressure on hunting and

Table 2.9.0-1. Alpine Development Project mitigation measures plan (continued).

Action	Benefit
	social structure of Colville River Delta residents by limiting access.
Consolidate airstrip with road.	Minimizes environmental impact through consolidation.
Re-route 3-mi gravel road around sensitive habitat and waterfowl (swan and brant) areas.	Minimizes gravel footprint in sensitive wetland habitat, waterfowl nesting areas, and potential cross-drainage ponding in sensitive areas. Diverts vehicular traffic and minimizes dust and noise disturbances to wildlife.
Field-locate some culverts during open water season and install structures at a minimum in accordance with accepted design practices (e.g., PBU, Lisburne Development, Drainage Design Manual [Appendix D]). Location to be coordinated with regulatory agencies.	Maintains cross drainage, minimizes ponding, mitigates seasonal flooding impact, and minimizes chances of design failure through use of proven design criteria.
Install 440-ft bridge and culverts over swale area	Maintains cross drainage, minimizes habitat impacts.
Shift road in swale area northward.	Maintains cross drainage and reduces gravel footprint in high-value wetlands/wildlife habitats.
Design road to avoid washout during flood events.	Avoids gravel deposition impact to wetlands.
Prudently automate drill sites/processing facility to reduce road use by the labor force during operations.	Reduces labor force during operations.
ROAD: CONSTRUCTION AND OPERATION	
Haul gravel via ice road and construct gravel pads and the 3-mi road during winter.	Minimizes impact to fish and wildlife habitat, and subsistence use. Avoids sensitive wildlife periods.
Employ dust control by watering road and setting speed limits.	Minimizes dust generation, disturbance to wildlife and subsistence use, and probability of vehicle(s) striking wildlife.
Use sea ice route from Olitok Point for logistic support. When terrestial ice roads are needed, offset ice road alignments from year to year.	Minimizes temporary compaction of vegetative mat.
When ice bridges over the Colville River main channel are required, conduct a monitoring program to confirm non-bottom fast conditions, assess water quality and ice conditions upstream and downstream of bridge.	Avoids unauthorized bottom founding of ice bridge and creates database for water quality and ice conditions in and around ice bridges.
Rehabilitate gravel pads using combination of revegetation and gravel removal. See Section 2.10, Other Mitigation, for details.	Restores tundra and hydrology.
PADS: DESIGN	
Optimize pad siting through mapping and classifying of habitat, fish, wildlife and subsistence use.	Avoids or minimizes impact to sensitive fish and wildlife habitat and subsistence use areas.

Table 2.9.0-1. Alpine Development Project mitigation measures plan (continued).

Action	Benefit
Re-locate all pads further north of Nanuk Lake to respond to Nuiqsut comments regarding high subsistence use in and around lake and integrate 1996 well results. Re-configure location of airstrip and processing facility to consolidate sources of noise, activities, and potential oil spill at a maximum distance away from the Nechelik (Nigliq) Channel, an identified high-subsistence-use area, and away from sensitive waterfowl nesting areas.	Minimizes impact to fish, wildlife, habitat, and subsistence use. Consolidates facilities. Locates potential oil spill source closer to an area more conducive for response, containment, and cleanup. Responds to Nuiqsut comments identifying Nechelik (Nigliq) Channel as high-subsistence-use waterway.
Minimize pad size and number by facility consolidation, close well spacing, directional drilling (high-angle well departures), and reserve pit elimination. Further reduce pad size by 15% from public notice version.	Minimizes gravel footprint impact (approximately 97 total acres) to wetlands, fish and wildlife habitat, and subsistence areas. Avoids need for additional drilling pads. Forces optimization of waste management.
Rotate orientation of Alpine Pad 2 to north-south direction.	Reduces hydrologic impact and gravel deposit.
Use two-dimensional surface water model and other analyses to determine flood regime for pad design which minimize impacts due to flooding.	Avoids gravel deposition impact to wetlands and ensures facility integrity.
PADS: CONSTRUCTION AND OPERATION	
Haul gravel via ice road and construct the pads during winter.	Minimizes impact to fish and wildlife habitat, and subsistence use caused by alternative construction of a gravel road. Avoids sensitive wildlife use periods.
Rehabilitate gravel pads using combination of revegetation and gravel removal. See Section 2.10, Other Mitigation.	Restores tundra and hydrology.
AIRSTRIP: DESIGN	
Design airstrip as wide section in 3-mi gravel road.	Minimizes impact by consolidating facilities.
Optimize siting of the airstrip by moving it eastward onto high ground away from subsistence areas and waterbird nesting areas.	Minimizes impacts to sensitive fish and wildlife habitat use periods and subsistence use areas.
Use two dimensional surface water model to determine flood regime to design airstrip for minimizing impacts due to flooding.	Minimizes gravel deposition impact to wetlands and ensures facility integrity.
AIRSTRIP: CONSTRUCTION AND OPERATION	
Haul gravel via ice road and construct the airstrip during winter.	Minimizes impact to fish and wildlife habitat, and subsistence use caused by alternative construction of a gravel road. Avoids sensitive wildlife use periods.
Restrict airstrip use from June 1-July 15 to aircraft weighing less than 105,000 lbs take-off weight (i.e., Boeing 737 prohibited) unless excepted by FAR PART 36-Stage 3 (noise level category), safety emergency, or by Subsistence	Minimizes noise disturbance during critical wildlife use periods (nesting/early brood-rearing) and subsistence use periods.

Table 2.9.0-1. Alpine Development Project mitigation measures plan (continued).

Action	Benefit
Oversight Panel (see Nuiqsut mitigation). Minimize aircraft use during June 1-July 15, and maintain 500-ft minimum altitude except for take-off and landing patterns, and pipeline surveillance. Maximize aircraft use during winter.	
Conduct a 3-year total $150,000 per year waterfowl monitoring program to evaluate airstrip impact. See 2.10, Other Mitigation.	Determines impact from airstrip use on waterfowl and establishes additional baseline data for development of counteraction plan, if needed.
Rehabilitate gravel pads using combination of revegetation and gravel removal. See Section 2.10, Other Mitigation, for details.	Restores tundra and hydrology.
GRAVEL MINE	
ASRC Mine Site – Use (Nuiqsut Constructor, Inc.) mine site in lieu of KRU Mine Site F. See approved Nuiqsut Constructors, Inc. Colville River 17 Permit (Appendix E). The application was submitted concurrently with ADP permit application.	Reduces and minimizes heavy truck traffic and associated wildlife and subsistence impacts. Nuiqsut Constructors, Inc. are to rehabilitate mine site into lake to create fish and wildlife habitat. Create local employment opportunities and revenue.
LOGISTICS: DESIGN	
Design a logistics plan to transports and stockpiles a majority of the materials and supplies during winter (i.e., December 1-April 19).	Minimizes aircraft traffic during summer (i.e., June 1-July 15) when waterfowl populations are high and subsistence use is high.
Provide incremental storage space on gravel pads to accommodate large seasonal (winter) material movements and stockpiling.	Allows minimization of summer aircraft traffic through large winter material movements.
Design modules for transport along sea ice road from Oliktok Point in winter.	With current level of analysis, avoids impact to fish, wildlife, habitat, and subsistence use and avoids cross-drainage alterations caused by alternative gravel road.
LOGISTICS: CONSTRUCTION AND OPERATION	
Haul gravel, majority of materials, and supplies, during winter.	Minimizes summer logistical activity and potential disturbance to wildlife and subsistence use.
Stage materials and supplies at KRU and Deadhorse before transport to ADP.	Minimizes summer aircraft traffic by providing flexibility to seasonally transported materials and supplies sent to ADP.
WASTE MANAGEMENT: DESIGN	
Design comprehensive waste management plan that addresses segregation, waste determination, handling, and disposal/recycling procedures. Communicate plan to employees and monitor compliance. Composting for organic waste disposal is being considered.	Minimizes waste generation, formalizes procedures and reduces probability of unauthorized discharge or improper management.

Table 2.9.0-1. Alpine Development Project mitigation measures plan (continued).

Action	Benefit
WASTE MANAGEMENT: CONSTRUCTION AND OPERATION	
During construction, haul solid waste to KRU disposal facilities and consider incineration of solid waste on-site during operations.	Minimizes on-site disposal/incineration of peak waste volumes generated during construction and avoids new, below-grade solid waste disposal site in Colville River Delta.
Haul pre-development drilling muds and cuttings to KRU for disposal until muds and cuttings can be ball-milled (ground) on-site with the resulting slurry pumped down a well for subsurface disposal. Pump production well fluids and domestic wastewater into state/federal-approved Class II wells.	Avoids surface discharge of wastes or shallow below-grade disposal in Colville River Delta area.
AIR QUALITY: DESIGN	
During the ADP PSD permitting process, mitigation will be determined and proposed.	Minimizes impact on air quality at Alpine in-field facility.
Install air quality monitoring station in Nuiqsut.	Assess potential incremental impact of Alpine.
OIL SPILL: DESIGN	
Also see Pipeline and Pads Design, Construction and Operation	
Create an Alpine ODPCP as part of the region-wide effort for North Slope oil spill contingency planning. Until such plan is developed, store less than 10,000 gallons and/or amend KRU ODPCP for pre-development drilling plan to include Alpine.	Maximizes use of existing response organization, equipment inventories, experience, and training.
Aerially videotape shoreline (including Harrison Bay), channel configurations, water current patterns, landforms downstream and 1 mi upstream of ADP potential spill scenarios. Also videotape ADP pipeline transportation corridor river/stream crossings. Video to be used to produce sensitivity maps to be included in the ODPCP. Use this information to develop pre-staged equipment storage, deployment and response plan.	Minimizes spill response time and increases effectiveness of response by pre-spill identification and prioritization of sensitive habitat, containment areas, response equipment pre-stage locations (including pre-spill boom anchors), and oil movement dynamics.
Optimize response plan by integrating habitat, fish, wildlife, and subsistence use, and geologic mapping of Colville River Delta and transportation corridor into North Slope-wide ODPCP.	Minimizes potential impact to fish, wildlife, habitat, and subsistence use.
Prestage spill response equipment at critical locations.	Minimizes spill response time.
Provide specialized spill prevention training to all employees.	Enhances quality of spill response.

Table 2.9.0-1. Alpine Development Project mitigation measures plan (continued).

Action	Benefit
SPILL CONSTRUCTION AND OPERATION	
Require all construction contractors to have certified SPCO plans.	Minimizes spills, and impacts from spills.
Require secondary containment (which meets regulatory standards) for all temporary fuel storage locations during construction.	Avoids spill discharges to waters of the United States.
Continue training update and equipping the Nuiqsut resident-based OSRT.	Minimizes response time and maximizes use of local environmental knowledge.
Use ACS, KRU, and PBU response organizations, equipment inventories, and technical expertise in spill event.	Minimizes response time and maximizes use of local resources and knowledge.
NUIQSUT	
Reimburse Kuukpik Corporation up to $60,000 annually, or greater by mutual agreement, for a Subsistence Oversight Panel (SOP) composed of five Nuiqsut residents who shall monitor the health of subsistence resources on Kuukpik lands and any impact of exploration, development, and production by ARCO on such resources. Reimbursement shall continue for the producing life of ADP. Panel to meet at least twice annually and produce a status report regarding complaints, concerns, or recommendations to be submitted to ARCO and Kuukpik at least annually.	Avoids and minimizes impact to subsistence use and social structures, provides a communication channel and entity to minimize cultural misunderstandings and resolve problems, minimizes potential conflict with operations or subsistence use, and allows transfer of safety-related information.
An initial socio-cultural assessment will be completed and a multi-year socio-cultural trends study to be undertaken by a qualified expert(s) in social trends assessment.	Socio-cultural trends study and analysis will assist in long-range planning. Provides basis and data for community planning and potential impact assessment.
Make available up to 500,000 ft^3 per day of natural gas, or the electrical equivalent generated from the well(s) or facilities nearest to Nuiqsut, for Nuiqsut's domestic, governmental, and other uses within the city limits of Nuiqsut. Natural gas or electricity would be made available, subject to a separate agreement detailing specific terms and conditions, at no cost, at a custody transfer metering point. ARCO shall have no obligation with regard to gas or electric transportation, construction, maintenance, or operation beyond the transfer metering point. If the gas- or electric-producing well(s) or equipment are shut down or abandoned, ARCO shall offer to sell equipment to Kuukpik. In the alternative, if Kuukpik wishes to drill its own gas well, ARCO shall provide seismic, drilling, and other data to assist in locating and tapping any other gas reserves on ARCO leasehold within a 10-mi radius of the City limits. ARCO's obligation regarding natural gas or electricity availability will terminate upon expiration or termination of ARCO leasehold within a 10-mi radius of the city limits.	Minimizes heating costs to Nuiqsut residents. Provides a more reliable and less expensive source of power. Avoids/minimizes need for NSB's annual cross country transportation of heating and power generation fuel; minimizes spill potential. Will improve air quality by reducing diesel-fired emission sources
ARCO will match, up to $30,000 per year for 10 years, all scholarship and training grants and loans made by Kuukpik for the acquisition by Kuukpik shareholders of skills, licenses,	Expand employment prospect opportunities for Kuukpik shareholders.

Table 2.9.0-1. Alpine Development Project mitigation measures plan (continued).

Action	Benefit
professional certifications, or qualifications appropriate or reasonably required for employment in the oil and gas and/or related support industries on the North Slope.	
No access restrictions in oilfield to subsistence users. Establish procedures for entrance to facilities, use of permanent gravel roads, and firearms discharge. These procedures will be coordinated through the SOP.	Minimizes impact to subsistence or cultural use patterns. Maximizes human safety and facilities integrity.
Provide signage at facility and pipeline locations in English and Inupiaq languages warning non-ARCO visitors of safety and awareness issues. Coordinate signage through the SOP.	Maximizes safety precautions. Safeguards ARCO and its contractors from harm while providing oilfield access to subsistence hunters.
Alpine winter ice roads will be open to Nuiqsut resident use and deliveries of goods and services to Nuiqsut. Use will be subject to ARCO's reasonable safety and security procedures, which will be coordinated through the Subsistence Oversight Panel and Nuiqsut's city government. General public access to ice roads will be regulated as are the existing road systems in the KRU and PBU.	Seasonally minimizes transportation costs to Nuiqsut residents, and maximizes access flexibility since no permanent road to Nuiqsut exists. Minimize external pressure on subsistence resources.
Continue training and providing equipment for the Nuiqsut Village OSRT.	Provides income to local residents, training in oil spill response and clean-up, and provides source of local knowledge to ARCO in the unlikely event of an oil spill.
Encourage Native and local hire and provide for a hiring coordinator. Communicate scopes of work.	Provides income to local residents and the community, and on-the-job training for local residents to develop job skills (welding, etc.) applicable to oilfield work.
Comply with a surface use agreement (see Appendix W) for ARCO's use of Kuukpik Lands. ARCO has agreed to certain mitigation measures and other consideration for access to Kuukpik lands.	Compensates for surface damages caused by development, production, and transportation of oil and gas on Kuukpik lands.
Provide non-resident oilfield workers with cultural awareness training. Includes possible use of existing ASRC Inupiat cultural awareness program.	Avoids/minimizes cultural misunderstandings by increasing sensitivity of oilfield workers to Nuiqsut's culture and lifestyle including values of land and natural resources used for subsistence, importance of access to traditional hunting areas, protection of grave and other sacred sites, and maintenance of community social cohesion.
Sport fishing and hunting by ARCO employees while conducting company business will be prohibited.	Avoids additional pressure on Colville subsistence resources.
Hire local residents, at competitive rates, to provide logistic/guiding support to ARCO environmental and technical field studies before, during, and after ADP.	Avoids conflicts with subsistence use and cultural values by having a local resident on-site during these operations. Provides economic benefits to local residents and community. Maximizes use of local and traditional knowledge.
Construct and develop ADP by staging equipment, personnel, and other support at the ADP in-field facility, KRU, PBU or Deadhorse.	Avoids impacts on Nuiqsut's schools, housing, and public facilities and services.

ARCO will selectively remove gravel from portions of the higher floodplain. Complete gravel removal in these areas might result in the development of long, linear, deep waterbodies in the ice-rich abandoned floodplain cover deposits; this, in turn, could lead to larger thermokarst development. To minimize this thermokarst effect, ARCO will remove gravel from the roads, pads and airstrip on the higher, abandoned floodplain cover deposits to two depths. ARCO will completely remove gravel on approximately two-thirds of this area, and partially remove gravel on the remaining one-third so that a 2- to 3-ft layer of gravel remains. The scattered distribution of moderately thick gravel will help prevent deep thermokarst development and prevent drainage of the long, linear waterbodies that are otherwise likely to develop in areas of complete gravel removal. This two-depth approach to gravel removal on the higher floodplain will facilitate passage of water during major floods and create a mosaic of aquatic and gravelly upland habitats.

To facilitate natural plant colonization, ARCO will fertilize areas where gravel has been removed. Studies indicate that natural colonization of bare tundra soil or a thin gravel till may be accomplished in 5 to 10 years, and that the resulting species composition resembles the dominant species in the adjacent tundra. ARCO will also plant aquatic grass (*Arctophila fulva*) and aquatic sedge (*Carex aquatilis*) in portions of the ice-rich areas where gravel has been completely removed, to aid colonization of the ponds that are likely to result from thermokarst development. ARCO will seed areas of moderately thick gravel fill with a mixture of native-grass cultivars and indigenous legumes. It is expected that the grasses will rapidly improve productivity, and the legumes will prove a long-term nitrogen source (through symbiotic relationship with nitrogen-fixing bacteria) that will improve diversity and sustainability. This approach will create a mix of aquatic, wet, moist, and dry habitats that will resemble the structure, function, and patchiness of the surrounding tundra.

Following ARCO's restoration and rehabilitation efforts, areas in which gravel pads and the airstrip were located will not disrupt the natural surface flow of water. The airstrip will also no longer provide access to the area.

2.10.3 Monitoring Waterbird Populations in the Vicinity of the Alpine Development

The development of a new oilfield on the Colville River Delta will necessitate the construction of drilling pads, roads, pipelines, processing facilities, and an airstrip in a general area already occupied by breeding waterbirds. The noise and human activities associated with these new facilities, and in particular, the new airstrip that will support jet traffic, may cause short- or long-term changes in the distribution, abundance, and breeding success of large waterbirds nesting in the immediate vicinity. Previous studies have shown that most behavioral disturbances of waterbirds from vehicles, construction of drilling pads and roads, and human activities associated with construction and operation tend to be short-term (Burgess et al. 1990; Murphy and Anderson 1993). Although several noise studies have been conducted in the oilfields (CPF-3, by Hampton and Joyce 1986; Gas Handling Expansion Program (GHX-1), by Anderson et al. 1992), the studies have focused on the effects (on waterbirds) of noise generated by large facilities. Currently, little information is available on the effects on waterbirds of noise from a new airstrip in a previously undisturbed area.

For the ADP, a monitoring program will determine the effects of noise and disturbance (from construction and operation of the new oilfield and airstrip) on the distribution, abundance, and breeding success of large waterbirds (i.e., swans, geese, loons, eiders). The program will incorporate a multi-year study in the immediate vicinity of the airstrip that includes the two-year construction period and one year of oilfield operations. The waterbird study will include locating and monitoring all nests within 1,000 yd of the airstrip, determining the effects of noise on the behavior of nesting birds, and assessing the effects of noise and disturbance on the nesting success and productivity of breeding waterbirds. Baseline data are available on the distribution and abundance of nesting waterbirds in the area (Johnson et al. 1996). These data comparisons will be used to determine the overall effects on waterbirds from construction and operation of the ADP.

Chapter 3

3. ALTERNATIVES TO PROPOSED ACTION

ARCO evaluated alternatives and options for each component of the proposed ADP. Such alternative analysis is required by the NEPA and the CWA section 404(b)(1) guidelines.

Chapter 3 describes these alternatives and options. For a description of the proposed alternative, see Chapter 2. This alternative is referred to as the proposed action in Chapter 3.

3.1 MAJOR ALTERNATIVES TO THE APPLICANT'S PROPOSED PROJECT

Six additional action alternatives and several options within alternatives are described in this section, as well as the no-action alternative. The action alternatives include three alternatives proposed by ARCO and three alternatives proposed by Native corporations (Figure 3.1.1-1). Coordination with permitting agencies and comments from public workshops helped clarify, modify, and evaluate these alternatives. The feasibility of these alternatives and options was evaluated according to environmental impacts, engineering practicality, regulatory requirements, and costs. Table 3.1.0-1 compares the acreage footprints among alternatives, Table 3.1.0-2 compares the alternative project components, Table 3.1.0-3 compares the costs of the alternatives and Table 3.1.0-4 compares environmental impacts among alternatives. Detailed environmental and cultural assessments of the alternatives/options are addressed in Chapter 4.

For ease of reference, the alternatives are numbered from 1 to 8 as shown in the tables and described in the text (e.g., #2 refers to the proposed action).

3.1.1 <u>No-Action Alternative (#1)</u>

A no-action alternative (#1) is considered as a requirement of NEPA. This alternative provides a baseline for comparison of the action alternatives.

Conditions that currently exist in the project area for the most part represent the no-action alternative. Accordingly, no construction of gravel roads and pads related to the ADP or oil production would occur in the project area. Alternative #1 does not meet the purpose and need of the project as described in Chapter 1. In particular, Alternative #1 would not result in production of the oil and gas reserves in the project area and, therefore, would contribute to the continuing decline of the Nation's domestic energy reserves and State of Alaska revenue.

Under Alternative #1, some environmental features in the project area will continue to change over time as a consequence of existing trends. Subsistence hunting and fishing will increase as the population of Nuiqsut increases (e.g., 26 percent growth rate over the past 20 years). Village infrastructure development such as electric power supply, sewage disposal, and roads will continue as the population increases, although the rate of such development may be slower than the population increase. Revenues, employment opportunities and other indirect economic benefits to the village of Nuiqsut, the NSB, and individuals will decrease as existing North Slope oil production declines.

3.1.2 <u>Summary of ARCO Alternatives (#3-#5)</u>

The three additional alternatives identified by ARCO (#3-#5) use the in-field facility configuration and location described for the proposed project (#2). These alternatives primarily differ from the proposed action based on the pipeline route, method for accessing project infrastructure, and pipeline installation (see Figure 3.1.1-1). One alternative (#3) is to modify the route to cross the Colville River down river, at the location identified as X10 (see Figure 3.1.1-1), from the proposed action. Another alternative (#4) is to construct a permanent gravel road connecting KRU to the in-field facility with the VSM-supported pipeline running roughly parallel. This alternative has a road and bridge for year-round vehicular access for oil and gas activities. Residents could use this infrastructure to travel to subsistence use areas and potentially to Fairbanks. These subsistence areas are currently only accessible through use of snowmobiles and airplane travel. The remaining alternative (#5) is to bury the pipeline in the above-described permanent gravel road and suspend the pipeline from the bridge. The pipeline would not be supported on VSMs which is preferred by some Colville Delta residents.

The costs of these alternatives are approximately $52, $89, and $115 million more than the proposed action, respectively. Elements of these alternatives are discussed more fully in this chapter.

Table 3.1.0-1. Estimated gravel footprint acreage impact of project alternatives relative to the proposed action.

	Alternatives						
Alternative #s	2	3	4	5	6	7	8
Component	Proposed Action	ARCO Alternative X10 Crossing No Road	ARCO Alternative X14 Crossing with Road	ARCO Alternative X14 Crossing with Road/Pipeline	ASRC Proposal	ASRC/Kuukpik Proposal	Kuukpik (Western Initiative)
Pipeline Mileage (including river crossings)							
ARCO in-field gathering line	2.3	2.3	2.3	2.3	2.3	2.3	2.3
ARCO X14: CPF-2 to Alpine 1	34.2	—	34.2	34.2	—	—	—
ARCO X10: CPF-2 to Alpine 1	—	27.9	—	—	—	—	—
ASRC: CPF-2 to Nuiqsut	—	—	—	—	29.4	33.9	33.9
ASRC/Kuukpik: Nuiqsut to Alpine 2	—	—	—	—	9.3	9.3	—
Kuukpik West. In.: Nuiqsut to Alpine 2	—	—	—	—	—	—	11.6
Total	**36.5**	**30.2**	**36.5**	**36.5**	**41.0**	**45.5**	**47.8**
Road Mileage (excluding bridges)							
In-field access road	2.9	2.9	2.9	2.9	2.9	2.9	2.9
ARCO road: DS-2M to Alpine 2	0	0	28.0	28.0	0	0	0
ASRC/Kuukpik road: DS-2M to Nuiqsut	0	0	0	0	0	26.8	26.8
ASRC/Kuukpik road: Nuiqsut to Alpine 2	0	0	0	0	9.0	9.0	0
Kuukpik road: Nuiqsut to Alpine 2	0	0	0	0	0	0	11.3
Total	**2.9**	**2.9**	**30.9**	**30.9**	**11.9**	**38.7**	**41.0**
Gravel Fill Acreage*							
In-field facilities	**97.2**	**97.2**	**97.2**	**97.2**	**59.0**	**59.0**	**30.0**
Separate processing/camp pad	0	0	0	0	0	0	29.0
ARCO road: DS-2M to Alpine 2	0	0	217.2	268.1	0	0	0
ASRC/Kuukpik road: DS-2M to Nuiqsut	0	0	0	0	0.0	256.6	256.6
ASRC/Kuukpik road: Nuiqsut to Alpine 2	0	0	0	0	69.8	86.2	0
Kuukpik road: Nuiqsut to Alpine 2	0	0	0	0	0	0	108.3
Total Acres	**97.2**	**97.2**	**314.4**	**365.3**	**128.8**	**401.8**	**423.9**

* NOTE: Road width (64 ft) is measured from side-slope toe to toe; width increases to 79 feet for pipeline buried in roadbed.

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SCALE IN MILES 0 1.5 3

N

Proposed In-field Facilities

Proposed Kuukpik (Western Initiative) Facility

Figure 3.1.1-1.
Project Alternatives

Table 3.1.0-2. Comparison of major alternative ADP components for the action alternatives.

Alternative #s	2	3	4	5	6	7	8
Component	Proposed Action	ARCO Alternative X10 Crossing No Road	ARCO Alternative X14 Crossing with Road	ARCO Alternative X14 Crossing with Road/ Pipeline	ASRC Proposal	ASRC/Kuukpik Proposal	Kuukpik (Western Initiative)
Field Development							
Gravel Pads	2	Same as #2	Same as #2	Same as #2	Same as #2	Same as #2	3
Airport	New in Delta	Same as #2	Same as #2	Same as #2	Existing in Nuiqsut	Same as #6	Same as #6
Pipeline Route/Colville River Crossing Location							
Pipeline Location	X14 Route	X10 Route	Same as #2	Same as #2	ASRC route	ASRC/ Kuukpik Route	Same as #7
Pipeline Distance	—	—	—	—	—	—	—
Pipeline Placement	Aboveground	Same as #2	Same as #2	Buried	Same as #2	Same as #5	Same as #5
Number of Colville River/Major Channel Pipeline Crossings	1	Same as #2	Same as #2	Same as #2	2	Same as #6	Same as #6
Number of Bridges	0	2 (Colville River, distributary)	1 (Colville River)	Same as #4	2 (Nechelik channel distributary)	3 (Colville River, Nechelik channel, distributary)	Same as #7
Colville River Crossing Method	HDD	Cable bridge span	Combined HDD/trenching or buried	Same as #4	HDD	Pile-support bridge	Same as #7
Access							
Transportation	Alpine airstrip and ice road/ice bridge	Same as #2	Same as #2 or marine barge dredge channel	Same as #4	Nuiqsut airstrip tundra travel, Nuiqsut to Alpine pad 2 gravel road	Same as #6 and gravel road from DS-2M to Nuiqsut, permanent bridge; or gravel road/ice bridge/summer ferry; or marine barge dredge channel	Similar to #7

Table 3.1.0-2. Comparison of major alternative ADP components for the action alternatives (continued).

Alternative #s	Alternatives 2	3	4	5	6	7	8
Component	Proposed Action	ARCO Alternative X10 Crossing No Road	ARCO Alternative X14 Crossing with Road	ARCO Alternative X14 Crossing with Road/ Pipeline	ASRC Proposal	ASRC/Kuukpik Proposal	Kuukpik (Western Initiative)
Use	Surface vehicle (winter)/air	Same as #2	Surface vehicle/air	Same as #4	Same as #2	Surface vehicle (all year)	Same as #2
Material Sites	Nuiqsut Constructors, Inc. Site	KRU site	Same as #3	Same as #3	Same as #2	Same as #2	Same as #2
Freshwater sites	Lakes within delta	Same as #2	Same as #2	Same as #2	Same as #2	Same as #2	Same as #2
Water Flood Sources	Oliktok Treatment Plant	KRU source wells or project area source wells	Same as #3	Same as #3	Same as #3	Same as #3	Same as #3
Energy							
Power Generation Location	Delta	Same as #2	Same as #2	Same as #2	Nuiqsut	Same as #6	Same as #6
Oil Spill Responsiveness[1]							
	Comprehensive spill prevention detection and response program; limited access on pipeline route during summer	Same as #2	Same as #2, except improved summer access	Same as #2	Same as #2	Same as #4	Same as #4

[1] Refer to Table 3.1.0-4 for a comparison of potential impacts by resource.

Table 3.1.0-3. Estimated incremental costs (savings) of alternatives relative to the proposed action in 1997 dollars.

					Alternatives		
Alternative #s	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Component		ARCO Alternative X10 River Crossing No Road	ARCO Alternative X14 Crossing with Road	ARCO Alternative X14 Crossing with Road/Pipeline[1]	ASRC Proposed	ASRC/Kuukpik Proposed	Kuukpik (Western Initiative)
Gravel Road[2]							
KRU 2M to Colville River		NA	$19,000,000	$19,000,000	NA	$21,000,000	$21,000,000
Colville River to Nuiqsut		NA	NA	NA	NA[3]	NA	NA
Nuiqsut to in-field facility		NA	NA	NA	11,000,000	11,000,000	11,000,000
Colville River to in-field facility			7,000,000	7,000,000			
Airstrip		0	0	0	(6,000,000)	(6,000,000)	(6,000,000)
Bridges							
Colville River		75,000,000	73,000,000	73,000,000	NA	70,000,000	70,000,000
Nechelik (Nigliq) Channel		NA	NA	NA	18,000,000	18,000,000	18,000,000
Distributary channel		NA	NA	NA	6,000,000	6,000,000	6,000,000
Sakoonang channel		3,000,000	NA	NA			
Cross-Country Pipelines (sales oil and water)							
KRU 2M to Colville River		(8,000,000)	NA	21,000,000	13,000,000	28,000,000	28,000,000
Colville River to in-field facility		(11,000,000)	NA	5,000,000	35,000,000	44,000,000	44,000,000
River Crossing Method (pipelines)							
Horizontal directional drilling (HDD)		(12,000,000)	(12,000,000)	(12,000,000)	0	(12,000,000)	(12,000,000)
Suspend from bridge		5,000,000	2,000,000	2,000,000	1,000,000	2,000,000	2,000,000
Trenching		NA	NA	NA			
Power Generation/Support Utilities							
Gas line from in-field facility to Nuiqsut		NA	NA	NA	8,000,000	10,000,000	6,000,000
Powerline from Nuiqsut to in-field facility		NA	NA	NA	6,000,000	7,000,000	5,000,000
In-field Facility							
Multiphase pipeline bundle		NA	NA	NA	NA	NA	14,000,000
TOTAL COST (savings)		$52,000,000	$89,000,000	$115,000,000	$92,000,000	$199,000,000	$207,000,000

Note: Costs based on unit costs developed with a 1.45 multiplier to account for design costs and contingencies. Costs rounded to nearest $1,000,000.
NA = Not applicable.

[1] Pipeline buried in gravel road.

[2] Road costs for preferred alternative include ice road construction, operation, and maintenance costs.

[3] Cost of BIA-sponsored road from Colville River to Nuiqsut not included.

Table 3.1.0-4. Summary of construction and operation environmental impacts of the Alpine Development project among alternatives[1] (continued).

Resources	No Action 1	Action Alternatives						
		ARCO Proposed						
		X14 Route No Road 2	X10 Route No Road 3	X14 Route with Road 4	X14 Route with Road and Pipeline 5	ASRC Proposal 6	ASRC/Kuukpik Proposal 7	Kuukpik (Western Initiative) 8
Hydrology/Geology								
Flooding	No change from existing conditions	Potential for increased local flooding upstream of proposed facility	Similar to #2	Same as #2 with potential increased flooding along road	Similar to # 4	Similar to #2 with increased potential in delta due to increased road length	Similar to # 4	Similar but more impact than #4 due to extra pad and increased road length
Erosion/Sedimentation	Continuation of increased sedimentation from tapping of Nanuk Lake	Potential for diminishing sedimentation downstream of facility	Similar to #2	Same as #2 with potential increased sediment upstream and decrease downstream	Similar to # 4	Same as #2 with potential for impact upstream and downstream due to road length	Similar to # 4	Similar but more impact than #4 due to extra pad and increased road length
Recharge	No change from existing conditions	No change to natural recharge; lake 9313 recharge will be enhanced	Similar to #2	Potential decrease along road	Similar to # 4	Similar to #2	Similar to # 4	Similar but more impact than #4 due to extra pad and increased road length
Storm Surge	No change from existing conditions	No change	No change	No change	No change	No change	No change	Similar but more impact than #4 due to extra pad and increased road length
Thermokarst	No change from existing conditions	Potential for increase due to ponding & dusting	Similar to #2	Potential for increase over #2 due to increased road length	Similar to # 4	Potential for more impact than #2 and less than #4 due to road length	Similar to # 4	Similar but more impact than #4 due to extra pad and increased road length
Water Quality	No change from existing conditions	Potential for decrease in water quality from oil spill, turbidity, fuel release and suspended solid concentration	More impacts than #2 due to increased potential for turbidity and fuel spills during construction due to additional bridge crossing	More impacts than #2 due to potential vehicular fuel spills on road but one less bridge	Similar to # 4	More impacts than #2 due to longer pipeline route and additional bridge crossing	More impacts than #6 due to longer pipeline route and road and additional bridge	More impact than #7 due to production pad near Nechelik Channel
Air Quality	No change from existing conditions	Increased air emissions of pollutants during construction, however, particulates would be below allowable PSD increments	Similar to #2	More impacts than #2 due to increased vehicular emissions and dust during operation due to vehicles traveling on road	Similar to # 4	Nuiqsut residents exposed to increased air pollutants due to nearness of support facilities and airport	More impacts than #6 due to emissions and dust from vehicles traveling road	Similar to #7

Table 3.1.0-4. Summary of construction and operation environmental impacts of the Alpine Development project among alternatives[1] (continued).

Resources	No Action 1	X14 Route No Road 2	X10 Route No Road 3	X14 Route with Road 4	X14 Route with Road and Pipeline 5	ASRC Proposal 6	ASRC/Kuukpik Proposal 7	Kuukpik (Western Initiative) 8
		Action Alternatives						
		ARCO Proposed						
Fisheries								
Overwintering Habitat	No change from existing conditions	Up to 15% reduction in overwintering habitat in lakes used as water sources during winter	Same as #2	Similar to #2, but fewer lakes are affected because ice roads are not needed	Same as #4	Same as #2	Same as #4	Same as #4
Water Withdrawal	No change from existing conditions	Potential for impingement during water withdrawal	Same as #2	Similar to #2 but fewer lakes are affected because ice roads are not	Same as #4	Same as #2	Same as #4	Same as #4
Flow Pattern Alteration	No change from existing conditions	Potential for flow alteration that may affect fish passage within the project area by the road between the drilling pads; no effect outside facilities area	Same as #2	Same as #2, except the additional potential for effects from flow alteration along road	Same as #4	Similar to #2, except the area affected by the gravel road within the delta is more sensitive to flow alteration than the area east of the Colville River	Similar to #4 except potential for flow alteration impacts increases as the miles of road increases	Same as #4
Contaminant Release	No change from existing conditions	Potential for low level contaminant release during construction and operation, confined to the in-field facilities area year-round, and along the ice road during winter	Same as #2 except potential for oil spill to enter Colville River if there is failure or leakage of the pipeline at the river crossing	Same as #3	Same as #3	Same as #3 except potential for oil spill to enter Colville River if there is failure or leakage of the pipeline at the elevated channel crossing	Same as #3 except potential for oil spill to enter Colville River if there is failure or leakage of the pipeline at either of the two river crossings	Same as #4
Wildlife								
Habitat Loss	No habitat loss	Approximately 0.1 acre of habitat lost permanently to placement of VSMs and 97 acres lost to in-field facilities; temporary loss of 367 acres of habitat in summer following ice road/pad use; compaction of vegetation from ice road/pad	Similar to #2, but with less habitat loss (<0.1 acre permanent and approximately 313 acres temporary) due to shorter route; loss for in field facilities is identical to #2	Approximately 217 acres of habitat lost to gravel placement for road (see Table 4.4.2-8), plus about 0.1 acres for VSM placement; loss for in-field facilities is identical to #2; temporary loss from ice roads during first winter similar to #2 (169 acres)	Approximately 268 acres of habitat lost to gravel to accommodate pipeline burial in road bed; loss for in-field facilities is identical to #2	Approximately 70 acres of habitat lost to gravel placement for road from Nuiqsut to Alpine facilities; 59 acres of habitat lost to in-field facilities; temporary loss greater than for #2	Approximately 343 acres of habitat lost to gravel placement for roads; habitat lost for in-field facilities identical to #6; temporary loss greater than for #2	Approximately 365 acres of habitat lost to gravel placement for roads; habitat lost for in-field facilities similar to #6, but less habitat lost on delta due to placement of processing facility west of delta; temporary loss greater than for #2

Table 3.1.0-4. Summary of construction and operation environmental impacts of the Alpine Development project among alternatives[1] (continued).

Resources	No Action 1	Action Alternatives: ARCO Proposed: X14 Route No Road 2	X10 Route No Road 3	X14 Route with Road 4	X14 Route with Road and Pipeline 5	ASRC Proposal 6	ASRC/Kuukpik Proposal 7	Kuukpik (Western Initiative) 8
Wildlife (continued)								
Habitat Use Pattern	No impact	Some changes in habitat use of areas affected by ice road/pads due to delayed melting and vegetation compaction, including limited nesting in following summer(s); displacement (or possible in dust-fallout zone (up to 300 ft) near in-field facilities	Similar to #2	Similar to #2, but also includes additional changes in habitat use from dust fallout, gravel spray, impoundments, and thermokarst associated with road to KRU; changes include attraction of some species to road, as well as displacement of others	Similar to #4	Similar to #4, but wildlife impacts lower because of shorter road (to Nuiqsut from Alpine facilities); Nuiqsut airstrip would cause fewer changes in wildlife use patterns than	Similar to #4, but wildlife impacts greater due to longer road route; effects of use of Nuiqsut airport similar to #6	Similar to #7
Disturbance	No impact	Minimal disturbance during winter construction; disturbance from in-field facilities includes noise, vehicles, pedestrians, and aircraft operations; greatest disturbance to birds within 500-700 ft of roads and pads	Similar to #2	Similar to #2 for in-field facilities, but increased disturbance from road to KRU; avoidance of road by calving caribou (within 1500-3300 ft); reduced crossing success by caribou at traffic rates of 15 vehicles/hr or more	Similar to #4	Similar to #4, but higher traffic rates on road from Nuiqsut would have greater impacts; routing of road on western delta would reduce impacts on birds, but increase impacts on mammals; use of Nuiqsut airstrip would reduce disturbance on delta	Effects greater than #4 due to longer road, southerly route would affect more caribou during calving; other effects similar to #6	Similar to #7, but location of road west of delta would decrease impacts on birds and increase impacts on mammals
Displacement	No impact	Minimal displacement during winter construction, when level of wildlife use is lowest; noise levels associated with in-field facilities could displace wildlife (within 0.5 mi); avoidance by maternal caribou within 1500-3300 ft of roads during calving season	Similar to #2	Similar to #2 for winter construction period; some displacement expected within buffer zones described in #4 above	Similar to #4	Similar to #4; displacement less because road is shorter	Similar to #4	Similar to #4

Table 3.1.0-4. Summary of construction and operation environmental impacts of the Alpine Development project among alternatives[1] (continued).

Resources	No Action 1	Action Alternatives: ARCO Proposed: X14 Route No Road 2	X10 Route No Road 3	X14 Route with Road 4	X14 Route with Road and Pipeline 5	ASRC Proposal 6	ASRC/Kuukpik Proposal 7	Kuukpik (Western Initiative) 8
Wildlife (continued)								
Attraction	No impact	Some attraction of predators likely during winter construction; facilities and VSMs may provide nest sites for predatory birds; minimal effect during operations unless improper garbage handling or feeding attract wildlife to in-field facilities	Similar to #2	Similar to #2; vehicles on road to KRU may attract predators (if feeding occurs); caribou attracted to elevated road for relief from fly harassment	Similar to #4	Similar to #4, but impact would be lower due to shorter road	Similar to #4	Similar to #4
Predation	No impact	Strict garbage handling procedures and feeding prohibition will minimize increases in predator populations and make increased predation on other species unlikely	Similar to #2	Similar to #2; worker education and penalties to eliminate feeding of wildlife would minimize effects of illegal feeding along road	Similar to #4	Similar to #4	Similar to #4	Similar to #4
Mortality/Injury	No impact	Minimal impact due to winter scheduling of activities on ice road (wildlife presence minimal); minimal impacts associated with in-field facilities; proper spill prevention and contaminants controls will minimize potential impacts	Similar to #2	Some wildlife mortality and injury will occur from encounters with vehicles on road to KRU, although number of animals struck is likely to be very low; similar to #2 for in-field facilities	Similar to #4	Similar to #4, but impact would be lower due to shorter road	Similar to #4, but impact would be greater due to longer road	Similar to #7

Table 3.1.0-4. Summary of construction and operation environmental impacts of the Alpine Development project among alternatives[1] (continued).

Resources	No Action	Action Alternatives						
		ARCO Proposed				ASRC Proposal	ASRC/Kuukpik Proposal	Kuukpik (Western Initiative)
		X14 Route No Road	X10 Route No Road	X14 Route with Road	X14 Route with Road and Pipeline			
	1	2	3	4	5	6	7	8
Threatened and Endangered Species								
Habitat Loss	No habitat loss	Impacts from habitat loss (permanent and temporary) minimal because spectacled and Steller's eiders are rare along pipeline route; location of in-field facilities south of primary eider nesting habitats significantly	Similar to #2	Similar to #2	Similar to #2	Similar to #2, except habitat loss from road on delta would impact more potential habitat for spectacled eiders	Similar to #6	Similar to #6
Disturbance	No impact	No disturbance during winter construction; disturbance at in-field facilities limited to pre-nesting period, when a few eiders may be present (types of disturbance described above under Wildlife)	Similar to #2	Similar to #2; disturbance by road to KRU unlikely due to rarity of eiders in vicinity of road route	Similar to #4	Road on delta more likely to affect spectacled eiders, primarily during pre-nesting, within 500-700 ft of road; indirect impacts of road (dust fallout, gravel spray, impoundments, etc.) also would affect eiders (attraction to snow-free areas near road, eiders (attraction to snow-free could increase disturbance); use of Nuiqsut airstrip would reduce aircraft disturbance on delta	Similar to #6	Similar to #6
Predation	No impact	Minimal to no effect (see above under Wildlife)	Similar to #2	Similar to #2	Similar to #2	Similar to #2	Similar to #2	Similar to #2
Mortality/Injury	No impact	Minimal to no effect (see above under Wildlife)	Similar to #2	Similar to #2; collisions of eiders with vehicles unlikely due to rarity along road route	Similar to #4	Similar to #2; vehicle collisions more likely due to road on delta	Similar to #6; effects greater due to longer road	Similar to #7

Table 3.1.0-4. Summary of construction and operation environmental impacts of the Alpine Development project among alternatives[1] (continued).

Resources	No Action 1	Action Alternatives: ARCO Proposed: X14 Route No Road 2	X10 Route No Road 3	X14 Route with Road 4	X14 Route with Road and Pipeline 5	ASRC Proposal 6	ASRC/Kuukpik Proposal 7	Kuukpik (Western Initiative) 8
Human Use Resources								
Socio-cultural System	No change from existing conditions	Similar to #1	Similar to #1	Increased impacts due to road and number of works residing in Nuiqsut	Similar to #1	Increased access to subsistence use areas; increased demand for public services, increased social interaction with non-local project personnel	Similar to #6	Similar to #6
Cultural Resources	No change from existing conditions	Similar to #1	Similar to #1	Similar to #1	Similar to #1	Similar to #1	Similar to #1	Similar to #1
Government Institutions								
Planning	Similar to existing conditions	Requires re-zoning of resource development district	Similar to #2	Similar to #2 and road alternatives will require substantial planning	Similar to #4	Similar to #4	Similar to #4	Similar to #4
Regulatory	Similar to existing conditions	CZM process; re-zoning, wildlife/subsistence enforcement	Similar to #2	Similar to #2	Similar to #2	Similar to #2	Similar to #2	Similar to #2
Economic Institutions								
Revenue	Reduced anticipated revenues all sources (tax, share holder, employment) due to declining property tax revenues	Tax, share holder, contracting earnings significant due to oil development on Native corporate lands	Similar to #2	Similar to #2	Similar to #2	Significantly greater than #2 due to supporting oil field service base in Nuiqsut	Similar to #6	Similar to #6
Employment	No change from existing conditions	Construction employment significant (such as winter ice, road construction)	Similar to #2	Slightly less than #2; no employment for winter ice road	Similar to #4	Significantly greater than #2 due to service base in Nuiqsut	Similar to #6	Similar to #6
Energy	No change from existing conditions	Potential for either natural gas or electricity to be supplied from production facility; North Slope Borough has responsibility to transfer energy to village	Similar to #2	Similar to #2 and access to motor gas more available due to road	Similar to #4	Similar to #2	Similar to #4	Similar to #4
Land Ownership	No change from existing conditions	Similar to #1	Similar to #1	Similar to #1	Similar to #1	Similar to #1	Similar to #1	Similar to #1

Table 3.1.0-4. Summary of construction and operation environmental impacts of the Alpine Development project among alternatives[1] (continued).

Resources	No Action 1	Action Alternatives: ARCO Proposed: X14 Route No Road 2	X10 Route No Road 3	X14 Route with Road 4	X14 Route with Road and Pipeline 5	ASRC Proposal 6	ASRC/Kuukpik Proposal 7	Kuukpik (Western Initiative) 8
Subsistence								
Fish/Wildlife Populations	No change from existing conditions	No significant changes in overall population	Similar to #2	Similar to #2	Similar to #2	Similar to #2	Similar to #2	Similar to #2
Camp Disturbance	No change from existing conditions	Slightly increased camp disturbance due to construction activities near streams	Similar to #2	Similar to #2	Similar to #2	Similar to #2	Similar to #2	Similar to #2
Access	No change from existing conditions	Similar to #1	Similar to #1	More impacts than #2 due to increased access to subsistence areas	Similar to #4	More access than #2 but less than #4 due to road mileage	More than #4 due to the greatest access to subsistence use areas due to the most road mileage	Similar to #7
Competition	No change from existing conditions	Unchanged except for increased fishing pressure from other North Slope residents (i.e., Barrow)	Similar to #2	Potential to be greater than #2 due to increased access from gravel road to KRU	Similar to #4	Similar to #2	Similar to #4	Similar to #4

[1]Conditions assume that the mitigation measures proposed by ARCO for the proposed action are implemented and are also adopted for the other action alternatives where applicable.
The impact analysis assumes that no significant oil spill occurs. Environmental impacts from oil spills are described in Section 4.6.

3.1.3 Summary of Native Corporation Proposals (#6-#8)

In response to ARCO's original May 1995 ADP (see Section 3.2.1.1), the ASRC and the Kuukpik Corporation, two Alaska Native chartered, for-profit corporations with landholding and/or mineral rights interests in the project area, offered three unsolicited proposals (see Appendix F) that are depicted in Figure 3.1.1-1. The main differences between these alternatives and the proposed action are that (1) the alternatives propose use of Nuiqsut and its airstrip as the main service base, in contrast to the construction of an airstrip at Alpine; (2) the alternatives would involve building all-weather roads and additional river crossings that would link Nuiqsut to Alpine and Nuiqsut to KRU; and (3) one alternative would site the production processing facility outside of the delta. The alternatives were proposed because some residents preferred that the pipeline not be located in the delta, which they considered to be a sensitive wildlife and subsistence area. In addition, a road would be constructed for two of the alternatives. The road would provide year-round vehicle access to subsistence use areas and potentially to Fairbanks. Residents could then have decreased costs for obtaining some goods and services. If the airport at Nuiqsut is used for the ADP, then the village would have increased indirect employment and income benefits and increased impacts. The proposals are described briefly in the sections that follow. Note that since the draft EED was published, the ASRC has written a letter supporting the ARCO preferred route (Appendix N).

3.1.3.1 ASRC Proposal (#6)

This proposal (#6) would reroute the pipelines from KRU to Nuiqsut. The pipeline would be supported on VSMs without a parallel permanent road. The pipeline would cross the main channel of the Colville River using the same HDD technology discussed in Section 2, but would do so at a more southerly location than ARCO's proposed action location. The existing airstrip in Nuiqsut would be used instead of building one at the in-field facility ADP location, and there would be a permanent gravel road from Nuiqsut to the in-field facility. The camp facility would also be located in Nuiqsut. From Nuiqsut to the in-field facility, the pipeline would parallel the road on VSMs. The road would have two bridges: one over the Nechelik (Nigliq) Channel and one over a distributary channel. The pipeline would be suspended from these bridges. The pad locations for the in-field facility would be the same as ARCO's proposed action. The cost of this proposal is estimated to be $92 million more than the proposed action. In addition, unknown incremental costs would likely accrue in the form of charges and fees levied by the Native corporations and the local government for use of Nuiqsut's facilities and infrastructure.

3.1.3.2 ASRC/Kuukpik Proposal (#7)

In this proposal (#7), the pipeline would follow a more southerly route than the ASRC proposal and would be buried in a permanent gravel road extending from KRU to the Colville River. The pipeline would cross the Colville River on a pile-supported bridge built to accommodate vehicular traffic. The bridge would connect to a proposed Bureau of Indian Affairs (BIA)-sponsored permanent gravel road from the river to Nuiqsut. The rest of the proposal is the same as ASRC's. As an option, a permanent bridge over the Colville River could be replaced by an ice bridge/ferry system. The costs of the pile-supported bridge proposal are an estimated $199 million more than the proposed action and $153 million more with an ice bridge/ferry system. In addition, unknown incremental costs would likely accrue in the form of charges and fees levied by the Native corporations and the local government for use of Nuiqsut's facilities and infrastructure.

3.1.3.3 Kuukpik Proposal ("Western Initiative") (#8)

This proposal (#8) is the same as ASRC/Kuukpik proposal, except that the ADP processing facility would be located on a third gravel pad on the west side of the Nechelik (Nigliq) Channel (see Figure 3.1.1-1). The gathering lines from the drill pad(s) to the processing facility would be buried in a road and suspended from a vehicular bridge crossing the Nechelik (Nigliq) Channel. The cost of this proposal is estimated to be $207 million more than the proposed action. In addition, unknown incremental costs would accrue in the form of charges and fees levied by the Native corporations and the local government for use of Nuiqsut's facilities and infrastructure.

3.2 PROJECT COMPONENT OPTIONS FOR ALTERNATIVES

3.2.1 In-field Facility Layouts

3.2.1.1 ARCO May 1995 Alpine Development Proposal and Proposed Action

ARCO initially presented an in-field facility layout prior to preparing the original EED for agency and public consideration that was arranged differently from the currently proposed action. Known as the May 1995 proposal, it included an overall in-field facility layout south of the proposed location, a processing/camp facility located on the westernmost gravel pad (instead of easternmost pad), an airstrip separated from the in-field road, and a spur road to lake L9312.

After integrating comments received from state, federal and local government agencies and the Nuiqsut public meetings, and after analyzing results from the winter 1996 exploratory delineation program, the in-field facility layout was moved approximately 1 mi north of the May 1995 location. Once the new locations of the drill pads were optimized to access the subsurface reservoir, ARCO considered four layout designs for configuring the in-field road, airstrip, and processing/camp facility. The layout designs were then ranked qualitatively by an expert panel of environmental scientists, planners, and a subsistence/ cultural specialist to determine the top-ranking layout having the optimal configuration. Considerations included placing the airport and road together to minimize drainage alterations and to consolidate facilities, moving the camp site and airstrip away from river channels and lakes to manage spill control more efficiently, and minimizing impacts to wildlife and their habitats by avoiding bird nesting and staging areas at Nanuk Lake and other wet habitats closer to the Colville River. Recommendations also included consolidating the airstrip, camp, and processing/drill facilities to reduce the area affected by noise; moving the facilities to higher ground wherever possible to minimize wetland, geomorphology, and hydrological impacts; and separating the pipeline (gathering line) from the in-field road to minimize disturbance to caribou movements. The in-field road route for the top-ranking layout was then modified to avoid potential swan and brant preferred habitat and use areas.

The top ranking layout became ARCO's proposed action in the original EED (see Figure 2.0-1). This option eliminated more subsistence concerns than the May 1995 layout by being located farther away from the Nanuk Lake complex, an important subsistence area identified by Nuiqsut villagers. It also consolidated the facilities that would generate the most activity, traffic, noise, and spill potential. The facilities were now farther away from the Nechelik (Nigliq) Channel, a high-use subsistence waterway. Spill potential into the Colville River and Beaufort Sea was better mitigated because the Sakoonang Channel is more conducive for spill containment and retrieval. In response to additional Native input, interested parties comments, and USACE coordination and consultation following the completion of the EED and release of the Public Notice, the proposed action was further refined through a change of overall footprint acreage (17 acres less than in the Public Notice and 17 acres more than in the original EED), the addition of a bridge on the gravel road, and a road rerouting to reduce hydrologic and habitat impacts (as described in Section 2).

3.2.1.2 ASRC and ASRC/Kuukpik Proposals (#6 and #7)

The in-field facility layout under these proposals (#6 and #7) includes a drilling/production pad and a drill pad in the Colville River Delta. The camp would be in Nuiqsut, and the existing Nuiqsut airstrip would be used.

3.2.1.3 Kuukpik Proposal ("Western Initiative") (#8)

This Native proposal (#8) is similar to the ASRC and ASRC/Kuukpik proposals, except that the processing facility would be on a third pad located on the west side of the Nechelik (Nigliq) Channel. The only facilities in the Colville River Delta would be the drill pad(s) and connecting gravel road. Gathering lines suspended from a bridge over the Nechelik (Nigliq) Channel would connect the drill pad(s) to the processing facility.

3.2.2 Pipeline Route and Colville River Crossing Locations/Methods

Four crossing locations (X10, X14, the ASRC location, and the Kuukpik location) and six crossing methods

(HDD, trenching, combined HDD/trenching, **buried**, cable span bridge, and pile-supported bridge) were evaluated. Rather than analyze each method at each location, representative alternatives were chosen for environmental analysis in this document.

The following sections describe a cable bridge span at X10 **(#3)**, trenching and a combined HDD/trenching crossing **or buried** at X14 **(#4 and #5)**, HDD at the ASRC location **(#6)**, and a pile-supported bridge at the Kuukpik location **(#7 and #8)**. These are the alternatives analyzed in Chapter 4. With the exception of an HDD crossing at X10, each crossing method appears to be feasible at X10 and X14.

3.2.2.1 Pipeline Route Using Colville River Crossing X10

Crossing X10 **(#3)** is located 4.4 mi downstream of the Nechelik (Nigliq) Channel on the east channel (main channel) of the Colville River (see Figure 3.1.1-1). At approximately **28** mi, the route is **6** mi shorter than the Crossing X14 route **(#2, #4, and #5)**. Crossing X14 is preferred, however, because of the shorter Colville River crossing (**4,300** ft vs. 9,000 ft). Initially, crossing methods were evaluated at X10, and it was determined that the soil there was comparably unsuitable for an HDD crossing.

<u>Cable Span Bridge</u>

In this crossing method, a 2,250-ft cable suspension bridge (Figure 3.2.2-1 **a and b**) would span the main Colville River active channel; the bridge structure would begin on the east bank. The remainder of the approximately 3,300-ft crossing would include a series of 200-ft continuous steel girder spans on the west side of the river. The single span over the main channel area was chosen because of the high cost of placing main substructure units in the active channel. The substructure units would be expensive because of the **construction and fabrication costs required for building a structure in general** soil conditions **that can withstand** high ice forces in the main channel.

The towers for the suspended span would consist of four-posted units made up of steel-rolled section columns with vertical and horizontal cross bracing. The tower height is set at elevation **245** ft, or approximately one-tenth the span length above the pipe at the tower. A main cable would be draped between the towers. Vertical suspender cables would be attached every 75 ft to the main cable and to a cross beam. The pipeline would be supported on the cross beam. Two wind cables would also run the full length of the bridge. The main cables would be anchored behind the towers, and the wind cables would be anchored on either side of the towers. All eight substructure units (two towers, two main cable anchors, and four wind tie-downs) would consist of pile groups tied together with a steel pile cap. Ice fenders would be placed in front of the west tower to minimize direct ice loads on the substructure unit.

The approach spans would use continuous steel plate girders because the main load-carrying element would be founded on steel pipe piles framed together with a steel cap above the design water level. The upstream pile would be fitted with an inclined steel nose to act as an ice breaker.

The bridge would be constructed over a two-year period using ice pads. During the first winter, the substructure units would be constructed, including the supporting substructure for the approach spans. The cables and pipeline would be installed during the second winter. The pipeline would be completely fabricated on a temporary ice pad on the bank behind the tower and pulled across the cable bridge. When the final position is reached, the pipeline would be permanently fixed to the supporting cross beams on the main span.

3.2.2.2 Pipeline Route Using Colville River Crossing X14

<u>Crossing Methods</u>

The crossing methods evaluated for Crossing X14 **(#2, #4, and #5)** included boring, using HDD technology (the proposed action), burying the pipeline using conventional trenching, and a combination of the two methods.

<u>Buried Using Conventional Trenching</u>. Construction would occur in winter when the river is frozen and the water at its lowest level. At Crossing X14, the water portion of the crossing is approximately 2,270 ft long;

the sand bar portion is approximately 1,060 ft long. The set-back in each bank would be a minimum of 128 ft. The pipeline would be gradually brought up to the surface on each bank requiring another 590 ft (295 ft on each side). The total crossing would be approximately 4,180 ft long (Figure 3.2.2-2).

The section in the active channel would require burying the pipe about 10 ft below the thalweg of the river (the deepest part of the river channel) and extending it level across the active channel plus a minimum of 128 ft on the east bank and 128 ft into the floodplain or sand bar area. The pipe would also be buried 8 to 10 ft into the sand bar area to protect it from flooding. Excavation would be through the ice, using a backhoe in the shallow areas and a dragline in the deeper areas. The ice would be cut into squares, removed, and the area kept clear by a clam bucket rig. The backhoe and dragline would be mounted on a U-shaped sled and moved from set-up to set-up by a bulldozer. The trench, which would be 10 ft wide at the bottom and sloped at 2:1, would be excavated to a minimum depth of 15 ft to provide 10 ft of cover. The extra depth would also mitigate the build-up of sloughed material.

Material would be removed to a disposal area immediately after excavation. Select backfill would be brought in to replace the excavated material to a depth of 2 ft over the top of the pipe (East Channel). The remaining backfilling would be completed by the river during spring break-up.

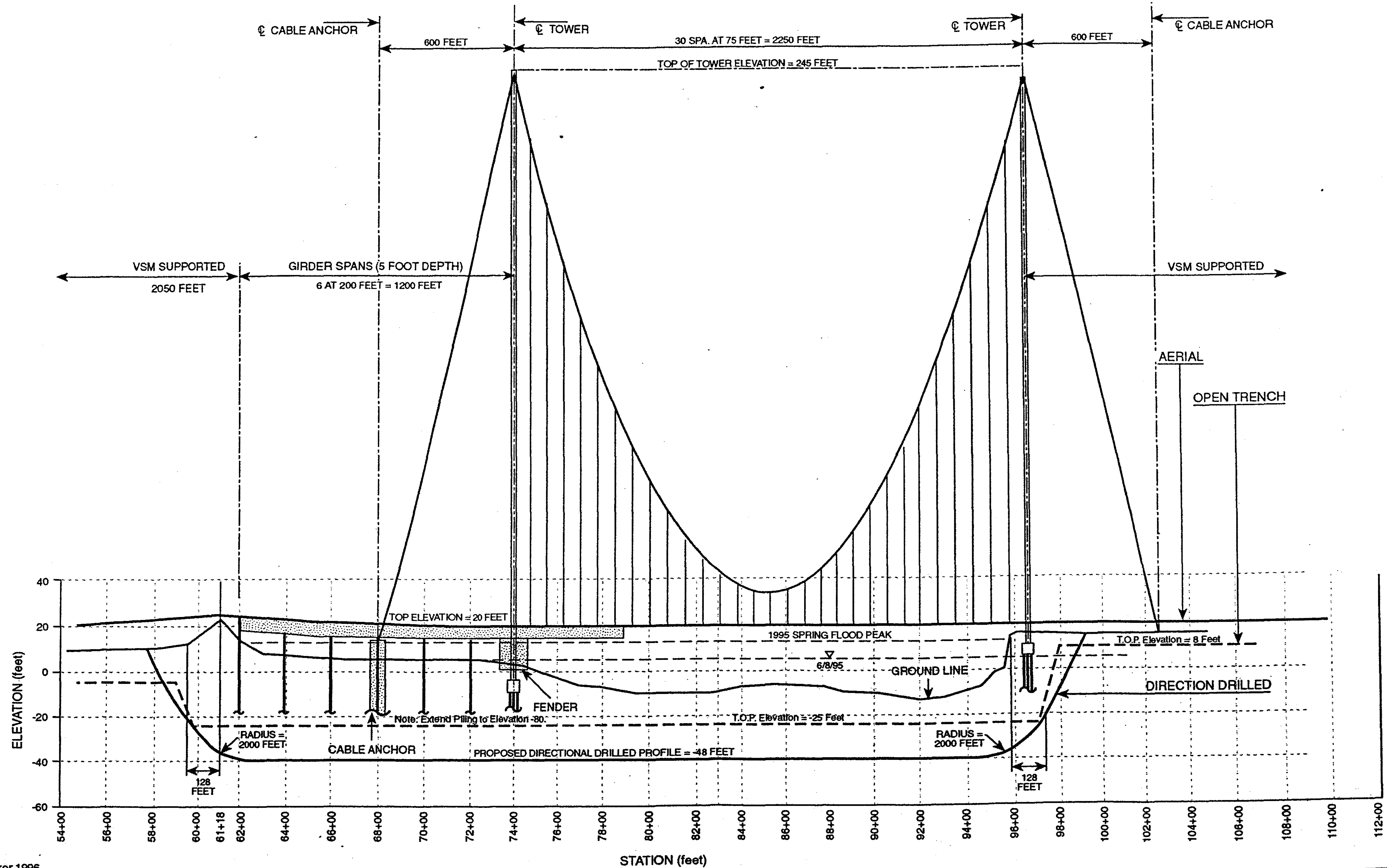
The trench would be designed to accommodate both the sales oil, diesel, and water pipelines. The three pipes would be insulated, concrete-coated, and spaced a minimum of 3 ft apart. Pipe would be welded into sections, tested, and set on rollers to accommodate pulling it into the water section. Pipe would be winched into place using a crane and sidebooms. The pipelines would then be covered over with 2 ft of imported material. The east bank of the water crossing would be backfilled to the top of ground with imported material, and concrete matting placed on top of the imported fill to protect it from river flows.

The sand bar would be frozen and require drilling and "shooting" to dig the trench. The drill patterns would be designed to provide maximum breakage and minimum "fly rock." Backhoes would excavate the shot material. The ditch would be 10 ft wide at the bottom to accommodate pipelines. The side walls would be sloped at ¼:1. The pipe would be coated with fusion-bonded epoxy (FBE), insulated with an outer steel jacket and concrete-coated. It would be welded into sections, with a minimum 3-ft spacing between the pipelines, tested and prepared for lowering into the trench. The west bank of the river would be excavated at the same elevations as the sand bar section for a minimum distance of 128 ft into the bank. The sand bar portion would be backfilled with the excavated material. The material would be in various small angular pieces but suitable for backfill because the pipe would be protected by the concrete coat. The bank areas would be backfilled with imported material to ensure stabilization. The bank face would be stabilized with concrete matting. The vegetation in the trenched area outside the active floodplain would be rehabilitated to its previous condition.

<u>**Combined HDD/Conventional Trenching.**</u> If the combined method is selected, the work would be performed during winter when the river is frozen. The HDD portion would be approximately 2,680 ft long from the east bank of the river to the east side of the sand bar; the open-cut portion (through the sand bar) would be approximately 1,380 ft long to the west bank of the river.

The directional drilling equipment would be set up on the east bank and drilled towards the sand bar. The drilled holes must maintain a minimum 10 ft of cover below the active channel thalweg and extend a minimum of 128 ft into the sand bar area and the east bank. The drilled holes would actually be much deeper across the active channel area.

Construction techniques for the directionally drilled section of the crossing and the trenching section of the crossing would be similar to those previously described.



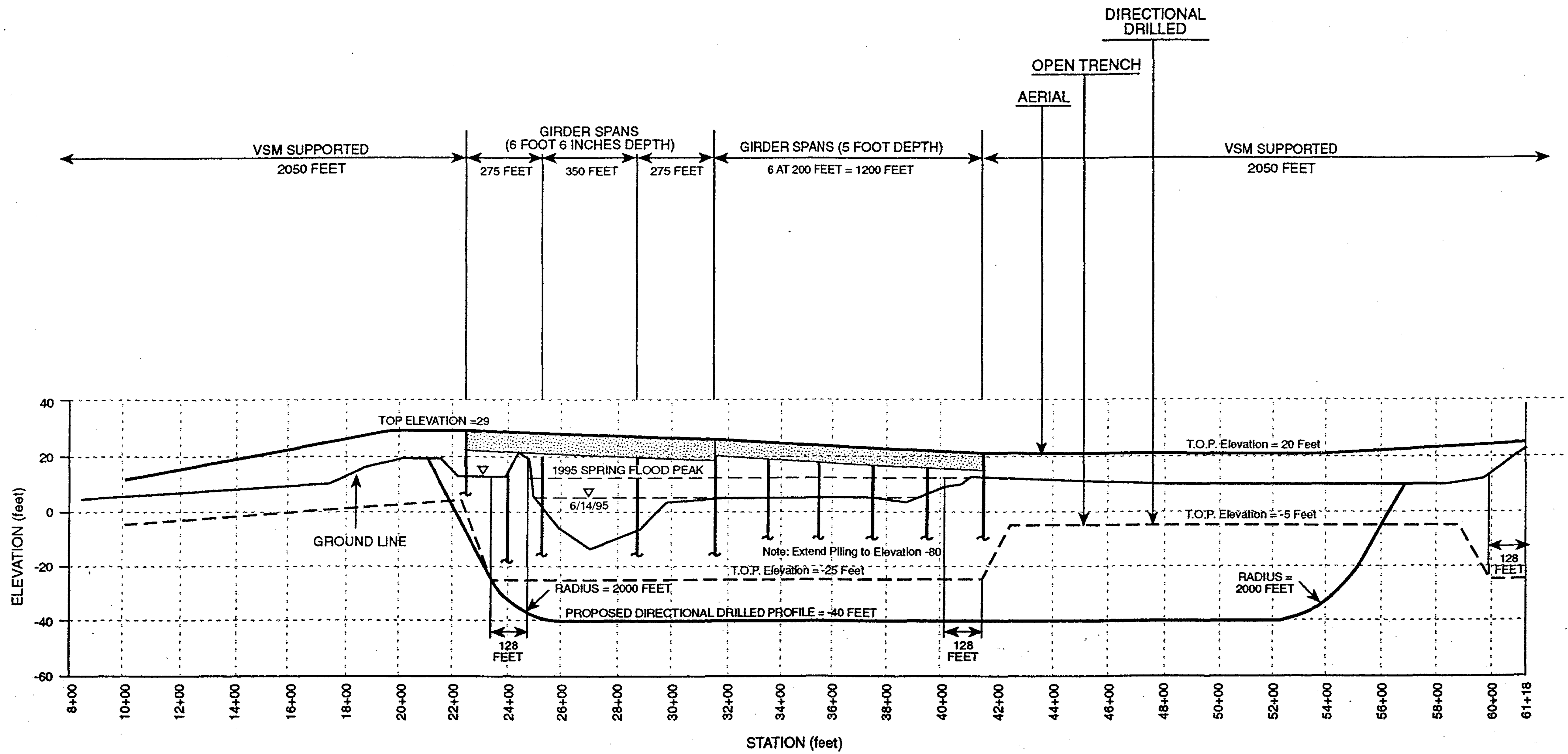
Source: Baker 1996

ARCO Alpine Development/55-2042-04(01) 8/97

HORIZONTAL SCALE IN FEET: 1 INCH = 400 FEET

VERTICAL SCALE IN FEET: 1 INCH = 20 FEET

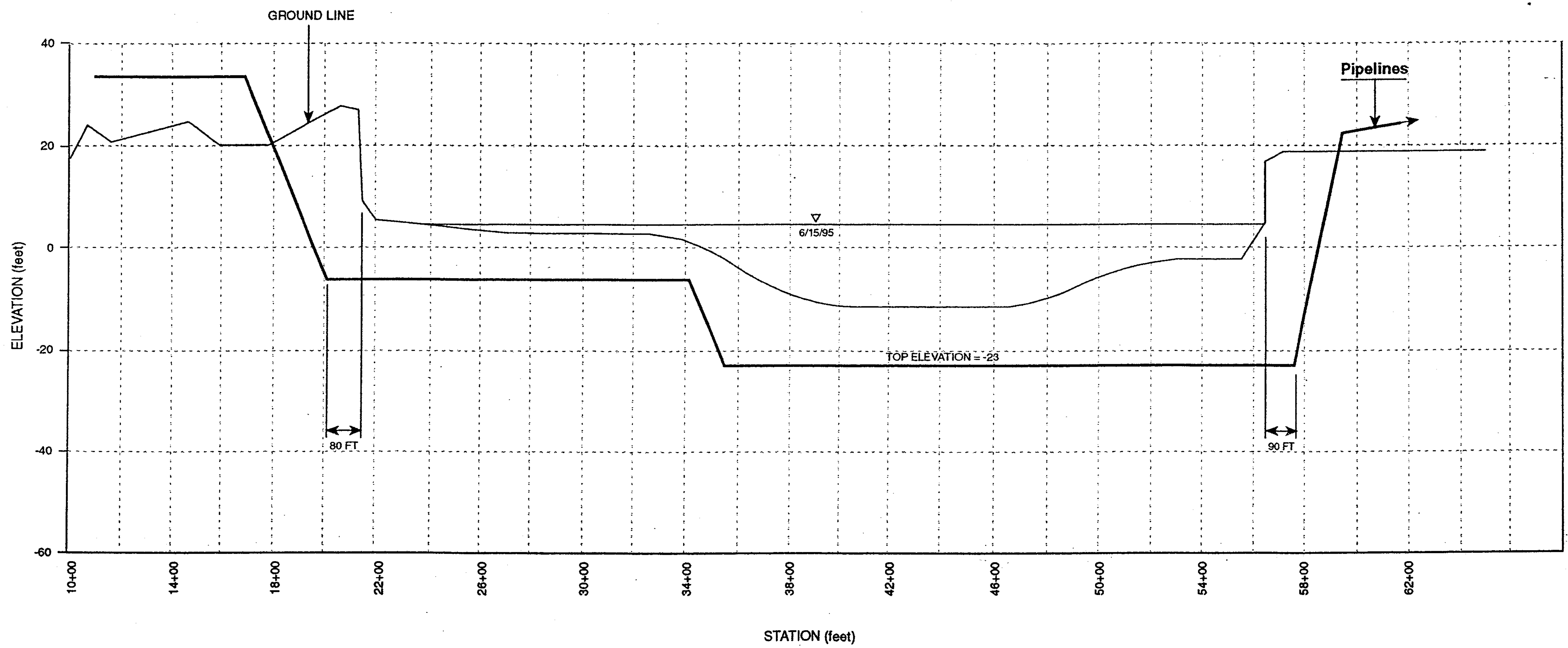
Figure 3.2.2-1a.
Cable Span Bridge Crossing at X10 (East Channel)



Source: Baker 1996

HORIZONTAL SCALE IN FEET: 1 INCH = 400 FEET
VERTICAL SCALE IN FEET: 1 INCH = 20 FEET

Figure 3.2.2-1b.
Cable Span Bridge Crossing at X10 (West Channel)



Source: Baker 1996

HORIZONTAL SCALE IN FEET: 1 INCH = 400 FEET
VERTICAL SCALE IN FEET: 1 INCH = 20 FEET

Figure 3.2.2-2. Open Trench Crossing at X14

Pipeline Configurations

Several methods could be used for pipeline construction from KRU to the ADP in-field facility (see Figure 3.1.1-1). The preferred method is the pipeline supported on VSMs without a permanent gravel road as described in Chapter 2. Alternative approaches are described below.

Crossing X14 with Aboveground Pipeline and Permanent Road (#4). Under this alternative, a permanent gravel road would be constructed, largely paralleling the pipeline. The gravel road would be 64 ft wide at the base, 5 ft high at the centerline, and 28 mi long. Approximately 217 acres of tundra would be permanently covered by the road.

The road would be built during the winter construction season. The gravel would be placed from "belly dumpers" directly onto the tundra. Approximately 8.6 million yd^3 of gravel would be required. The road route would be 1 to 2 mi south of the proposed pipeline route. This route was selected to take advantage of higher ground and to impact fewer lakes and wetlands compared to a road paralleling the aboveground pipeline.

A permanent gravel road would require numerous culverts and possibly bridges to maintain cross drainage and prevent ponding during summer. Vehicles would drive across minor channels with a low-water crossing system. The crossings would be impassable for the three to four weeks a year during break-up. Data collected on the area's drainage patterns would be analyzed to design the culvert and/or bridge system.

Crossing X14 with Pipeline Buried in Permanent Road (#5). The pipeline would be buried in the gravel road described above. However, the footprint of the road would be 15 feet wider to (1) accommodate the pipeline and the insulation board, and (2) prevent the thaw bulb, which would develop around the pipeline, from penetrating the permafrost. Figure 3.2.2-3 is a cross-sectional view of the buried pipeline. The bottom width of the road would be approximately 79 ft. Approximately 268 acres of tundra would be covered by road if this alternative is selected.

Construction would be conducted during winter months. The construction sequencing is more complicated, however, than simple road construction. The gravel work, pipeline preparation, and pipeline installation must be closely coordinated. The increased construction effort substantially increases the overall activity level and costs for this alternative.

3.2.2.3 ASRC Crossing with Aboveground Pipeline and No Permanent Road (#6)

Under this alternative, the pipeline route would be south of ARCO's proposed action alignment. The pipeline would be on upland areas away from the Colville River Delta. The crossing (location is shown on Figure 3.1.1-1) would be accomplished using the HDD technology described in Chapter 2.

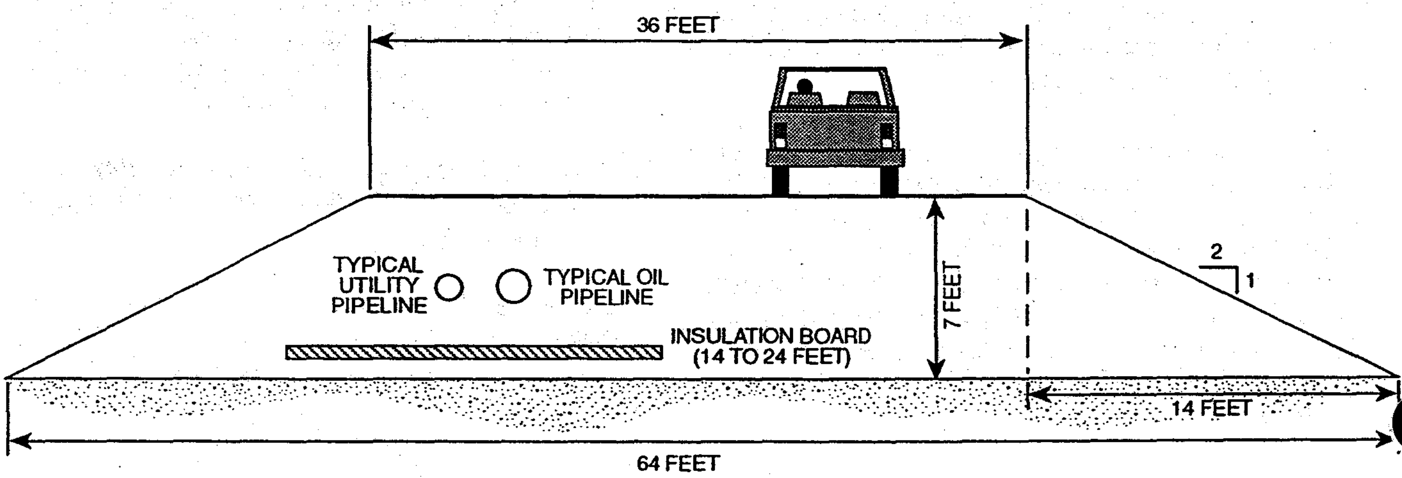
3.2.2.4 ASRC/Kuukpik and Western Initiative Crossing with Pipeline Buried in Permanent Road (#7, #8)

These proposals route the pipeline farther south than the ASRC proposal (see Figure 3.1.1-1), with a crossing of the Colville River near the confluence of the Itkillik River. The pipeline would be suspended from a pile-supported bridge capable of accommodating vehicles. The pipeline would be buried in a permanent gravel road connecting KRU to the in-field facilities.

Vehicular Pile-Supported Bridge

In the active channel of the Colville River, the substructures for the bridge would be spaced 200 ft apart for a total length of 2,200 ft. Each substructure would consist of four support piles and eight buffer piles for ice flow protection (12 total piles). Each pile would be 48 inches in diameter and 100 to 120 ft long. Twelve substructures would be required to support the bridge.

The floodplain or sand bar area would require substructures spaced at 225 ft intervals for a total length of 1,800 ft. Each substructure would have four support piles. Eight substructures would be required to support the bridge in this area. The pile dimensions and length would be identical to those in the active channel.



Source: Baker 1996

Figure 3.2.2-3. Buried Pipeline in Permanent Road

NOT TO SCALE

3.2.3 Access

The proposed access option, described in Section 2.3, is a seasonal as-needed ice road/ice bridge system and an airstrip at the ADP in-field facility. Other access options are described below.

3.2.3.1 Use of Nuiqsut Airstrip—All Native Proposals (#6-#8)

All Native proposals would use the existing Nuiqsut airstrip rather than constructing one at the ADP in-field facility. This would require construction of an 8-mi permanent gravel road with bridges over both the Nechelik (Nigliq) Channel and a side channel to link Nuiqsut to the in-field facility. The road would be required for general logistics and transport of a relief well rig in the event of an uncontrolled blowout and damaged on-site rig.

3.2.3.2 Gravel Road/Permanent Bridge—ASRC/Kuukpik and Kuukpik Proposals (#7, #8)

These alternatives have been described previously. The ASRC proposal does not include a gravel road, permanent bridge between the Colville River and KRU, or use of the planned BIA road.

3.2.3.3 Gravel Road/Ice Bridge/Ferry—ASRC/Kuukpik and Kuukpik Proposal Options (#7, #8)

This option would be similar to the gravel road/permanent bridge alternative, except that a permanent bridge would not be built at the Colville River. The river would be crossed by an ice bridge or ferry depending on the season.

3.2.3.4 Barge/Dredge Channel

This option would involve dredging certain portions of the Colville River channels for barging of materials to a staging area for transport to the ADP in-field facility by gravel road. Facilities and equipment would either be barged up the East Channel of the Colville River to Alpine or up the Nechelik (Nigliq) Channel to the in-field facility. For the East Channel option, river barges, loaded to approximately 1,000 tons, would be transported to Crossing X14. Crossing X10 is less desirable because of the second channel crossing. A docking facility would extend into the west side of the East Channel, approximately 2,000 ft from the high water bank. The facility would either be a sacrificial (i.e., would wash out each season) gravel staging pad or a permanent installation.

This option would also require installing a 46-ft-wide, 3- to 5-ft high, approximately 7.5-mi long gravel road from the dock to the ADP in-field facility. Approximately 42 acres of tundra would be permanently covered by road. Road construction would require up to 2.7 million yd^3 of gravel. The barges would dock and the materials would be loaded onto trucks or crawlers for transport to the in-field facility. This option and one using the Nechelik (Nigliq) Channel were dropped from further consideration in this EED because of costs, environmental impacts to wildlife and fish habitat, impacts to subsistence use patterns and uncertainty about ice conditions being suitable for successfully barging material in the Arctic Ocean and Harrison Bay. However, one of ARCO's co-owners is still supporting further evaluation of the barge/dredge channel option. Evaluation is ongoing.

3.2.3.5 Tundra Travel

This alternative would be used only in case of emergency for the proposed action, as well as for all alternatives when access on roads is not available. Access would typically be by means of a Rolligon during non-winter months and snowmobiles or other tracked or rubber tired vehicles during winter.

3.2.4 Material Sites

The Nuiqsut Constructors, Inc. new mine site (also referred to as the ASRC mine site) is the proposed option discussed in Section 2.

3.2.4.1 Existing KRU Site

This option would use the existing KRU Mine Site F located approximately 35 mi east of the ADP in-field facilities. This option would require transporting the gravel to the site using an ice road/ice bridge.

3.2.4.2 Existing Stockpiled Gravel at Nuiqsut

Approximately 350,000 yd^3 of gravel are stockpiled at Nuiqsut. Up to 200,000 yd^3 of the gravel is dedicated for building the BIA-sponsored road from Nuiqsut to the Colville River. The remaining 150,000 yd^3 would be inadequate to meet the gravel requirements of the ADP.

This option was dropped from further consideration for economic reasons. There is not enough gravel at Nuiqsut to justify the cost of building an 8-mi ice road from Nuiqsut to the in-field facility for hauling the gravel.

3.2.4.3 New Colville River Delta Sites

ARCO drilled 14 exploratory geotechnical borings in and around the Colville River Delta in winter of 1995/96 and found no practicable gravel resources. The overburden covering the gravel was too deep to make excavation economically practicable and resultant temporary storage of overburden would have comparably more impact. This option was dropped from further consideration.

3.2.4.4 Dredge From Colville River

The closest in-river gravel source to the Alpine location is in the Nechelik (Nigliq) Channel near Nuiqsut. Dredging for the gravel would require considerable in-water work and barging. This option, which was feasible but not economically or environmentally practicable, was dropped from further consideration.

3.2.4.5 Mine from Tapped Lakes

There is no known source of gravel in the tapped lakes in the project area. Exploratory geotechnical borings drilled in 1996 showed no viable gravel resources. This option was, therefore, dropped from further consideration.

3.2.5 Freshwater Sites

The preferred option, using fresh water for drilling, potable, and firefighting uses, is described in Section 2.5, and includes use of lakes within the delta.

3.2.5.1 Existing KRU Sources

This option would require transporting a constant supply of water to the ADP in-field facility from KRU. Due to the high cost of transportation this option was dropped from further consideration.

3.2.5.2 Colville River

The Colville River main channel and Nechelik (Nigliq) Channel were considered for a freshwater source. Under these alternatives, water would be pumped from the channels. A seasonal ice road or gravel road would be constructed from a pumping station on the bank of the Sakoonang Channel directly east to the in-field facility or on the bank of the Nechelik (Nigliq) Channel directly west of the in-field facility. A filtration system would restrict intake of fish and solids.

Initial discussion with state and federal agencies indicates that this option may be considered acceptable for certain volumes and durations and may be proposed as an optional component of the proposed action.

3.2.5.3 Flooded Mine Site Connected to the Colville River

This alternative would require transporting a constant supply of water to the Alpine Development from the Nuiqsut Constructors , Inc. ASRC mine site on the east bank of the Colville River. The mode of transportation would depend on the selected access alternative and seasonal limitations. This option is viable but not proposed because there are locally available water sources.

3.2.6 Waterflood Sources

The proposed option is to transport seawater to the ADP in-field facility through a separate utility pipeline supported on the same VSMs used for the sales oil pipeline. The seawater would be routed through KRU from the existing treatment plant at Oliktok Point.

3.2.6.1 Source Water Wells at KRU

Source water wells at KRU were considered as an option. Reservoir data suggest that there is not an ample supply of water to meet the project production needs. However, the KRU water wells are comparably more expensive and may be needed for potential KRU facility expansions.

3.2.6.2 Source Water Wells in Project Area

Source water wells within the vicinity of the ADP area were also considered as an option. Reservoir data indicate there is not enough water to meet the production waterflood needs of the project. Consequently, this option was eliminated.

3.3 MAJOR ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED CONSIDERATION

3.3.1 Location

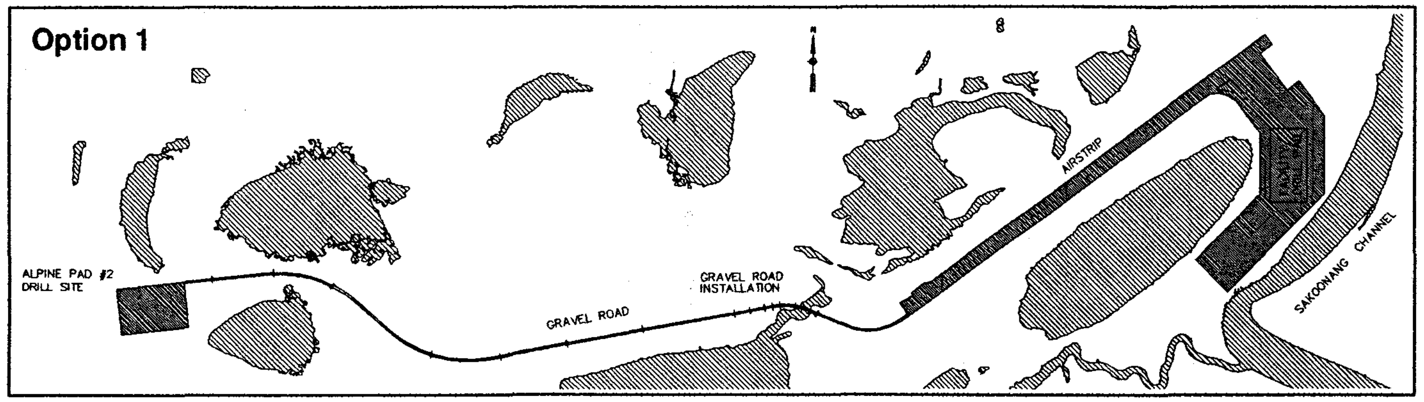
Prior to 1990, ARCO acquired leases from the state of Alaska and other entities for extracting oil and gas in the Colville Delta (approximately 164,479 acres in size). ARCO then conducted exploratory drilling and seismic surveys throughout the delta in 1991 to determine the presence of oil and gas. Exploration continued throughout the delta, culminating in the discovery of the Alpine reservoir in 1994. Reservoir delineation drilling was conducted in the winter of 1995-1996. Proposed surface locations of the ADP were determined based on maximizing oil and gas production, protecting environmental, subsistence, and cultural resources, and minimizing construction and operational costs.

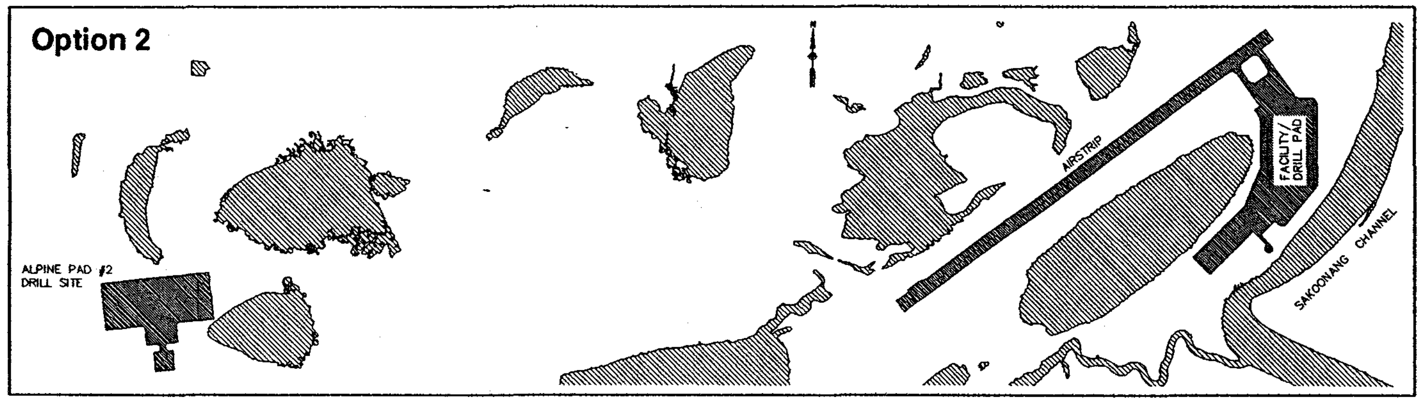
3.3.2 Alternatives Analysis

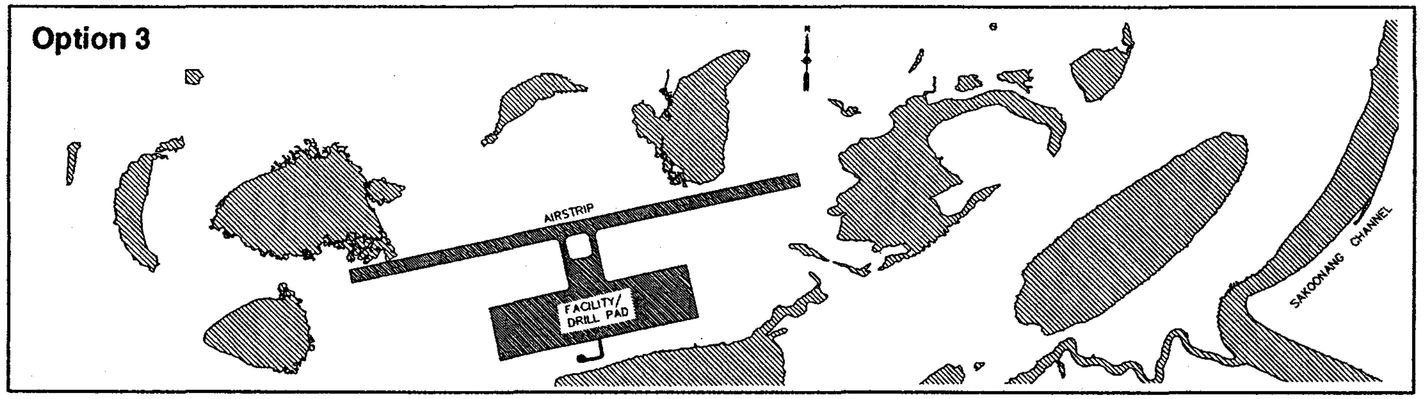
ARCO considered but eliminated three in-field layouts that were substantially different from the proposed action and its initial refinements described in Section 3.2.1.1. The three layouts, developed in consultation with USACE, are illustrated in Figure 3.1.1-2 relative to the layout described in the Public Notice (option 1). Their designs centered on reducing the size of the gravel footprint by largely eliminating the gravel road. The two, single pad designs (options #3 and #4 in Figure 3.1.1-2) were eliminated from further consideration in the EED because the oil reservoir could not be effectively produced from a single pad. Drilling technology is not sufficiently advanced to use one pad to diagonally drill into enough of the known oil reservoir to make the ADP economically feasible without eventually building a second pad. In addition, high value wildlife habitat identified by ARCO scientists and important subsistence use areas (e.g., Nanuk Lake) identified by the Nuiqsut hunters and fishers occur in the immediate vicinity of the single pad layout (option #3 in Figure 3.1.1-2) located in the central area of the ADP in-field facilities site. The two-pad design (option #2 in Figure 3.1.1-2) was eliminated from consideration because the second pad could not be accessed by a drill-rig to drill a relief well in the event of a well blowout. The absence of a year-round road or year-round means of access to the western drill pad represented an unacceptable breach in ARCO safely operating the project, and also a barrier to responding to an oil spill associated with a well blowout year-round. An airstrip at Alpine Pad 2 was evaluated but found to have acreage impacts similar to the proposed action and increased operations and maintenance costs due to seasonal ability to manage well performance and intervene on-demand and year-round.

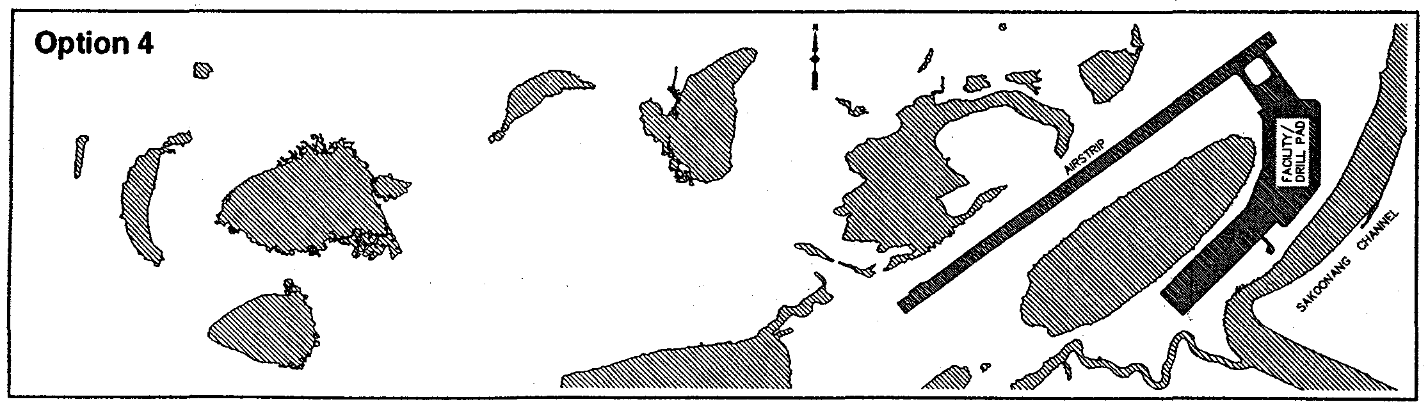
3.3.3 Options Analysis

Options within alternatives were explored for material (gravel) and freshwater sources. Initial gravel options that were later eliminated included gravel at the project site, stockpiled gravel reserves at Nuiqsut, Colville River delta sites, dredging from the Colville River, and dredging from tapped lakes (refer to Section 3.2.4). Freshwater sources that were reviewed and rejected included use of the KRU sites, Colville River, and flooded mine sites connected to the Colville River (refer to Section 3.2.5).









Option 1 - USACE Submittal "Public Notice" - Two Pads With Road

VOLUME GRAVEL (C.Y.)	TOTAL FOOTPRINT (ACRES)	EXPECTED IMPACTS TO DRILLING	EXPECTED IMPACTS TO OIL AND GAS RECOVERY	IMPACTS TO OPERATIONS AND MAINTENANCE	SAFETY	FITS NEED OF APPLICANT
1,323M	115	NO IMPACT (BASE CASE, 92 WELLS)	NO IMPACT (BASE CASE, ESTIMATED 365MM BBL RECOVERABLE RESERVES)	NONE (ORIGINAL BASE CASE)	NONE (ORIGINAL BASE CASE)	YES, THIS ORIGINAL BASE CASE WAS SELECTED AND SLIGHTLY MODIFIED

Option 2 - Two Pads Without Road

VOLUME GRAVEL (C.Y.)	TOTAL FOOTPRINT (ACRES)	EXPECTED IMPACTS TO DRILLING	EXPECTED IMPACTS TO OIL AND GAS RECOVERY	IMPACTS TO OPERATIONS AND MAINTENANCE	SAFETY	FITS NEED OF APPLICANT
968M	93	NO IMPACT (BASE CASE, 92 WELLS)	NO IMPACT (BASE CASE, ESTIMATED 365MM BBL RECOVERABLE RESERVES)	SIGNIFICANTLY MORE DIFFICULT AND COSTLY O&M. RELIEF WELL RIG REQUIRED ON ALPINE PAD 2 AT TIME WHEN THERE IS NO ICE ROAD	PERSONNEL AND OPERATIONS LESS SAFE THAN BASE CASE DUE TO ACCESS LIMITATIONS DURING PERIODS WHEN THERE IS NO ICE ROAD	NO, DUE TO LOWER SAFETY, AND MORE COSTLY AND LESS RELIABLE OPERATIONS AND MAINTENANCE

Option 3 - Single Pad "All Facilities" at Central Location

VOLUME GRAVEL (C.Y.)	TOTAL FOOTPRINT (ACRES)	EXPECTED IMPACTS TO DRILLING	EXPECTED IMPACTS TO OIL AND GAS RECOVERY	IMPACTS TO OPERATIONS AND MAINTENANCE	SAFETY	FITS NEED OF APPLICANT
1,124M	78	-47.6MM DRILLING COST (64 WELLS, 28 FEWER THAN BASE CASE)	-9.4MM BBL, EXPECTED RECOVERY IS 74 PERCENT OF BASE CASE	O&M COST EXPECTED TO BE SLIGHTLY LESS THAN BASE CASE	SAFETY IS NOT SIGNIFICANTLY DIFFERENT THAN BASE CASE	NO, DUE TO GREATER HABITAT IMPACT AND SIGNIFICANTLY LOWER RECOVERY OF OIL AND GAS

Option 4 - Single Pad at Current DS-1 Location

VOLUME GRAVEL (C.Y.)	TOTAL FOOTPRINT (ACRES)	EXPECTED IMPACTS TO DRILLING	EXPECTED IMPACTS TO OIL AND GAS RECOVERY	IMPACTS TO OPERATIONS AND MAINTENANCE	SAFETY	FITS NEED OF APPLICANT
764M	76	-72.4MM DRILLING COST (53 WELLS, 39 FEWER THAN BASE CASE)	-113MM BBL, EXPECTED RECOVERY IS 69 PERCENT OF BASE CASE	O&M COST NOT SIGNIFICANTLY DIFFERENT THAN BASE CASE	SAFETY IS NOT SIGNIFICANTLY DIFFERENT THAN BASE CASE	NO, DUE TO SIGNIFICANTLY LOWER RECOVERY OF OIL AND GAS

Figure 3.1.1-2
Infield Layout Options

Chapter 4

4. AFFECTED ENVIRONMENT, ENVIRONMENTAL CONSEQUENCES, AND MITIGATION MEASURES

4.1 INTRODUCTION

Chapter 4 describes the affected environment, environmental consequences, and mitigation measures for the following resource categories: physical, chemical, biological, and human use resources. Within the resource categories, (1) hydrology, geology, and geomorphology are addressed under physical resources; (2) air quality and water quality under chemical resources; (3) fish, wildlife, and threatened and endangered species under biological resources; (4) and communities of the Colville Region, government institutions, economic institutions, and Kuukpikmiut subsistence under human use resources. The affected environment, environmental consequences, and mitigation measures are separately discussed under each of these resource subjects. The environmental consequences section is further divided into a discussion of impacts of the proposed project and impacts of the alternatives. Oil spill and cumulative effects analyses are discussed for the proposed project at the end of this section.

The proposed ADP consists of the following major elements (see Chapter 2 for a more complete description):

- Field development including a processing/ campsite/drilling-production pad, a drilling-production pad, in-field road, in-field gathering lines, and an airstrip;
- An approximately 34.2-mi sales oil pipeline, a diesel fuel pipeline, seawater pipeline, and a fiber optic cable supported on VSMs connecting the ADP with KRU CPF-2 pad;
- An underground pipeline crossing of the Colville River using proposed HDD technology;
- Ice roads and air transportation for access (a gravel road is not part of the proposed action);
- Gravel obtained from the ASRC mine site operated by Nuiqsut Constructors, Inc.

Chapter 4.2

4.2 PHYSICAL RESOURCES

Over six years of floodplain data (that included flood frequency and duration, local surface geomorphology, and over 40+ years of erosional and depositional landform information) were collected prior to siting the ADP in-field facilities. This information was supplemented with additional detailed habitat mapping to ensure that most of the ADP in-field facilities are sited in locations least prone to flooding. Very detailed floodplain studies were conducted to minimize impacts from flooding.

Although hydrologic information generally is lacking for most North Slope rivers, hydrologic studies have been conducted on the Colville River Delta by Arnborg et al. (1966), Jorgenson et al. (1993, 1994, 1996), and Ray and Aldrich (1996a,b,c,d). Hydrologic data for streams in the transportation corridor are limited to a few discharge measurements of the Kachemach and Miluveach rivers from 1981 (Drage et al. 1983). The hydrologic phenomena of greatest interest in relation to the ADP are the flooding regimes of rivers in the delta and the transportation corridor, the seasonal distribution of flow, and flow velocities.

The Colville River Delta is a dynamic area shaped by complex hydrologic, geologic, and geomorphic processes, that have resulted in a wide variety of landforms. The delta and nearby coast have also been the subject of geologic and geomorphic studies by Walker (1963, 1976, 1983a,b, 1994), Reimnitz et al. (1985), Rawlinson (1993), and Jorgenson et al. (1993, 1996). These studies have demonstrated that the principal geologic and geomorphic concerns for development on the Colville River Delta are the presence of ice-rich permafrost (perennially frozen ground), which can become unstable when disturbed, and erosion and deposition along large river channels and lakeshores. Accordingly, this section first summarizes the nature and distribution of surface deposits and water flows that have been considered in project design and then addresses the most relevant concerns regarding impacts of hydrologic, geologic, and geomorphic processes.

4.2.1 Affected Environment

4.2.1.1 Hydrology

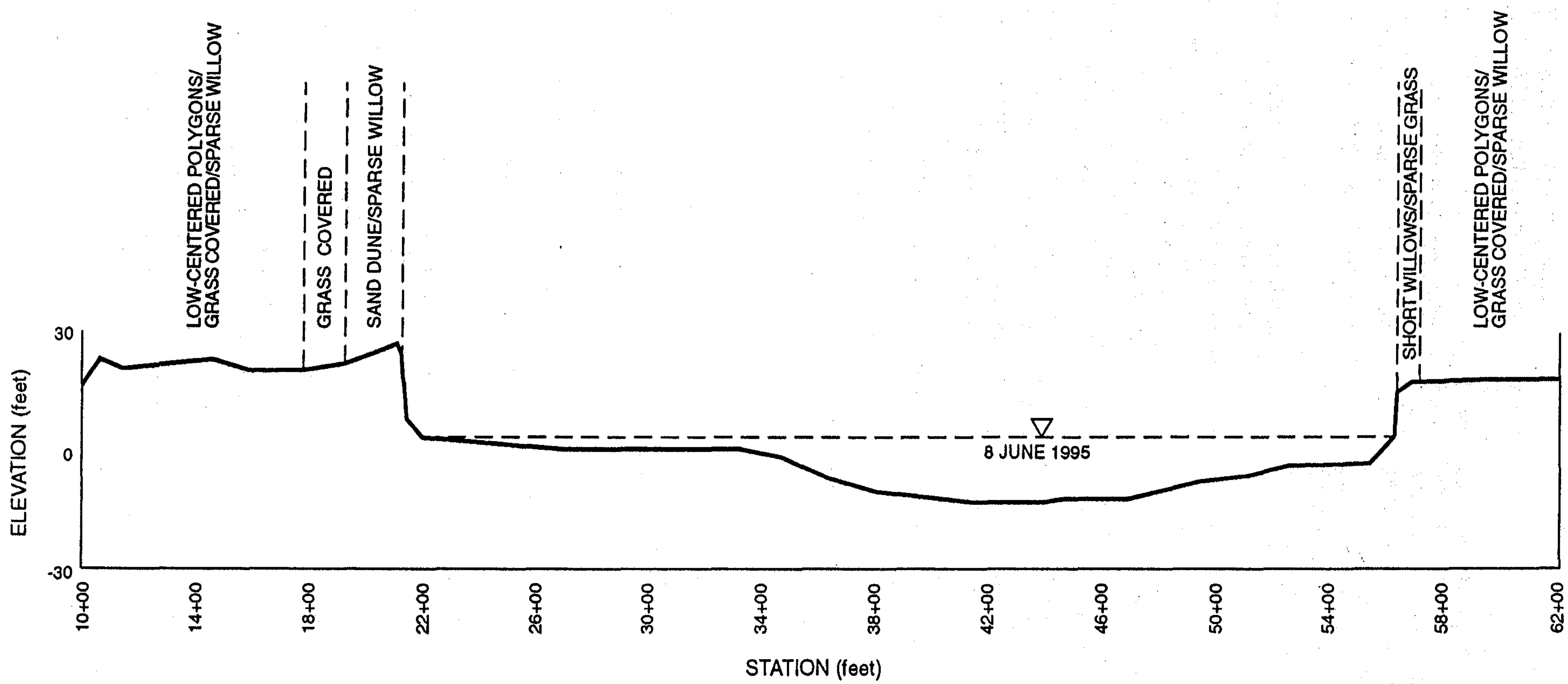
Waterbody Descriptions

Colville River. The Colville River is the longest river (370 mi) on the North Slope of Alaska. The drainage basin, which covers 20,920 mi² from the Brooks Range to the Arctic Ocean (USGS 1978; Jorgenson et al. 1994), is located within three physiographic regions: the Arctic Coastal Plain (10 percent of the basin), the Arctic Foothills (64 percent), and the Brooks Range (26 percent) (Walker and McCloy 1969). No glaciers occur within the drainage basin, although the basin is entirely underlain by continuous permafrost (Péwé 1966).

The Colville River enters the delta north of the mouth of the Itkillik River, approximately 4 mi southeast of Nuiqsut. The delta is more than 25 mi long and covers about 250 mi² (Jorgenson et al. 1994) or about 1 percent of the entire Colville River drainage basin. Most of the water reaching the delta is carried to the ocean through two main channels: the East Channel and the Nechelik (Nigliq) Channel (Arnborg et al. 1966). Approximately 80% of the discharge at the head of the delta flows in the East Channel and its distributaries, while the remaining 20% flows in the Nechelik (Nigliq) Channel (Arnborg et al. 1966). Several distributaries branch from the East Channel, including the Sakoonang and Tamayayak channels.

In general, the channels of the Colville River and its distributaries are broad and relatively shallow. The East Channel is some 3,000 ft wide; a representative cross section of the East Channel downstream from the Putu Channel is shown in Figure 4.2.1-1. Depths in this channel generally range from 15 to 25 ft (measured from typical summer water surfaces), but exceed 40 ft at a few locations (Ray and Aldrich 1996d). The Nechelik (Nigliq) Channel is about 1,000 ft wide and 10 to 30 ft deep (Walker 1983b; Ray and Aldrich 1996d); maximum depths are about 40 ft. The Sakoonang and Tamayayak channels are narrower, on the order of 200 and 500 ft, respectively. The deepest parts of those two channels approach 30 ft (Ray and Aldrich 1996d).

Kachemach and Miluveach Rivers. The Kachemach and Miluveach rivers, which drain the Arctic Coastal Plain east of the lower Colville River, are completely underlain by permafrost. The Kachemach River is approximately 35 mi long, with a drainage area of 213 mi². This river forks into three channels at the mouth; these flow into the eastern side of the East Channel of the Colville River between the Tamayayak Channel and a location just downstream of the Kupigruak Channel. The Miluveach River is about 40 mi long and has a drainage area of 184 mi². This river flows into the eastern side of the East Channel of the Colville



Source: Shannon & Wilson 1996

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Notes: 1. Elevations are based on USCGS Monument "RIVER", elevation = 41.99 feet.
2. [illegible]s section is looking downstream.

Figure 4.2.1-1.
East Channel Cross Section Approximately 1.5 Miles Downstream From the Putu Channel

River, approximately 5 mi downstream of the Kupigruak Channel. The lower portions of both rivers are characterized by meandering channels and oxbow lakes.

Small Streams. Small tundra streams are common in the project area. In general, these streams form along ice wedges, where the soil subsides due to the melting of the ice in the ground (Walker 1973a). These streams are generally only a few miles long and drain into the Colville, Kachemach, or Miluveach rivers. Many of these streams are "beaded," consisting of a series of small ponds connected by short channel segments.

Lakes and Ponds. Ponds and lakes are the most prevalent waterbodies on the Colville River Delta. Most of the ponds are located within low-centered ice-wedge polygons (small low-lying areas surrounded by a raised rim formed by frost action) (Walker 1983a). Many of the ponds and lakes are shallow (less than 6 ft deep) and freeze to the bottom in the winter. They are formed from thawing of ice-rich sediments during a "thaw-lake cycle" that includes thawing, expansion, drainage, ice-aggradation, and eventual thawing again (Sellmann et al. 1975; Walker et al. 1980). Lakes of over 10 acres are numerous, covering 16 percent of the delta surface (Walker 1978). These lakes are generally 11 to 15 ft deep, but they can be as deep as 28 ft (Moulton 1996). Because they have greater masses of ice and water to warm and melt at break-up, these lakes remain ice-covered into early July, much later than the smaller lakes (Walker 1978).

Natural recharge of the lakes is accomplished by overbank flooding, snow melt overland flow, and groundwater flow. ARCO conducted flood studies in the delta which suggest that some lakes recharge every year (lakes 9524 and 9525), only 1-3 years (lakes 9316 and 9313), 3-10 years (lakes 9321 and 8533), and 5-25 years (lakes 9310, 9311 and 9312).

The lakes in the transportation corridor tend to be shallower than those on the delta. These lakes typically are 3 to 7 ft deep, with a few up to 15 ft deep (Moulton 1996).

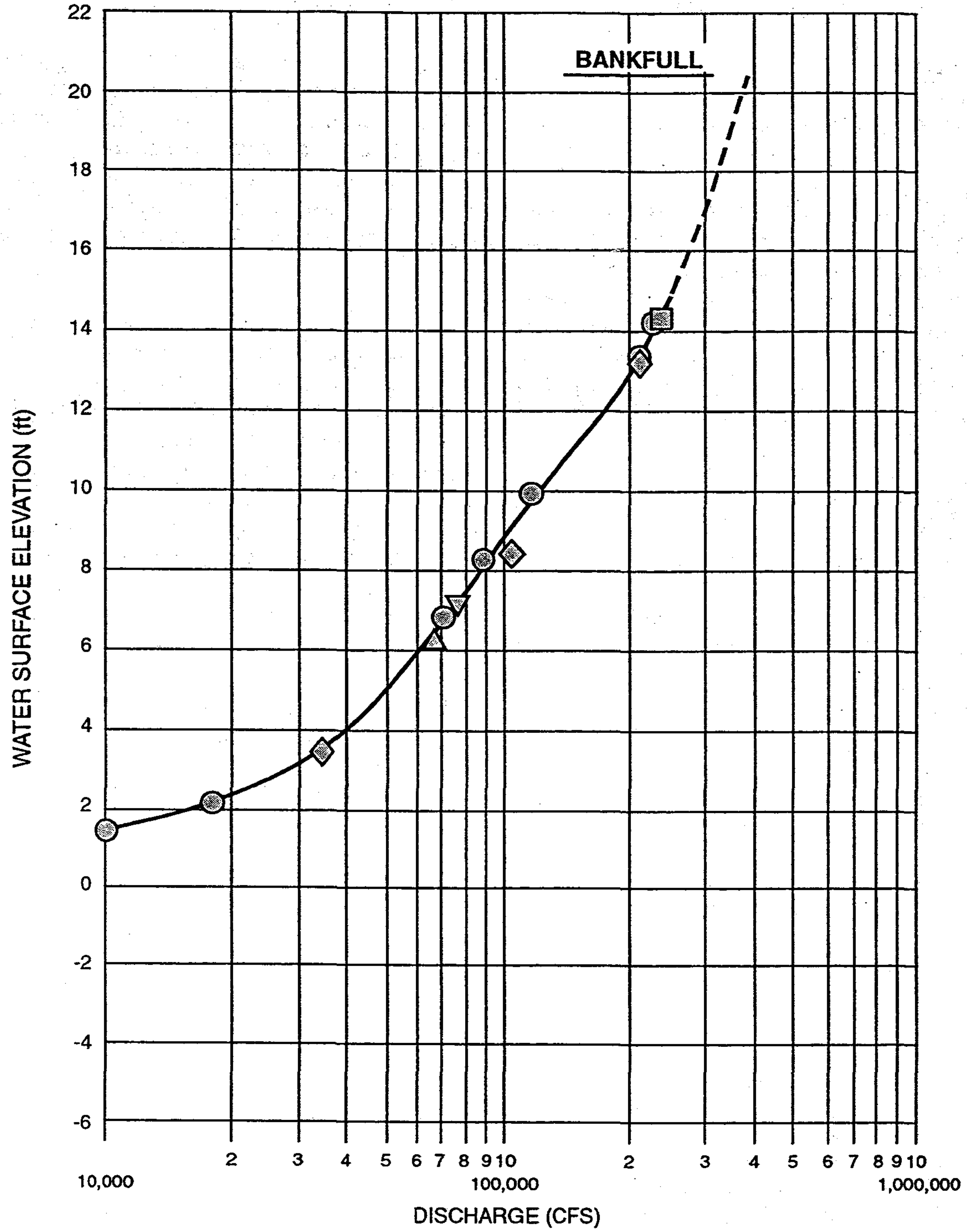
River Discharge

Colville River. Walker and McCloy (1969) have described the seasonal distribution of flow in the Colville River. Winter is a 33-week period of little flow (which allows seawater to penetrate up the delta distributaries [Arnborg et al. 1966]). Spring is a 3-week period characterized by increasing flow, break-up of the ice cover, and flooding. Summer is a 12-week period of low flow during dry periods and higher flow during rainy periods, and fall is a 4-week period of low, stable flow.

Spring break-up on the Colville River generally occurs before the break-up of coastal plain streams, such as the Kachemach and Miluveach rivers, because the Colville River headwaters are located in the Brooks Range and foothills. The break-up front begins during the sunnier, warmer conditions that occur there in spring (free of coastal fog and associated cold air) and proceeds north-ward (Drage et al. 1983). The peak break-up discharge for the Colville River typically occurs between mid-May and mid-June. Based on data collected at the head of the delta, the median date of peak break-up discharge is June 2. This date is a few days earlier than for the Kuparuk River, which has a median date of June 6. Generally, the main channels are ice-free within a few days before or after the peak discharge. However, in some years ice does not clear completely from the channels for up to 2 weeks after the peak discharge (Ray and Aldrich 1996a).

Although break-up flows only last about three weeks, a significant portion of the total annual flow usually occurs during break-up. Walker (1972) estimated that 55% of the annual flow occurred during the 18-day spring break-up flooding in 1971. In 1962, however, break-up flooding occurred over a 30-day period (Arnborg et al. 1966), during which 45 percent of the total flow usually recorded between May 24 and September 30 occurred. Although data for other years are sparse, these two years probably represent the range of flow volumes during typical break-up flooding.

The peak break-up discharge at the head of the delta averages 264,000 cubic ft per second (cfs) (based on data from 1962, 1977, and 1992-95; Ray and Aldrich 1996b) and has a water surface elevation of approximately 15.7 ft above mean sea level (amsl) (Figure 4.2.1-2). This flow is substantially greater than the peak break-up flows on the Kuparuk River, which average 51,600 and 3,410 cfs, respectively (EarthInfo 1993a; USGS 1994, 1995). Flow velocities at the head of the Colville River Delta during break-up flooding



Notes: 1. Elevations are based on U.S.C.G.S. monument "River"- elevation = 41.99 feet above mean sea level.

2. Discharge measurement cross section located approximately 1 mile downstream from the Itkillik River.

Source: Shannon & Wilson 1996

ARCO Alpine Development/55-2042-04(01) 8/97

- ▣ Based on the discharge measurement made by Shannon & Wilson on 2 June 1993 (Jorgenson et al., 1994)
- ▽ Based on the discharge measurement made by Shannon & Wilson on 11 June 1995 (Aldrich and Ray, 1996a)
- ◉ Based on the discharge measurements made by the USGS in 1977
- △ Based on the discharge measurement made by the Arctic Hydrologic Consultants on 10 June 1992 (Jorgenson et al., 1993)
- ◇ Based on the discharge measurements made in 1962 (Amborg et al.,1996)

Figure 4.2.1-2.
Colville River at Head of Delta Stage-Discharge Relationship

typically average 4 to 6 ft per second (fps) (Ray and Aldrich 1996c).

Typical summer flows at the head of the Colville River Delta range between 20,000 and 80,000 cfs. Water surface elevations typically range between 2 and 8 ft amsl, respectively (Figure 4.2.1-3). Flow velocities average 1 to 3 fps during the summer, and velocities in the downstream distributaries are lower because of the flatter water surface slopes there.

According to Walker (1983a), Colville River flow continues to subside in the fall until it ceases to flow sometime during winter. Several attempts to measure discharge during winter months have yielded velocity readings of zero (Walker 1973b). However, because the flow area of the channels under the ice can be as high as 10,000 ft^2 and the minimum detectable velocity for many current meters is 0.1 fps, flows as high as 1,000 cfs could go undetected. Other researchers reported having detected flow upstream of the delta in March and April. In particular, a discharge measurement note from the U.S. Geological Survey (USGS) reported that on May 1, 1969, flow was visible in the Colville River a mile southeast of Umiat, but it was insufficient to turn the flow meter. The USGS estimated the flow at that time could have been as high as 300 cfs. Thus, based on the best information available at this time, late winter flows should be considered to range from zero to 1,000 cfs.

<u>Kachemach and Miluveach Rivers</u>. Hydrologic data are extremely limited for the Kachemach and Miluveach rivers. However, the discharge patterns of these streams are probably similar to those of other rivers on the Arctic Coastal Plain. Consequently, data from the Putuligayuk River (located about 40 mi east of the project area) and other information on coastal plain streams have been used to estimate hydrologic conditions for the Kachemach and Miluveach rivers.

Rivers with drainage basins located entirely within the Arctic Coastal Plain typically are the last rivers on the North Slope to undergo break-up because snow melts later there than in the foothills and mountains. The Kachemach and Miluveach rivers breakup after the Colville River, similar to the Putuligayuk River, for which the median date of peak break-up discharge is June 10 (EarthInfo 1993a; USGS 1994, 1995). The average peak break-up discharges for the Kachemach and Miluveach rivers are estimated to be 2,770 and 2,480 cfs, respectively (Table 4.2.1-1). The average length of break-up on coastal plain streams is about 10 to 12 days (Drage et al. 1983), and flow velocity during break-up probably averages 3 to 5.5 fps.

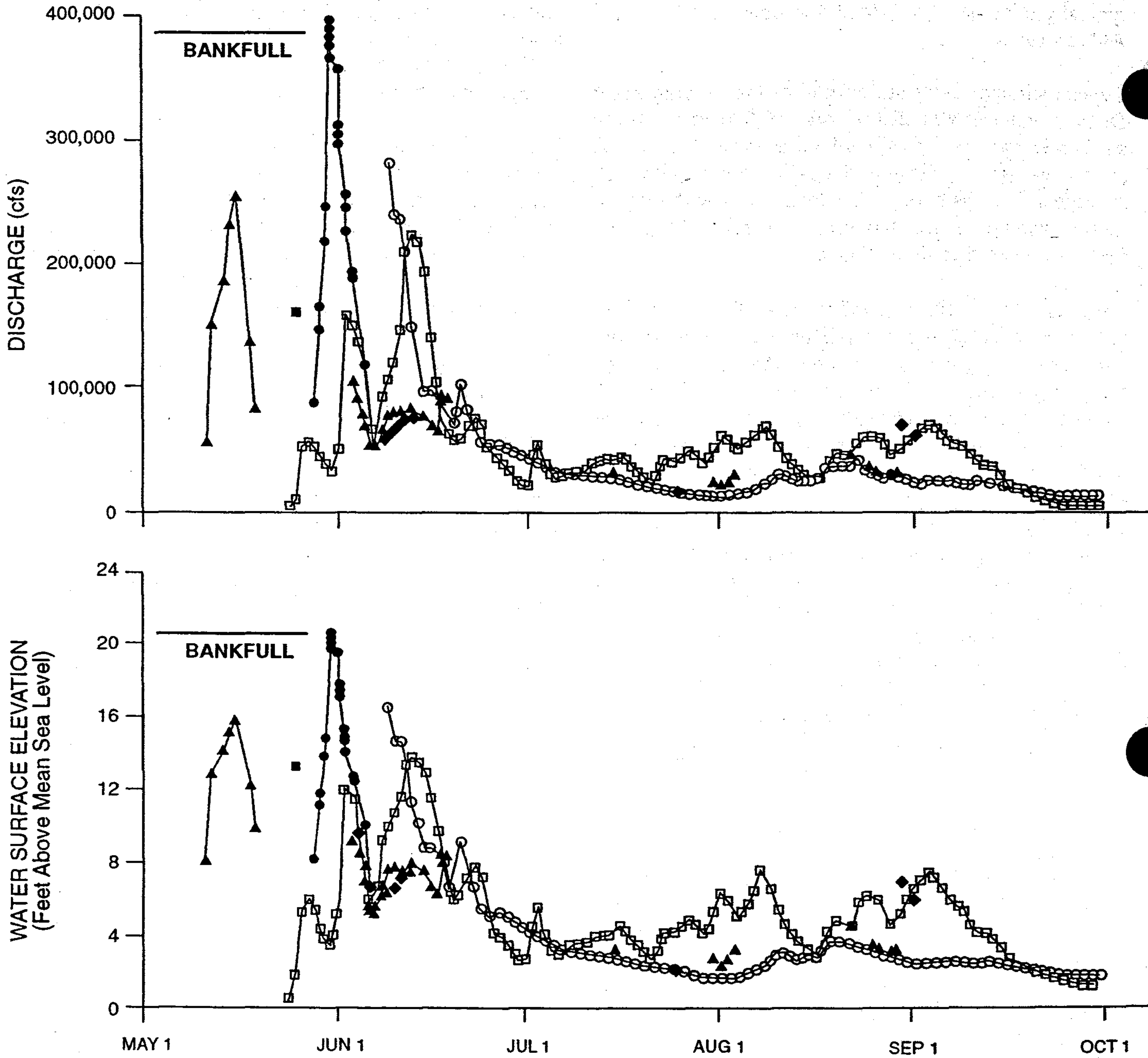
Summer flows drop far below the flows experienced during break-up. Mean monthly flows for the Kachemach and Miluveach rivers probably range from around **550** cfs in June to less than 20 cfs in August and September (see Table 4.2.1-1). Velocities during the summer are probably as high as 3.5 fps during high flows and as low as 0.5 fps during low-flow periods.

The coastal plain streams typically flow only three or four months of the year. As winter approaches, the water freezes and flow ceases, usually in late September or October (Drage et al. 1983). The median dates on which the flow drops to 0 cfs in the Putuligayuk and Kuparuk rivers are October 10 and November 10, respectively (EarthInfo 1993a; USGS 1994, 1995). The dates on which the flow stops in the Kachemach and Miluveach rivers are probably more similar to that for the Putuligayuk than for the Kuparuk.

<u>Small Streams</u>. Most of the discharge in small streams occurs during spring break-up. Summer flows typically are negligible, and flow ceases completely during winter. Velocities in these small streams are low and probably do not exceed 3 fps.

<u>Flooding Regime</u>

<u>Colville River</u>. Floods on North Slope rivers are influenced by the type of physiographic region drained. Snowmelt flooding occurs annually in all North Slope rivers. For rivers having drainage basins entirely within the Arctic Coastal Plain, snowmelt flooding nearly always produces the annual peak discharge. The flooding regime of the Colville River is more complex, because the basin drains the Brooks Range and foothills in addition to the coastal plain. Basins that drain the Brooks Range and foothills can experience summer floods from large rainstorms. Rainfall floods are less frequent than snowmelt floods, but they can be larger. In 27 years of data on the Sagavanirktok River near Sagwon (approximately 55 mi southeast of the Miluveach River), the two largest floods resulted from rainfall. Long-term records of flow do not exist for the Colville River. Based on 40 years of observation, however, it is known that floods caused by rainfall have not produced overbank flow (J. Helmericks



Notes: 1. Data were obtained at a location one mile downstream from the Itkillik River.

2. Elevations are based on USCGS Monument "RIVER" at an elevation of 41.99 feet.

3. 1992-1995 discharges are based on water surface elevation measurements and the rating curve in Figure 4.2.1-2.

4. 1977 discharges are mean daily discharges obtained from USGS Water Resources Data. 1977 water surface elvations are based on the USGS mean daily discharges and the rating curve in Figure 4.2.1-2.

5. 1962 data were obtained from the hydrograph and rating curve in Arnborg, et. al. (1966).

Source: Shannon & Wilson 1996

ARCO Alpine Development/55-2042-04(01) 8/97

1995
1994
1993
1992
1977
1962

Figure 4.2.1-3.
Water Surface Elevation and Discharge Data for the Head of the Colville River Delta

Table 4.2.1-1. **Mean flow and velocity estimates for the Kachemach and Miluveach rivers.**

River	Parameter	Mean Annual Peak	Mean Flow June	July	August	September
Kachemach	Discharge (cfs)	2,770	550	26	11	18
	Velocity (fps)	3.0-5.5	2.5-3.5	1.2-2.0	0.5-1.1	1.0-1.5
Miluveach	Discharge (cfs)	2,480	470	22	10	16
	Velocity (fps)	3.0-5.5	2.5-3.5	1.2-2.0	0.5-1.1	1.0-1.5

Notes:

1 The mean annual flood peak discharge estimates are based on a modification of the 2-year flood peak regression equations developed by Jones and Fahl (1994) for Area 3. The modification involved adding an adjustment factor based on flood peak data from the Putuligayuk River.

2 The mean monthly flows were computed using discharges for using 22 years of USGS data from the Putuligayuk River (EarthInfo 1993a).

3 The velocity estimates are based on velocities measured in the Putuligayuk River.

1996 personal communication). Thus, large rainfall floods are rare on the Colville River Delta.

The discharge of the 2-year flood is predicted to be 233,000 cfs (see Figure 4.2.1-2). Bankfull discharge at the head of the delta is estimated to be 385,000 cfs. Based on the flood-frequency curve (Figure 4.2.1-4), the bankfull discharge has a "return period" of about 8 years, meaning that, on average, an event equal to or greater than this magnitude is expected to occur about once every eight years. The 50- and 100-year return period flows are estimated to be 600,000 and 700,000 cfs, respectively. Although no information is available concerning the return period of the bankfull discharge at other locations on the delta, it is probably about the same as at the head of the delta.

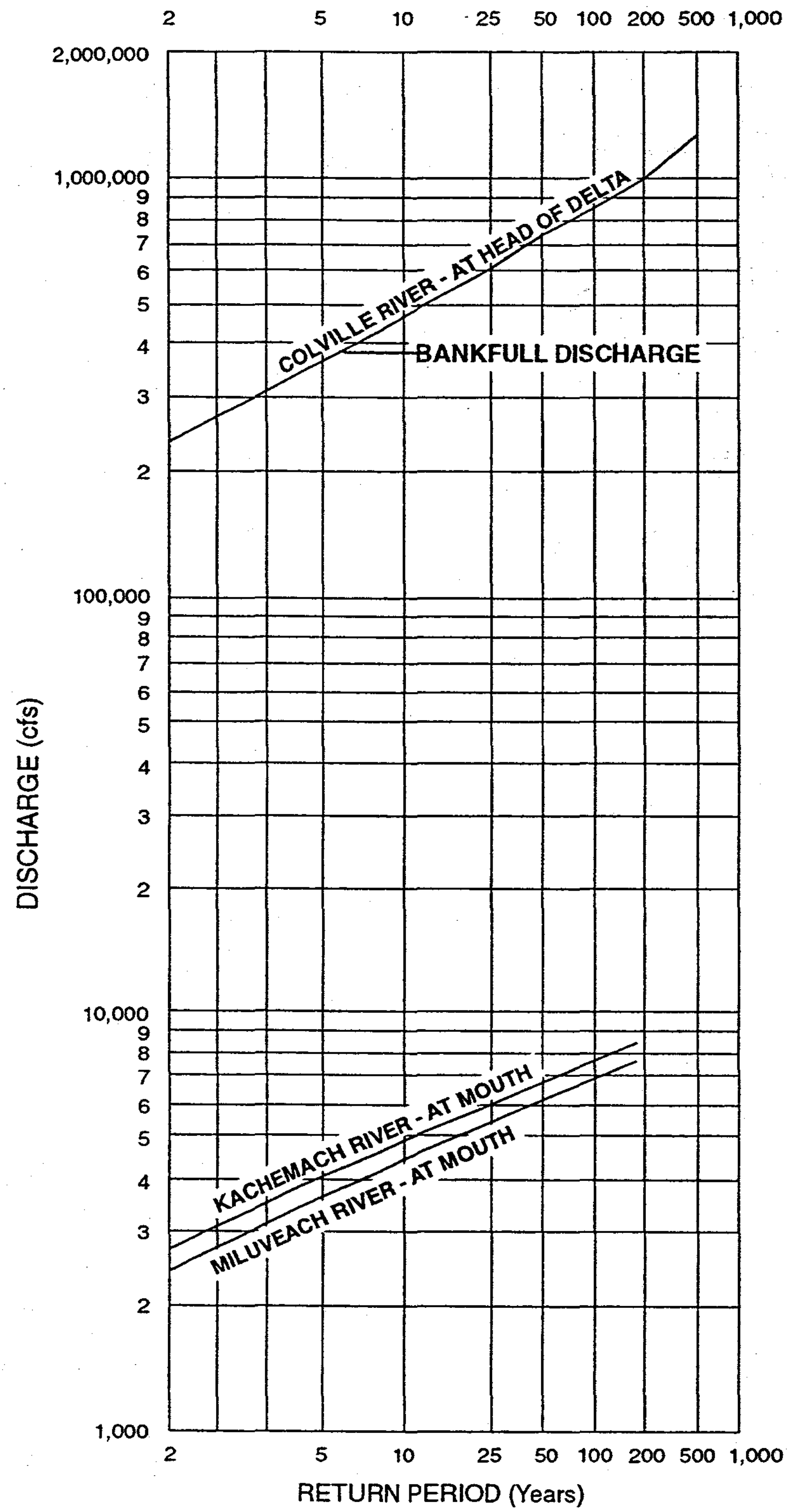
Ice jams can lead to significant flooding on the delta, even during periods of moderate discharge. In 1966, an ice jam in the vicinity of the Putu Channel (near the present location of Nuiqsut) caused water to flow over the bank for up to 4 mi east of the East Channel and ice floes to be deposited up to 1 mi east of the East Channel (J. Helmericks 1996 personal communication). The ice floes moving downriver at break-up can be large. Ice floes stranded at the head of the delta were 7.5 to 13.5 ft wide, 12 to 26 ft long, and 2.5 to 5.5 ft thick (Jorgenson et al. 1994). The largest floes observed in the river at break-up were estimated to be 80 to 120 ft wide and 130 to 150 ft long.

Colville River flooding can cover large portions of the delta (Figure 4.2.1-5). Walker (1983a) estimated that floodwaters often cover up to 65 percent of the delta. Jorgenson et al. (1994) estimated that floodwaters covered 43 percent and 58 percent of selected portions of the delta in 1992 (less than a 2-yr flood event) and 1993 (approximately a 5-yr flood event) respectively.

A Colville River two-dimensional surface water model has been used to predict water levels during floods of a number of return periods. Models were run for existing conditions (no gravel structures) and with gravel structures in place. The information that follows relates to the 50-year flood. Predicted water depths around the proposed facilities (with no facilities in place) vary from zero (dry) to about 8 ft. Water levels will not reach the Alpine Pad 1 (drill site/production facilities) or most of the airstrip. Water depths along most of the road and Alpine Pad 2 (satellite drill site) will be less than 2 to 3 ft deep. Water in the swale during the 50-yr flood will be as deep as 8 ft.

The map of water levels presented in Geomorphology and Hydrology of the Colville River Delta in 1995 (refer to Appendix M) for the 1995 runoff (240,000 cfs) is a good approximation of the 2-year flood water levels. Maps of water levels, water depths and depth-averaged velocities for the 50-year (Q_{50}), 100-year (Q_{100}) and 200-year (Q_{200}) floods, with and without the in-field facility gravel footprint structures, are presented in Colville River Two-Dimensional Surface Water Model by Shannon and Wilson, July 1997 (refer to Appendix M).

__Kachemach and Miluveach Rivers__. Because their drainage basins are located entirely within the Arctic Coastal Plain, it is likely that snowmelt flooding



Source: Shannon & Wilson 1996

ARCO Alpine Development/55-2042-04(01) 9/97

Notes: 1. The Colville River curve is based on 6 years of flood peak data collected at the head of the colville River Delta (Aldrich and Ray 1996a) and 20 years of data extrapolated from measured flood peaks on the Kuparuk River.

2. The Kachemach and Miluveach River curves are based on a modification of the regression equations developed by Jones and Fahl (1994). The modification involved adding an adjustment factor based on flood peak data from the Putuligayuk River.

3. The return period is the average interval of time within which a given discharge will be equaled or exceeded.

Figure 4.2.1-4. Colville, Kachemach, and Miluveach Rivers Flood-Frequency Relationship

Source: Flood-frequency model based on relative heights of terrain units and analysis of flood distribution, 1992-1995 (Jorgenson et al. 1996).
Map registered to SPOT image base map.
Projection: UTM Zone 5, Datum NAD 27

ABR File: FLODFRRF.PRJ

N

SCALE IN MILES
0 2 4

Frequency
- High (every 1-2 yr)
- Moderate (every 3-4 yr)
- Low (est. every 5-25 yr)
- Very Low (est. every 26-150 yr)
- Non-flooded

Proposed Project
- In-field Facilities
- Pipelines

Figure 4.2.1-5.
Predicted Flood Frequency, Colville River Delta

produces the annual peak flow on the Kachemach and Miluveach rivers. Large rainfall floods are rare, because rainfall intensity is generally low, and the lakes and tundra can absorb rainfall and retard runoff. For example, snowmelt runoff has been responsible for the peak flood on the Putuligayuk River every one of the 24 years the river has been monitored. On the Kachemach and Miluveach rivers, the largest floods also are likely to be from snowmelt runoff.

Using the flood-frequency curves for these rivers (see Figure 4.2.1-4), the 50-year return period flows for the Kachemach and Miluveach rivers are estimated to be 6,860 and 6,290 cfs, and the 100-year return period flows are estimated to be 7,690 and 7,050 cfs, respectively. The bankfull discharge and the return period of the bankfull discharge are not known.

Storm Surges

A storm surge is coastal flooding caused by the piling up of seawater against the shore, as a result of wind stress and atmospheric pressure differences caused by a storm. Along the northern coast of Alaska, storm surges usually occur during late summer and fall (August-October). The frequency of major storm surges is low, but several have been recorded within the last century (Reimnitz and Maurer 1979). The two worst cases of surge flooding on record occurred in October 1963 and September 1970. Along the fringe of the Colville River Delta, two storm surge driftlines (identified by local residents as related to the 1963 and 1970 storms) had elevations of 5.0 and 6.6 ft (amsl), respectively (Jorgenson et al. 1993). Estimates of storm surge heights at the delta fringe for frequency intervals of 10, 50, and 100 years are 6.5, 9.2, and 10.6 ft, respectively (Jorgenson et al. 1993).

Saltwater inundation resulting from storm surges can kill tundra vegetation, but the distribution of salt-killed tundra (see Section 4.4.2.1) can be used to identify areas so flooded (Jorgenson et al. 1993). The lack of salt-killed tundra within the proposed in-field facility indicates that seawater from storm surges has not recently penetrated that far into the delta. However, the **in-field facility location** may be subject to freshwater flooding as a result of storm surge, particularly near the Nechelik (Nigliq) Channel, where backwater effects may be caused by the increase in the water level at the channel mouth.

Sediment Transport

Colville River. Most of the annual sediment load is transported over a short period of time. Although the Colville River flows for most of the year, much of the sediment discharge occurs during the first three weeks of flow. Arnborg et al. (1967) estimated that 73 percent of the total suspended sediment load (6.4 million tons) was transported during break-up in 1962. Suspended sediment concentrations that year ranged up to 1,650 parts per million (ppm), and typical summer concentrations ranged between 20 and 100 ppm (Arnborg et al. 1967). The USGS (1978) reported that suspended sediment concentrations ranged from 869 ppm two weeks after break-up in 1977 (samples were collected during the receding break-up flow) to as low as 3 ppm during a low-flow period in July. The median sediment concentration for 1977 was 16 ppm (EarthInfo 1993b). The median suspended sediment concentration for the Kuparuk River was 5 ppm, based on data collected by the USGS between 1971 and 1986 (EarthInfo 1993b). The highest suspended sediment concentration for the same period was 336 ppm.

Kachemach and Miluveach Rivers. No suspended sediment data are available for the Kachemach and Miluveach rivers. However, suspended sediment data collected in the Putuligayuk River indicate the concentrations to be expected in these rivers. The median suspended sediment concentration for 14 samples collected between 1970 and 1976 was 29 ppm (EarthInfo 1993b).

Groundwater Resources

The project area lies within a zone of continuous permafrost. Groundwater, therefore, is restricted to thawed areas that form beneath rivers and lakes, saline zones within the permafrost, and beneath the permafrost.

Thawed areas form only under lakes and river channels deeper than about 7 ft. Seepage from these areas is a potential source of groundwater in the active layer. Because of irregular water depths, the thawed area beneath the Colville River is probably discontinuous (Walker 1983a). In addition, the groundwater beneath the Colville channels **has areas with high saline concentrations.** The boundary between fresh and saline groundwater is unknown but probably migrates inland during low-flow periods and seaward during flood events (Williams and van Everdingen 1973).

Permafrost ranges from 700 to 2,165 ft deep on the North Slope (Rawlinson 1983). Groundwater beneath the permafrost is brackish to saline (Williams and van Everdingen 1973). Saline groundwater also occurs within the permafrost, in locations where dissolved salts depress the freezing point of the water.

During the summer, groundwater occurs within the active (thawed) layer above the permafrost. The thickness of the active layer is typically 1.5 ft, but ranges from 1 ft under dense organic mats to about 3 ft in coarse-textured soil (Rawlinson 1983).

4.2.1.2 Geology/Geomorphology

The Colville River Delta is located on the Arctic Coastal Plain in an area where the underlying metamorphic and igneous basement rocks and oil-bearing formations are found at shallower depths than in other areas on the North Slope (Detterman et al. 1975; Carter et al. 1977; Grantz 1980; Dinter et al. 1987). These formations are overlain by up to 2,200 ft of poorly consolidated sediments derived from material eroded from the Brooks Range and deposited over a broad alluvial plain. This accounts for the characteristic flatness of the terrain. Overlying these sediments are recent (less than 2 million years old) unconsolidated deposits collectively referred to as the Gubik Formation (Black 1964; Bringham 1985).

These surface deposits have been shaped by the dynamic interaction of sea-level changes, glaciations, major drainage changes and associated deposition and erosion, development of permafrost, wind activity during dry climatic periods, and lake development (Hopkins 1982; Dinter 1985; Rawlinson 1993). The surface deposits in the proposed transportation corridor and delta associated with these processes are described briefly below. More detailed descriptions and a map of their distribution are provided in Appendix G.

In the transportation corridor, surface deposits have been affected greatly by deposition during glacial and interglacial periods and by a sequence of sea-level changes (Carter and Galloway 1982; Rawlinson 1993). The alluvial plain deposits in the area of KRU were deposited by braided streams meandering over a broad, nearly flat plain and then covered by wind-blown sand. The alluvial and alluvial-marine terraces in the corridor were formed by similar processes over the last few million years, but these are marked by a series of benches, between the Colville River and KRU, that were undercut by elevated sea levels (Carter and Galloway 1982; Rawlinson 1993).

Similar to most large deltas around the world, the Colville River Delta is characterized by migrating distributary channels, waterbodies of various origins, natural levees, sand dunes, sand bars, and mud flats (Walker 1976, 1983a). Unlike deltas in temperate climates, however, it is greatly influenced by two other factors: low temperatures, which preserve most of the annual precipitation until spring break-up, and the presence of permafrost (Walker 1976). Permafrost affects the seasonal character of river discharge and the timing and nature of erosion, contributes to the accumulation of ice and organic matter, and causes the development of distinctive surface features such as ice-wedges and "thaw" lakes formed by thawing of ice-rich sediments (Walker 1976; Jorgenson et al. 1996).

Landforms within the delta are highly complex as a result of fluvial (flowing water) deposition, eolian (wind) transport, development of thaw lakes, and marine processes. Floodplain deposits are composed of various materials (silt, sand, gravel, peat, and ice) and can be subdivided into five classes of terrain units (riverbed, high-water channel, active cover deposit, inactive cover deposit, and abandoned delta floodplain deposits), depending on the type of material and depositional process (see Appendix G). Riverbed/sandbar deposits occupy a large portion of the delta, with the size of bars increasing and texture decreasing in a downstream direction. Gravel bars are rare, consisting of a few patches of gravel near the head of the delta (Walker 1976). Over time, the floodplains increase in height as sediments and organic material accumulate at the surface and ice forms in the underlying permafrost (Jorgenson et al. 1996). River banks along the older, higher floodplain deposits generally range from 18 ft above low water level near the head of the delta to 6 ft at the outer edge of the delta, although some banks that have cut into sand dunes and old alluvial terraces are 23 to 30 ft high (Ritchie and Walker 1974).

The accumulation of peat in these fluvial sediments and other stable surface deposits is an important factor contributing to the development of the arctic landscape. Peat accumulation has contributed substantially to floodplain deposits, raising the surface of the floodplain and altering flooding frequency. The thickest peat accumulation found thus far on the delta (in an abandoned floodplain [floodplain no longer affected by flooding] deposit) is 6.8 ft, with a radiocarbon date of 2,860 years before the present (Jorgenson et al. 1996). The development of a peat layer at the surface is also important for insulating the underlying permafrost and enhancing further ice accumulation. Disruption of the surface peat layer can have serious consequences for the thermal stability of underlying ice-rich sediments.

Windblown sand and silt have accumulated at the surface of most deposits on the Colville River Delta and transportation corridor and have formed prominent sand dunes in the delta (Carter 1981; Walker 1976). Active sand dunes are common along the western banks of channels downwind from large riverbars (Walker 1983a). Older, stabilized dunes are also common and are frequently capped by a thin layer of windblown silt.

Thaw lakes are found throughout the delta and transportation corridor, particularly on older, ice-rich floodplain deposits. A particular form of thaw-lake development in deltas is the "tapped" lake, which is formed by erosion of meandering channels into the sediments that contain the lake, causing it to drain (Walker 1978). Tapped lakes then are subject to flooding and filling by sediments deposited during floods.

Marine processes are most active during the short ice-free period and contribute to the build-up of tidal flats along the outer edge of the delta (Walker 1974). The nearly flat, barren mud and sand flats are flooded periodically by tidal waters and storm surges. Much of the material in the tidal flats is deposited during spring floods following break-up. Because river flooding and break-up occur before the sea ice breaks up, floodwater from the river deposits sediment as it floods over the sea ice. Rising sea levels (estimated at 0.8 ft/100 years worldwide; Peltier and Tushingham 1989) probably have contributed to the accumulation of sediments on the tidal flats and increased the frequency and extent of flooding on the older, higher floodplain deposits that developed during an earlier era (Jorgenson et al. 1996).

The distance and depth to gravel deposits in and near the delta are of interest because gravel must be extracted as fill for roads and pads. In the delta, gravel generally is absent near the ground surface (Rawlinson 1993), although small amounts of gravel are present in riverbed material exposed near the head of the delta. Gravel has been dredged from below the Nechelik (Nigliq) Channel for use in Nuiqsut (Walker 1994). Gravel is also exposed in riverbed and terrace deposits along the Miluveach and Kachemach rivers. Near the proposed locations of the ADP drill pad(s), however, gravel was not encountered in boreholes until penetrations reached 30 ft below the surface during the 1995-96 exploratory drilling program.

Permafrost and Thaw Stability

Permafrost, particularly permafrost that is ice-rich (laden with ice crystals), is of serious concern for engineering design and for location of facilities to avoid thermally unstable areas, such as thaw lakes. Permafrost is nearly continuous beneath the Arctic Coastal Plain as a result of the low average ground temperature, which is about 16°F at Prudhoe Bay (Lachenbruch et al. 1982).

The form of the ground surface on the coastal plain is strongly affected by the distribution and amount of ice in permafrost, by seasonal freezing and thawing of the active (seasonally thawed) layer, and by differential melting of subsurface ice (thaw degradation). Common permafrost-related surface forms include ice-wedge polygons (patterned ground) and pingos (ice-cored mounds). Seasonal frost-related features include frost boils, and thaw-degradation features include thaw lakes and some high-centered polygons (Washburn 1956). Permafrost also affects soils and vegetation indirectly by altering drainage and nutrient regimes (Everett 1975; Walker et al. 1980).

The ice accumulation in fine-grained sediments is one of the primary factors affecting engineering design in the Arctic. Ice tends to be concentrated in the top 5 to 10 ft of the permafrost (Sellmann et al. 1975). In this zone, segregated ice and ice wedges occupy as much as 85 percent of the ground volume, with the former contributing the greater volume (Brown 1967). Segregated ice forms as lenses in the soil matrix. The volume of segregated ice in the top 5 to 10 ft of older floodplain deposits on the Colville River Delta typically ranges from 70 to 85 percent (Jorgenson et al. 1996). Ice wedges are vertically oriented masses of ice that taper downward and develop by water repeatedly filling and freezing in cracks formed at the surface by thermal contraction. Ice wedges generally are less than 10 ft wide and 25 ft deep (Black 1976) but occasionally may be up to 80 ft deep (Carter 1988). Although no data are available to estimate how much ice is present in ice wedges, the presence of numerous ice-wedge polygons on the highest and oldest floodplain surfaces suggests that the volume may be large. On the MacKenzie River Delta in the Northwest Territories, the volume contributed by ice wedges exceeded 50 percent within 3 to 7 ft of the ground surface (Pollard and French 1980).

Another indicator of the very high ice content in the higher, older floodplain deposits on the Colville River Delta is the depth (11 to 15 ft; Moulton 1996) of thaw lakes in the delta (Jorgenson et al. 1996). These depths suggest that ice constitutes half or more of the volume of the top 15 to 30 ft of sediments, which are highly unstable when thawed. In contrast, thaw lakes on alluvial-marine terraces in the eastern portion of the transportation corridor generally have depths of 3 to 7 ft, indicating lower, albeit substantial, ice content. Even with lower ice content, most soils in the transportation corridor are unstable when thawed, and thaw-lake basins occupy a large percentage of the landscape.

Erosion and Deposition

Overall, the primary agents affecting the rate of landscape change on the Colville River Delta and the transportation corridor are fluvial erosion and deposition along river channels and the development of thaw-lakes in ice-rich sediments (Walker 1976, 1983a; Jorgenson et al. 1993; Rawlinson 1993). An analysis of landscape change within the proposed in-field facility location on the Colville River Delta revealed that 6.4% of the area has been affected by erosion and deposition over a 37-year period between 1955 and 1992 (Jorgenson et al. 1993) (Figure 4.2.1-6). Most of this change resulted from erosion (1.3%) and deposition (2.6%) of sediments within the main channels and adjacent barren riverbed deposits. Erosion of banks along older, higher floodplain deposits was somewhat lower (1.0%) than along active channels. Drainage of thaw lakes and deposition of sediments in drained lake basins accounted for a moderate landscape change (1.8%).

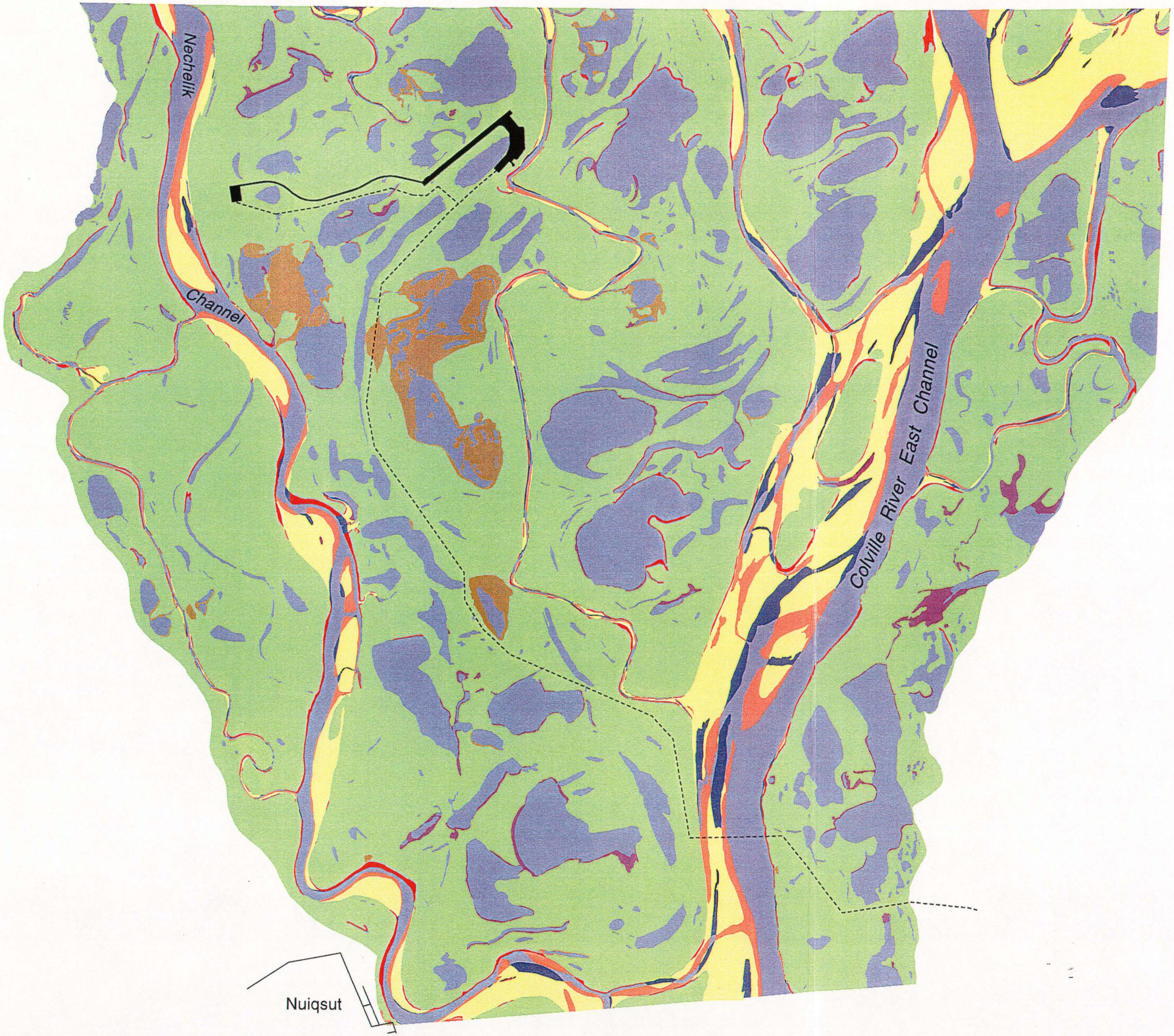
Within the main channels, most of the erosion and deposition resulted from lateral movement of channels across barren riverbed and from migration of mid-channel bars. In the East Channel, mid-channel bars migrate as much 35 ft per year as material is eroded from the upstream end and deposited below the downstream end (Jorgenson et al. 1993). Other portions of the riverbed along point bars and where channels split, show similarly high erosion and deposition rates.

Although the extent of erosion along the banks of older, higher portions of the floodplain is less than in barren riverbed deposits, it still can be considerable. In the East Channel, erosion generally is greatest at the unprotected ends of narrow islands, where erosion rates of 7 to 14 ft per year have been measured (Jorgenson et al. 1993). Along the sides of islands and cutbanks in meandering channels, erosion rates can exceed 3 ft per year; for instance, erosion at two sites along the Nechelik (Nigliq) Channel averaged 3 to 6 ft per year over a 23- to 30-year period (Walker 1983a). However, averaging rates over a long period can mask the episodic nature of erosion, in that undercutting of 25 to 30 ft may result from a single storm (Walker and Morgan 1964). At the two locations being considered for pipeline crossings (X10 and X14), erosion of the banks has been considerably less (averaging 1.2 and 1.1 ft per year, respectively).

Factors influencing erosion along river channels include the timing of flood events and the accumulation of peat and ice in the older floodplain deposits. Although spring break-up is normally the largest flooding event each year, the amount of erosion at that time can be limited by the frozen active layer and ice frozen to the surface of the riverbed (Carter et al. 1987). Thermal erosion of banks occurs during floods and lower flow stages later in the season.

Thermal erosion of ice-rich sediment at and below the water surface leads to the collapse of large blocks, a predominant factor in bank erosion (Walker and Morgan 1964; Walker 1966; Ritchie and Walker 1974). Peat-rich soils tend to have lower erosion rates (2.5 ft per year) than highly mineralized soils (6.5 ft per year), presumably because of the protection provided by the fibrous peat mats (Walker 1983a).

Erosion of shorelines in large thaw lakes isolated from rivers is caused both by wind-driven waves and by melting of ice-rich sediments. Erosion rates for exposed shorelines in the large thaw lakes of the central delta generally are much higher (up to 6 ft per year) than in smaller lakes with more protected



Source: Landscape change based on photo-interpretation of 1992 CIR and 1955 B+W photography (Jorgenson et al. 1996). Map registered to SPOT image base map.
Projection: UTM Zone 5, Datum NAD 27

ABR File: 5592CHRF.PRJ

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SCALE IN MILES
0 1 2

Areas of Erosion and Deposition

	Area (%)
Eroded Riverbed/Sandbar	1.3
Riverbed/Sandbar Deposition	2.6
Unchanged Riverbed/Sandbar	7.6
Thaw Basin Drainage/Deposition	1.8
Other Eroded Terrain	1.0
Unchanged Terrain	58.8
Lake-level Change	0.9
Unchanged Water	26.1

Proposed Project

■ In-field Facilities

-------- Pipelines

Figure 4.2.1-6.
Landscape Change from 1955 to 1992, Central Colville River Delta

shorelines (Jorgenson et al. 1993). The erosion of ice-rich sediments by thaw-lake processes illustrates an important paradox about the stability of floodplain deposits in the delta: the oldest, highest terrain units contain such high ice contents that they have become the most unstable and erodible areas. Indeed, the high proportion of surface area covered by thaw lakes in the central delta (oldest areas), and the general occurrence of abandoned floodplain deposits as small patches surrounding large thaw lakes (see Appendix G), indicate that most of the older, ice-rich deposits already have been lost to erosion by thaw lakes.

Changes in the extent of tidal flats along the lower Nechelik (Nigliq) Channel indicate that tidal flats expand into nearshore waters at a rate of up to 22 ft per year at the mouths of channels emptying directly into the Beaufort Sea (Jorgenson et al. 1993). In most delta areas, however, the expansion rate is much lower (about 1.4 ft per year; Reimnitz et al. 1985). In contrast, coastal bluffs adjacent to the delta erode at an average rate of 6.9 ft per year because of thermal and storm erosion (Reimnitz et al. 1985).

4.2.2 Environmental Consequences

The potential hydrologic and geomorphic impacts of the ADP include degradation of permafrost and erosion and deposition resulting from alteration of drainage patterns. Impacts that affect the thermal regime of the ground surface, and thus the stability of the underlying permafrost, include the presence of the buried hot-oil pipeline at the Colville River crossing and secondary impacts caused by dust fallout, water impoundments, compaction by the ice road, and damage associated with cleanup of oil spills. The alteration of drainage patterns by road construction and fill placement has the potential to cause erosion and sedimentation problems, but with proper design and maintenance (developed from experience in the North Slope oilfields) these problems are mostly avoidable, as is discussed in Section 4.2.3 Mitigation Measures.

4.2.2.1 Impacts of the Proposed Action (Alternative #2)

Thermokarst. Thermokarst results when the soil thermal regime is disturbed, leading to melting of permafrost and ground subsidence. Any changes in vegetative cover and soil moisture regime that are due to disturbance of the ground surface can increase the depth of the active layer, melt ice-rich permafrost below the active layer, and lead to the development of thermokarst terrain (Brown and Grave 1979; Jorgenson 1986; Lawson 1986). Thermokarst has resulted from a wide variety of disturbances associated with oil development, including dust deposition (Walker and Everett 1987), placement of thin gravel fill (Jorgenson and Joyce 1994), impoundments (Walker and Walker 1991), heavily used seismic trails (Felix and Raynolds 1989), off-road traffic (Brown and Grave 1979; Walker et al. 1987; Slaughter et al. 1990), heated structures (Brown and Grave 1979; Burgess et al. 1993a), cleanup of oil spills (Jorgenson et al. 1991b), and removal of gravel for land rehabilitation (Jorgenson and Joyce 1994). The thermal stability of permafrost associated with these impacts is closely linked to changes in vegetation and soil moisture, as well as to particle size, ice content, and soil thaw-strain characteristics. Because the intensity and timing of disturbance strongly affect the impacts on terrain, limiting most activities to winter greatly reduces the amount of thermokarst from the levels associated with past practices (Brown and Grave 1979).

As suggested above, dust deposition could cause thermokarsting. Vehicle traffic on the pads and road serves as the most likely dust source. Areas downwind, adjacent to the pads and road, could collect dust which could change the albedo, possibly resulting in increased absorption of solar radiation, and changes in the thermal regime.

Burying a hot-oil pipeline below the Colville River has potential effects on the thermal stability of the permafrost in the adjacent floodplain. These effects are of central concern, especially with regard to geomorphic impacts of this project. Under the river channel, where most of the sediments are coarse-textured and unfrozen, thaw settlement will not be a problem. On either side of the river, however, the pipeline will pass through fine-grained, ice-rich (70 to 80 percent ice) sediments (typical of inactive-floodplain cover deposits) as it transitions between below ground and aboveground. The need to prevent thawing of ice-rich sediments was recognized early in the ADP engineering design process, and appropriate, proven technology (described in Section 4.3.2-1) will be incorporated into the project design as required by the ROW review and approval process to avoid thermokarst and thaw settlement.

Impoundment of snow meltwater in polygon centers caused by the placement of gravel for the access road, airstrip, and pads could result in minor thermokarsting on ice-rich, inactive and abandoned floodplain cover deposits. Impoundments associated with gravel structures form as a result of impeded drainage of surface runoff and thermal erosion (Berg 1980; Klinger et al. 1983; Walker et al. 1987). Wetlands associated with ice-wedge polygons and low-lying, vegetated thaw-lake basins are more susceptible to impounding than higher, moist tundra areas (Walker et al. 1987). Although in many instances the impoundments are temporary (during spring runoff), some areas can experience prolonged deep flooding. These impacts will be avoided or minimized by carefully selecting pad locations to minimize impeding cross-drainage, and maintaining adequate cross-pad drainage using culverts and a bridge as specified in the tables in Section 2.9, Roads and Pads Design, and Appendix Q, Alpine Development Hydrology and Drainage Proposal.

Traffic on the winter ice road is likely to cause negligible or minor amounts of thermokarst along the route. Areas sensitive to compaction include Moist Sedge-Shrub Meadows and Wet Sedge Meadows (see Section 4.4.2 for habitat descriptions). Compaction of vegetation can alter drainage, cause impoundment of meltwater, alter the thermal regime, and cause thaw settlement (Felix et al. 1992). The movement of gravel from the mine site on the ice road during the first two winters of construction will likely cause minor amounts of compaction, leading to minor thermokarst and the other effects described above. These impacts should not occur during the operational phase of the project.

Emergency tundra travel during winter will have little to no impact, but emergency traffic on the tundra during summer would cause impacts on ground stability and vegetation, including compaction, disruption of the surface layer, damage to willow cover, and scarring of the surface layer. These impacts can be avoided by limiting the number of vehicle passes in an area, avoiding tight turns, and using low-ground-pressure vehicles (rolligons). Existing procedures for emergency on-tundra travel that have been in place for other North Slope operations will be maintained at the ADP.

4.2.2.2 Flooding

Water levels will be different after the gravel road and pads have been constructed. During the 50-year flood with no flow through the road, water levels immediately upstream of the road are expected to rise about 2 ft, and water levels downstream are expected to fall about 2 ft. Drainage structures will be designed to pass some 10,000 to 15,000 cfs through the road during the 50-year flood. The final amount will not be known until the design is complete. For a 10,000 to 15,000 cfs discharge through the road, water levels upstream are expected to be about 1.4 ft to 1.6 ft higher, and water levels immediately downstream of the road are expected to be about 1.0 ft to 1.4 ft lower than if there are no gravel structures (Refer to Appendix M). Shannon & Wilson, July 1997 Technical Memorandum titled Changes in Headwater and Tailwater Elevations as a Result of Passing Water Through The Facilities provides additional information on flooding.

<u>Erosion and Sedimentation</u>. Erosion and sedimentation can result from inadequate design and placement of culverts at small stream crossings and from of floodwater impedance on broader floodplains such as the Colville River Delta. In the Prudhoe Bay and Kuparuk oilfields, gravel fill has eroded from roadbeds adjacent to culverts in numerous locations, depositing gravel on the tundra below culverts (Ott 1993). These problems will be minimized through adequate design and siting of drainage structures, slope protection and maintenance, and construction timing (see Section 2.9 tables, Roads and Pad Design, and Appendix Q, Alpine Development Hydrology and Drainage Proposal).

Based on an evaluation of the bridge and culvert design, affects from changes in inundation and sedimentation due to the facilities are expected to be minor (Appendix Q, Alpine Development Hydrology and Drainage Proposal). Concerns focus on both the lower, early successional habitats on the lower portion of the floodplain and the higher, later successional habitats found on the inactive and abandoned portions of the floodplain. For the lower portion of the floodplain, passage of small, frequent events (< 5-year event) will: (1) allow low-lying areas to be flooded to a depth (within 0.4 ft) and frequency similar to original conditions, (2) allow sediment to enter the basin in amounts similar to original conditions, and (3) avoid backing up water and causing overbank flow. This should provide adequate inundation and sedimentation to maintain the structure and function of ecological communities (Aquatic Grass Marsh, Salt Marsh, Riverine Shrub, and Nonpatterned Wet Meadow) in the drained lake basins above and below the bridge. During large flood events, the gravel fill will impede and redirect some flow around the ends. This impedance would likely increase water levels on the upstream side and decrease water levels on the downstream side of the structure. Effects are expected to be minor because: (1) flooding of higher areas is infrequent and of short duration, and (2) water velocities are expected to be low (< 2 fps for 200-year flood event) and (3) there will be little change in particle sizes in distal portions of the floodplain. Such changes in frequency of inundation and sedimentation of overbank areas are not expected to have much affect on species composition of ecological communities because plants on the delta are well adapted to occasional sedimentation.

During high-flood events, the gravel structure would only impede and redirect the flow of water, not prevent its movement. The expected result would be an increase in water levels on the upstream side and a decrease in water levels on the downstream side of the structure. In addition, the water velocities around the margins of the structures at the east and west ends would be higher than if there were no structure. The velocities are not expected to be high enough to cause erosion or scour of the natural tundra or the gravel structures.

The proposed in-field facilities cause minor impacts from increased erosion from constricting and concentrating water flow. The water velocities expected at the margins of the in-field facility gravel structures during flood events will be low enough to prevent erosion. Cross-drainage structures will constrict and concentrate the flows to small areas such that localized erosion could occur. Additional detail can be found in Appendix Q, Alpine Development Hydrology and Drainage Proposal. The road and drainage structures will be designed to minimize the potential for wash outs that could deposit gravel on tundra.

4.2.2.3 Impacts of Alternatives #3 - #8

In-field Facilities

ARCO Alternatives (#3 - #5). The potential impacts of the in-field facility layout alternatives would be similar to those described above for the proposed project.

ASRC and ASRC/Kuukpik Proposals (#6 - #7). The alternatives would result in minor amounts of thermokarst caused by impedance of floodwater, impoundment of water in low-centered polygons, and consequent changes in soil thermal regime. The interception of floodwater also would cause a small increase in sedimentation rates. The access road from Nuiqsut associated with these alternatives (along with the proposed facilities layout) would impede a major portion of the discharge in the Nechelik (Nigliq) Channel during large, rare flood events.

Kuukpik (Western Initiative) Proposal (#8). This alternative would have minor or negligible effects on thermokarst (similar to those described for the proposed project). A minor increase in sedimentation would possibly occur because floodwater would be impeded by the presence of the road crossing the floodplain, but the location of most of the road on higher ground west of the westernmost distributary of the Nechelik (Nigliq) Channel would diminish this effect.

Pipeline Route/Crossing Location.

Crossing X10 Pipeline (#3). Impacts of this alternative would be similar to those described above for the X14 pipeline, except that twice as much acreage would be required for the exit pads.

Crossing X14 Pipeline with Permanent Road (#4, #5). The permanent road associated with these alternatives would likely have major effects on sedimentation. The road would impede drainage on the floodplain of the East Channel, which carries a substantial percentage of the Colville River floodwater during large flood events. This drainage impedance would cause more water to flow down the Nechelik (Nigliq) Channel, thereby increasing any drainage problems associated with the in-field facilities.

ASRC Pipeline (#6). The impacts of this alternative would be similar to those described for the proposed X14 pipeline and the X10 pipeline alternative. Due to the narrower floodplain and higher stages involved in large flood events, the pipeline would be at greater risk of damage from ice floes than at the two crossings farther north.

ASRC/Kuukpik Pipeline with Permanent Road (#7). This alternative would likely increase sedimentation because the road would block more water during flood events (as described above for the ARCO gravel road). The road would divert more water into the Nechelik (Nigliq) Channel and toward the in-field facilities.

Kuukpik (Western Initiative) Pipeline with Permanent Road (#8). This alternative would have negligible thermokarst effects and minor effects from increased sedimentation because more floodwater would be impeded by the presence of a road on the floodplain.

River Crossing Method

Cable Bridge Span (#3). This option would have negligible effects on thermokarst and sedimentation.

Buried Using Conventional Trenching (#4, #8). The impacts of this option would be similar to those described above for the HDD crossing alternative, except that trenching at the east and west banks may increase the probability of thermokarst or sedimentation.

Vehicular Pile-Supported Bridge (#7, #5). This option has the potential for causing ice-jamming on the Colville River during spring breakup. Ice jams would occur because the piles are in the river channel and these pilings have the potential to catch large ice flows moving downstream in the channel. Erosion along the river banks may also increase because the pilings would create current eddies.

Field Access

Nuiqsut Airstrip (#6 - #8). The use of the existing airstrip at Nuiqsut would have negligible impacts from thermokarst or sedimentation. However, these benefits would be offset by impacts from the 8 mi gravel road and the associated minor and major stream crossings required to travel between the Nuiqsut airstrip and the ADP in-field facility.

Gravel Road/Permanent Bridge (#7, #8). The gravel road would have major effects on sedimentation and impede drainage on the Colville River floodplain, particularly near the East Channel. Because the East Channel carries a substantial percentage of river floodwater during major floods, altering water passage in this channel could increase flow in the Nechelik (Nigliq) Channel and thus increase flooding in the vicinity of the in-field facilities.

Gravel Road/Ice Bridge/Summer Ferry (#7, #8). This option would have effects similar to those described above for the gravel road. Temporary gravel roads or other temporary structures would have to be constructed on the sandbars on the west banks to provide access to deep water.

4.2.3 Mitigation Measures for the Proposed Action (Alternative #2)

4.2.3.1 Thermokarst

ADP facility gravel pads and roads will be nominally 5 ft thick. Thermal analyses show that this is the thickness of gravel that will thaw in a typical summer, without the thaw penetrating the underlying permafrost. The pad side slopes will remain steep. These actions will prevent thermokarst formation at the pad sites.

Other ARCO mitigative measures to minimize thermokarst include (1) scheduling construction and associated road traffic in winter when dust from the road will be less, and (2) minimizing traffic flow. Dust generation is closely associated with high traffic levels on gravel roads. It is anticipated that 4-6 vehicles will use the 3-mi road between Alpine Pad 1 and Alpine Pad 2 on a daily basis. Furthermore, 12-15 round trips are anticipated on the road per day during construction and drilling with significantly fewer during operation.

Routing the ice road in slightly different locations each winter will avoid cumulative effect of compaction on underlying vegetation and reduce or eliminate thermokarsting. Thermokarsting will be minimized by limiting road construction on the floodplain, particularly construction of a gravel road for field access. Thermokarst from impoundments can be avoided by ensuring sufficient drainage in the facilities area to handle water from the small, high-frequency flooding events that are likely to occur there.

A buried hot-oil pipeline below the Colville River has potential for affecting the thermal stability of the permafrost both under the river and in the adjacent floodplain. Thaw settlement under the river is not expected to be a problem since the soils are relatively coarse grained and thaw stable. The materials in the floodplain next to the river are thaw unstable since they are fine-grained and ice-rich. The design of the below-ground to aboveground pipeline transitions will be based upon detailed thermal modeling to account for heat input by the pipelines, heat removal by thermal syphons, heat transfer through the soil and insulation, and other pertinent factors. Specific design details are summarized below.

- Thaw-unstable soils in the transitions that will be affected by the pipelines will be excavated and replaced with thaw-stable materials.

- Insulation will be installed on the outside of the casing to minimize growth of the thaw bulb.

- Insulation will be installed near the surface of the backfill to control surface heat flow.

- Thermal siphons for passive refrigeration will be installed along the length of the pipeline between the high river bank and exit point on each side. These siphons will extract heat from the ground above the pipeline and maintain the thermal stability of the transitions.

- The transitions will be instrumented with thermistors that will be used to periodically monitor the performance of the transition design.

4.2.3.2 Erosion/Deposition

In-field mitigative measures to limit erosion and control deposition of sediments will include ensuring sufficient cross drainage in the in-field facility area during flooding events on the delta and armoring the roadbed, if necessary, in exposed areas subject to higher velocity currents. As noted above, the expected water velocities at the margins of the in-field facility gravel structures will be low enough that there will be little to no erosion potential. The erosional effects of wind waves during flood conditions are being analyzed. Additional detail about planned mitigative measures is in Appendix Q, Alpine Development Hydrology and Drainage Proposal.

4.2.3.3 Drainage

Mitigation of potential impacts to drainage resulting from placing the ADP in-field facility gravel structures will be through the use of cross drainage structures (a bridge and culverts). Potential scour caused by the bridge and culverts will be mitigated through scour protection. A general discussion of scour, scour protection, and remedial actions follows.

Scouring is likely under certain flood events immediately above and below the bridge opening and culverts due to increased water velocities. Potential affects, however, will be mitigated through placement of appropriate protective armoring and remediation measures. For the bridge opening, armoring will be placed on the bridge approach road sideslopes, abutments, ground surface extensions from road sideslopes and abutments, and swale bottom. There is uncertainty, however, how much scouring will occur during infrequent breakup floods when the ground surface, which has a thick fibrous organic mat, is still frozen. Given this uncertainty, the armoring design limits protective armoring to appropriate levels where water velocities are expected to be highest or above velocities capable of scouring vegetation. The extensive perimeter areas above and below the bridge opening, where there is still concern for scouring from more infrequent flood events, will not be protected initially due to uncertainty regarding extent of scouring. Instead, these perimeter areas will be monitored for scour damage and appropriate remedial measures will be developed and implemented in consultation with the overseeing government agencies. Remedial measures may include: removal of eroded materials; placement of large gravel or other erosion resistance material in scour holes; additional armoring with concrete matting, sandbags, or geotextiles; and revegetation of damaged areas. This approach recognizes that some damage may be caused by a large, infrequent event (e.g., 50-year flood), but that remedial treatment of the damaged areas is likely to have much less overall impact than the initial damage caused to large areas by installing protective armoring that may not be necessary.

Chapter 4.3

4.3 CHEMICAL RESOURCES

4.3.1 Water Quality

This section documents the baseline (i.e., present) water quality in the project area, where the resource is essentially unaltered, since human activity has been limited to the village of Nuiqsut and the Helmericks family homesite. Some historical data are available to help characterize water quality in rivers, ponds, lakes, and groundwater within the project area. Water quality and sediment chemistry data have also been reported for Harrison Bay.

4.3.1.1 Affected Environment

Colville River and Distributaries

Water quality in the Colville River and its distributary channels varies seasonally with changes in the streamflow regime. Water quality data reported for the USGS gauging station on the Colville River's main channel upstream from Nuiqsut (Gage No. 15880000) are summarized in Appendix H. These data were collected at irregular intervals between 1975 and 1981.

Water quality conditions in the Colville River do not always meet Alaska water quality criteria for fish, wildlife, and human consumption (ADEC 1995). For example, some metals (e.g., copper, zinc, cadmium and lead) have commonly been found at concentrations exceeding the criteria designed to protect aquatic life from toxic effects. These metals come from soils in the undeveloped watershed. Highly turbid (i.e., silty) water floods the Colville River every June, summer water temperatures sometimes exceed the water quality criteria, and dissolved oxygen conditions are naturally low during the winter. These variations in water quality are part of the natural environment for fish and wildlife of the Colville River Delta and do not result from man-caused disturbances. **When natural water quality conditions do not meet Alaska water quality criteria, ADEC will determine whether a natural condition should be approved as a site-specific water quality criterion. ADEC regulations provide that such a determination by the department is appropriate if the natural condition of the water body is of lower quality than the water quality standards, and if the natural condition of the water body is fully protective of designated beneficial uses.**

Water Temperature. Colville River water temperatures increase from break-up to a peak in early August, then the river gradually cools until freeze-up in late September or early October. Water temperatures reported for the USGS Colville River gauging station near Nuiqsut ranged from 34°F in April 1975 to 64°F in August 1977 (Appendix H, Aldrich 1995). A similar range of temperatures was reported for the Kuparuk River (Aldrich 1995).

USGS records do not include any Colville River data for the fall and winter months of September through March. However, Entrix (1986) reported under-ice temperatures near freezing (30 to 36°F) in the main river channel and Nechelik (Nigliq) Channel between late October and late December 1985.

Dissolved Oxygen. Dissolved oxygen is essential for respiration of fish and many other aquatic organisms, and its levels depend on the physical, chemical, and biochemical activities in a waterbody. Dissolved oxygen is generally present in high concentrations (9 to 12 mg/L) in the Colville River during the summer (Aldrich 1995). However, naturally occurring oxygen depletion has been documented in Colville River Delta channels in the winter. Alexander et al. (1975) reported dissolved oxygen measurements in the main channel and the Nechelik (Nigliq) Channel, near their junction, through the fall and early winter of 1972. By mid-November, saline waters had intruded and reduced bottom water oxygen concentrations to below 4 mg/L. By April and May, oxygen concentrations became minimal, although no water samples had zero oxygen. Alexander et al. (1975) also measured low dissolved oxygen concentrations (1.61 to 3.78 mg/L) in brackish Colville River water at the mouth of the Itkillik River in April of 1972 and 1973. Dissolved oxygen at the Kuparuk River was similarly low (1.4 mg/L) before break-up in April 1975 (Aldrich 1995).

Salinity. Salinity is an important factor in determining the suitability of habitat for different life stages of Colville River Delta fish species. Seawater penetrates at least 30 mi up the Colville River Delta channels during fall and winter (Selkregg 1975). Entrix (1986) reported that a saline wedge extended to Uyagagviit, approximately 15 mi upstream of the mouth of the Nechelik (Nigliq) Channel, soon after the mid-September freeze-up in 1985, and remained there through the end of monitoring in mid-December. When monitoring ended, the edge of the saline wedge was approximately 1 mi upstream from Putu and still advancing upstream. Moulton (1995) indicated a saline wedge reached the upper Nechelik (Nigliq) Channel near Nuiqsut in late October each year between 1990 and 1994. Alexander et al. (1975) reported salinity concentrations approximately twice as high at Wood's Camp (39.6 to 40.8 parts per trillion [ppt]) near the Nechelik (Nigliq) Channel mouth compared to salinity 27 mi upstream on the main channel at Itkillik (11.4 to 27.7 ppt) in late April. Together, these studies show that salinity increases in the Colville River channels as seawater advances upstream during winter.

Turbidity. Turbidity, which is a measure of water clarity, varies tremendously by season (0.70 to 200 nephelometric turbidity units [NTU], Appendix H) in the Colville River. It is highest following spring break-up when large amounts of sediment are transported by the flooding river. Turbidity decreases as the flows recede, so water is clearest in the winter after freeze-up.

Maximum turbidity during spring floods is typically higher in large mountain rivers, such as the Colville River, as compared to smaller tundra streams (Craig and McCart 1975). These large rivers carry additional sediment from erosion occurring in the mountains.

Suspended Sediment. Fine sediment (i.e., sand and silt) from erosion in the Colville River watershed is suspended in river water as it flows to the sea. Excessive sediment, however, impairs water quality and can be detrimental to fish. Although the average annual total suspended solids (TSS) concentration in the Colville River is low (less than 10 mg/L), very high TSS concentrations (1,650 mg/L) have been measured during June floods (Selkregg 1975). Most of the annual sediment load (6.4 million tons) is carried between May and October, with approximately 75% passing through the delta in early summer from the beginning of break-up to the end of post-break-up flooding. Over half of the sediment discharge occurred in June (in 1962), and as much as 500 tons were discharged in one 24-hour period (Selkregg 1975). Productive fisheries in the Colville River Delta area show that fish populations have adapted to the naturally high levels of suspended sediment that occur in summer.

Maximum suspended sediment concentrations are generally lower in tundra streams when compared to large mountain rivers such as the Colville River (Craig and McCart 1975).

pH. The intensity of the acidic or basic character of water is indicated by its pH (i.e., hydrogen ion activity). USGS pH measurements near Nuiqsut from 1975 through 1981 show that Colville River water is generally neutral to slightly acidic (6.20 to 8.20, Appendix H). The lowest (i.e., slightly acidic) pH measurements occurred in June. The Kuparuk River's pH reading (5.9 to 8.5) bracketed the Colville River measurements, with the lowest pH also occurring in June (Aldrich 1995). These limited data suggest that slightly acidic (i.e., pH less than 7) conditions sometimes occur naturally in project area rivers and streams, and may be more likely to occur during the high-flow season.

Bacteria. Fecal coliform is a bacterial group commonly used to indicate the possible presence of pathogenic bacteria. Fecal coliform bacteria are present in the feces of warm-blooded animals (e.g., caribou, waterfowl, etc.). The USGS reported low fecal coliform concentrations ranging from 0 to 28 colonies/100 milliliter (ml) in Colville River samples collected from 1979 to 1981 upstream from Nuiqsut (Appendix H; Aldrich 1995). State water quality standards range from 20 colonies/100 ml for drinking water to 200 colonies/100 ml for other water supply uses (e.g., industrial) and secondary (i.e., non-contact) recreation (ADEC 1995). The protozoan *Giardia*, an intestinal parasite that is carried by mammals, is prevalent in surface waters throughout Alaska, and water treatment is required for human consumption.

Nutrients. Nutrients, primarily nitrogen and phosphorus, are important in determining algae productivity and subsequently the availability of food for higher life forms, such as fish. Alexander et al. (1975) observed relatively high concentrations persisting in the Colville River until the water reached Harrison Bay, whereupon biological utilization removed all of the nitrate after mixing with seawater. In the study cited, nitrogen in the Colville River at the confluence of the Itkillik River was higher in spring than in the fall, since freezing concentrates the nutrients. Although generally low phosphate concentrations have been found in Colville River water (Alexander et al. 1975; Aldrich 1995), the river supports an abundant fishery. Maximum nutrient concentrations in the Kuparuk River between 1974 and 1986 were slightly lower than those reported for the Colville River (Aldrich 1995).

Metals. Measuring metals in water is important to water quality because metals at excessive concentrations are toxic to fish and other aquatic life. Samples collected at the USGS station near Nuiqsut in June 1977, and between June 1979 and August 1981, were analyzed for 14 trace metals (Appendix H; Aldrich 1995). Freshwater chronic aquatic toxicity criteria established by the EPA were naturally exceeded in one or more samples analyzed for cadmium, copper, lead, and zinc. Generally, sample concentrations were less than one order of magnitude higher than water quality criteria. In one sample, the total lead concentration in the Colville River was 30 times higher than the criterion (Aldrich 1995). These sample concentrations reflect the natural geochemistry of the Colville River watershed in the absence of industrial development. Similar trace metal concentrations were reported for the Kuparuk River both before and after oilfield development (Aldrich 1995).

<u>**Other Water Quality Parameters**</u>. Data collected by the USGS for additional water quality parameters include conductivity, carbon dioxide, alkalinity, bicarbonate, total organic carbon, total hardness, and some dissolved inorganic substances (Appendix H). These conventional parameters are useful for characterizing general water quality. No historical data exist for toxic organic substances in the Colville River, and they are not likely to be present given the lack of industrial development.

Other Rivers and Streams in the Project Area

Water quality data are not available for the Kachemach River, Miluveach River, Kalubik Creek, or the smaller unnamed tundra streams in the project area. Tundra streams are meandering creeks and small rivers that drain tundra-covered slopes of the arctic foothills and coastal plains, before flowing into the larger mountain streams or directly into the Beaufort Sea. Tundra streams that flow to the Beaufort Sea in the undeveloped area east of Prudhoe Bay have relatively low dissolved ion content, neutral to slightly alkaline pH (6.5 to 8.5), and a yellow to brown color (Craig and McCart 1975). Tundra streams in the project area are likely to exhibit water quality characteristics similar to these. Generally, summer temperatures of arctic streams seldom exceed 60°F (BLM 1988).

Lakes and Ponds

Lakes and ponds in the Colville River Delta area are typical of those found throughout the Arctic Coastal Plain. They are generally cold (32 to 38°F); however, shallow, clear arctic lakes may reach temperatures as high as 68°F in the summer (Feulner et al. 1971; Bureau of Land Management [BLM] 1988). Arctic lakes are normally at or near saturation levels for dissolved oxygen during the open-water season; however, oxygen depletion may occur under the ice during winter. Water in many Colville River Delta lakes contains coliform bacteria from wildlife feces (Lobdell 1995a).

Water chemistry in Colville River Delta lakes is highly variable and dependent on the distance from the Beaufort Sea, frequency of flooding, and whether they are tapped (i.e., connected to river channels most of the year) or perched (i.e., isolated from river channels most of the year). Lakes and ponds close to the Beaufort Sea are saline from storm surges and sea spray. As storm surges push seawater up the Colville River channels, fresh water in tapped lakes mixes with saltwater. Moulton (1993) reported average salinity measurements that were highest in river channels (12.5 ppt), intermediate in tapped lakes (7.2 ppt), and lowest in perched lakes (1.0 ppt). The differences in salinity are magnified in the variability of dissolved minerals. Chloride (4 to 4,800 ppm) and dissolved solids (<10 to 9,200 mg/L) concentrations ranged over three orders of magnitude in more than 100 Colville River Delta lakes and ponds sampled between 1991 and 1994 (Lobdell 1995b). Dilution with fresh water occurs after break-up when most delta lakes are flooded by the river.

Nutrient levels are much lower in Colville River Delta lakes and ponds than in the turbid waters of the river and its tributaries. Nutrient analyses of water samples from the Colville River between Umiat and the delta were compared with samples from 10 lakes and ponds near the Colville River (Alexander et al. 1975). Most notable were the almost undetectable concentrations of nitrate and nitrite in the lakes and ponds (0.00 to 0.45 µg-atoms NO_3-N/L) contrasted with high nitrate and nitrite concentrations in the river (2.34 to 4.8 µg-atoms NO_3-N/L). Phosphate concentrations in sampled lakes and ponds were also extremely low. The naturally low nutrient concentrations suggest that algae are using most of the available nutrients in area lakes and ponds; thus, increases in nutrients may stimulate additional productivity of algae and other aquatic life.

Groundwater

The project area lies within a zone of continuous permafrost, as does the entire North Slope. Accordingly, groundwater is restricted to either the thin active layer (thawed) above the permafrost or to zones below or within the permafrost. Permafrost ranges from 700 to over 2,100 ft deep on the North Slope. Groundwater within the permafrost occurs in discontinuous confined locations where dissolved salts depress the freezing point of the water. The saline quality of groundwater ensures that it is unsuitable for drinking water. Groundwater below the permafrost ranges in quality from brackish to saline, again ensuring that such sources are unsuitable for potable water use. Consistent with the poor quality of groundwater throughout the North Slope region, no North Slope potable water, for industrial or domestic use, originates from any underground source. Existing permits and related applications for North Slope injection wells confirm this information.

In the project area, permafrost is approximately 800 ft deep. Well logs demonstrate that all the rock formations between the permafrost and the oil reservoir are dense shales, mudstones, and siltstones, with a few thin sandstone intervals. These formations contain high-salinity groundwater generally inaccessible due to very low permeability, and which is unusable for potable water. Consistent with these data, no underground sources of drinking water occur in the ADP area.

Marine Water

Coastal waters of the Beaufort Sea are generally cold (30 to 37°F) and saline (27 to 32 ppt) for much of the year (Craig 1984). During summer, the nearshore region is characterized by relatively warm (41 to 50°F), turbid, and often brackish (<20 ppt salinity) water (Craig 1984). Brackish water entering the Beaufort Sea from the Colville River in the summer generally has low salinity (1.5 ppt) and a warm temperature (54°F, Kinney et al. 1972; Johnson and Hartman 1969). Temperature and salinity in the nearshore area are strongly influenced by the direction and speed of summer winds, the discharge of fresh water from coastal rivers, and the proximity of ice (USACE 1980). During the open-water season, shallow nearshore waters are subject to frequent and dramatic shifts in temperature and salinity when changes occur in wind speed and direction.

Melting ice is of low salinity and nutrient content, resulting in the formation of extreme haloclines (i.e., changes in salt concentration with depth) in the surface waters of Harrison Bay (Alexander et al. 1975). This stratification is readily attenuated by wind mixing but becomes pronounced again during calm weather. Inorganic nitrogen present at the beginning of summer is rapidly depleted, and concentrations fall to levels that limit phytoplankton productivity. Phosphate concentrations in seawater are much higher than in the rivers and probably do not limit marine primary productivity. The mixing of under-ice waters during winter replenishes the nutrients depleted by phytoplankton productivity in the summer and supplies oxygen to shallower environments. Dissolved oxygen concentrations in the nearshore zone are usually high, and the temporal and spatial variations that occur are not considered significant in restricting biota (USACE 1980). Turbidity from the Colville River during the annual June flood, together with other factors, blocks light and measurably reduces the phytoplankton productivity of inshore waters (Minerals Management Service [MMS] 1995).

Due to little or no industrial activity in the area, most contaminants occur at low levels in the Beaufort Sea (MMS 1995). However, turbidity, trace metals, and hydrocarbons are introduced into the marine environment through river runoff, coastal erosion, atmospheric deposition, and natural seeps. The Colville River and other rivers that flow into the Beaufort Sea remain relatively unaffected by human activities.

Limited data on trace-metal concentrations in the Beaufort Sea suggest they are generally considerably lower than EPA criteria for protection of aquatic life; no pollution is indicated (MMS 1995). Burrell et al. (1970) reported total zinc concentrations in surface and subsurface waters ranging from 0.04 to 3.70 parts per billion (ppb), well below the 86 ppb marine chronic aquatic toxicity criterion established by EPA. A few mercury values above the EPA aquatic life criterion have been reported, but these likely represent sample contamination (MMS 1995).

Marine sediment data indicate historical water quality conditions. Steinhauer and Boehm (1992) identified the Colville River as the source for high concentrations of saturated hydrocarbons in Harrison Bay, relative to other areas of the Beaufort Sea, and for the higher year-to-year variability in total saturated hydrocarbon concentrations observed in regional sediments. Similarly, higher concentrations and yearly variation of total polycyclic aromatic hydrocarbons (PAH) in Harrison Bay sediments (1.02 mg/kg average) were attributed to the influence of the Colville River on the overall organic load to the offshore area. The PAH assemblages for river sediment samples were similar to those for the offshore sediments. The primary source for these elevated sediment hydrocarbon concentrations is the organic matter carried by the Colville River. This organic matter includes fractions derived from coal, oil, and peat in the river's watershed. Natural petroleum seeps and erosion of shoreline peat are additional sources.

4.3.1.2 Environmental Consequences

Impacts of the Proposed Action (Alternative #2)

Potential water quality impacts from the ADP , fall into three general categories: (1) accidental release of fuels and other substances, including oil spills; (2) reductions in dissolved oxygen from lakes used for water supply; and (3) increases in erosion and sedimentation causing higher turbidity and suspended solids concentrations.

Water quality impacts may occur during construction, oil extraction, and transport operations. Potentially affected water resources include groundwater, the Colville River and its distributary channels, other rivers and streams in the project area, Harrison Bay, and lakes and ponds. The primary beneficial uses for these high-quality waters are growth and propagation of fish and wildlife.

Accidental Spills. During project construction and operation any spills or leaks of petroleum products that reach water may cause some water quality degradation (USACE 1980). The extent and duration of impacts will depend on the type of product, location, volume, season, and duration of spill or leak and the timeliness and effectiveness of containment and cleanup operations. Diesel fuel, gasoline, jet fuel, motor oil, hydraulic oil, antifreeze, and other fuels and lubricants will be used by trucks, airplanes, and heavy equipment. Spills or leaks may occur because of accidents, or during refueling or normal operations (e.g., corrosion resulting in small pipe leaks). Impacts from these types of spills will generally be confined to small areas on ice pads or gravel pads where cleanup is easily accomplished. Once construction is completed, the likelihood of spills and leaks will be reduced because vehicle activity will be much less during project operations.

A break or leak in the seawater pipeline from Oliktok Point could impact water quality in adjacent wetlands, ponds, streams, or rivers. At Oliktok, suspended solids, and oxygen are removed from the seawater and biocides (glutaraldehyde and occasionally sodium hypochlorite) are added. Water temperatures in the pipeline will be maintained at a minimum of 40°F. Depending on the location and quantity of seawater discharged, the introduction of deoxygenated saline water could reduce aquatic life in the immediate area. Dilution and flushing will limit impacts for any salt water spill entering one of the rivers. Lake and pond water quality is generally characterized by fresh water; therefore, substantial changes in water chemistry could occur following a spill. Larger lakes will provide greater dilution to reduce impacts. Although localized impacts will be more severe, a spill of salt water into a small pond or lake would be confined to a relatively small area. Long-term alterations could occur in freshwater communities (USACE 1980), particularly in perched lakes and ponds. Flooding at spring break-up will dilute and flush the seawater from streams and low-lying lakes and ponds.

Once the sales oil and seawater pipelines are built, they will be flushed with pressurized water to check for leaks. This hydrostatic testing will be performed with fresh water. Water used for hydrostatic testing will be returned to KRU and injected into wells for waterflood, thus there will be no intentional discharge in the ADP area. Some hydrostatic test water could be discharged through pipe leaks, and some of this discharge could reach surface waters along the pipeline route but there will be no impact to water quality because fresh water would be discharged.

Sewage and solid waste will not impact water quality. Sewage and solid waste from construction will be trucked to KRU for treatment. During operations, sewage and other solids will be incinerated on-site, and grey water (e.g. wash water) will be injected or used for waterflood.

Reductions in Dissolved Oxygen Due to Water Withdrawals. Fresh water will be withdrawn from lake L9313 and used for drilling, potable water supplies, and firefighting. The drilling program requires 21,000-63,000 barrels (bbl) of water per day, which will gradually lower the lake water level (see Section 2-24). Since this is a high perched lake that is recharged by floods every three to five years, the oxygen depletion and water quality degradation resulting from withdrawal over several years may eventually cause some fish mortality; this lake supports a very small population of fish (See Fishery Impacts Section).

The Sakoonang and Nechelik (Nigliq) channels are being evaluated as potential drilling water sources. Additional lakes in the delta and transportation corridor have been identified as water sources for ice road and ice bridge construction. Water withdrawals from lakes in the project area are regulated to a maximum of 15% of the under-ice water depth. Where deep lakes are refilled annually by floodwaters (i.e., tapped lakes), the water quality impacts are expected to be minimal. However, annual winter water withdrawals from perched or drainage lakes could reduce dissolved oxygen and water quality and impact existing fish populations, if any were present.

Erosion and Sedimentation. Alterations in surface drainage patterns due to roads, pads, and other facilities could affect both water levels and water quality in adjacent wetlands and streams (e.g., the Sakoonang Channel). Culverts and berms tend to concentrate flows that would otherwise be dispersed over a wider area. Concentrated flows are more likely to cause erosion of ice-rich soils and, consequently, may increase turbidity and sediment deposition within small drainage areas adjacent to roads and other facilities.

Where gravel fill is used to construct the road, the airstrip, and pads in wet areas, the receiving waters could temporarily have higher suspended solids concentrations and be more turbid. However, since gravel fill construction will take place in winter, no significant water quality impacts are anticipated.

Dust fallout onto ponds and lakes adjacent to roads and construction areas may increase turbidity within the facilities area. Algae productivity may also increase from nutrients entering the water (Alexander and Miller 1977). The greatest probability for these subtle effects on pond life would occur within 330 ft of the activity (USACE 1980). However, since construction will occur during winter, any water quality impacts from dust are expected to be minimal. Once construction is completed, the 3-mi gravel road between pads will be the only dust source.

Impacts of Alternatives (#3 - #8)

Field Development. Water quality impacts of the alternatives would be similar to those of the proposed project, except for the southern facilities layout (alternatives dropped from detailed consideration) and the alternatives with a permanent gravel road connecting in-field facilities to Nuiqsut (#6 - #8). These alternatives would have greater potential impacts. The southern facility layout would result in three lakes (9310, 9311, and 9312) at risk, potentially contaminating the water with accidental fuel spills or increasing the turbidity from road dust (see Figure 2.0-1). The magnitude of these impacts, however, would likely be small because people would be present to quickly detect and clean-up a spill, and dust can be controlled. The alternatives with the permanent gravel road and bridges to the in-field facility would have the greatest impact on water quality, even though the airstrip would be located in Nuiqsut. Dust, disruption of drainage patterns, and the increased likelihood of a fuel spill from more traffic would impact water quality by increasing turbidity, suspended solids, water temperature, and contamination.

Pipeline Route. Water quality impacts from the alternative routes would be greater than the proposed route in all cases. The X10 (#3) and ASRC route (#6) would have the least impacts of the alternatives since there would be no gravel road between the Colville River and KRU, but both involve crossing long spans, which would increase the risk of an oil spill from a break in the pipeline. Additional impacts are identified above for the ASRC route (#6), where the pipeline is buried in the road and crosses bridges in the delta. The greatest impacts to water quality would be from the ASRC/Kuukpik (#7) and the Western Initiative (#8) routes because the pipeline would be contained in the road from ADP to KRU. The impacts would be the same as those described earlier for roads, but the magnitude of the impacts would increase because of the greater length and width of the road. The impacts from dust fallout could increase over time if traffic volume increases.

River Crossing. Trenching the pipeline across the Colville River (#4, #5) would result in water quality impacts greater than the proposed action because of the in-water activity and disturbance to the river bottom. Increases in river bed erosion may occur during spring break-up, with marginal increases in turbidity and sediment deposition in downstream reaches.

Structures supporting a cable bridge (#3) would be subjected to yearly flooding and ice flows. Placement of piles may temporarily cause a minor localized increase in downstream turbidity and suspended solids but would have less impact on water quality than trenching. The pile-supported bridge that is part of the ASRC/Kuukpik and Kuukpik proposals (#7, #8) would cause water quality impacts similar to, but slightly greater than, the cable bridge (#3) because of the in-water placement and maintenance of the piles. Since construction would take place in winter, localized increases in turbidity and suspended solids from disturbance of the river bed would not occur until breakup. The effects would then be masked by the naturally heavy sediment load.

Site Access. The proposed site access by ice road, with an ice bridge over the Colville River, and in-field airstrip (#2, 3) is expected to minimize water quality effects by limiting drainage alteration and consequent erosion and sedimentation. Although the ASRC, ASRC/Kuukpik, and Western Initiative alternatives (#6 - #8) would not require construction of a new in-field airstrip, the gravel roads under these alternatives are more likely to cause turbidity and sedimentation from erosion and dust fallout. A permanent bridge or ferry to cross the Colville River Channel (#7, 8) would also increase the risk of small leaks and spills entering the river and may cause water quality impacts associated with bank disturbance during dock or bridge construction.

4.3.1.3 Mitigation Measures for the Proposed Action (Alternative #2)

Mitigation measures for water quality will be identical to those identified in the hydrology, geomorphology, fishery, and oil spill sections of this document. The measures include scheduling most construction during winter; minimizing road construction and the size of in-field facilities that alter drainage; installing culverts and the bridge crossing the swale to maintain drainage patterns; restricting access and traffic to minimize dust, vehicle leaks, and fuel spills; controlling dust with standard dust suppression techniques used on the North Slope; and instituting a pollution prevention program, educational programs, precautions, and spill response and clean-up plans in use on the North Slope to minimize a contaminant spill.

4.3.2 Air Quality

The proposed ADP will introduce several new sources of air pollutants: gas and diesel-fired facilities located on the production/drilling pad(s), and diesel-fired sources on a nearby drilling pad(s). Although the emissions will reduce ambient air quality at the in-field facility location, the potential emissions from the ADP will be less than most of the existing oil and gas production facilities on the North Slope because the proposed production facilities are rated at much smaller capacities. The capacities of gas turbines and heat input of gas heaters for the proposed project are less than 20% of existing capacities and heat input at KRU, and less than 10% of those at a major production facility in Prudhoe. Emission sources of this scale will have little impact on air quality in the region. The ambient air quality impacts of the proposed project are anticipated to be low, and the pollutant levels will not exceed applicable standards.

4.3.2.1 Affected Environment

Atmospheric Conditions

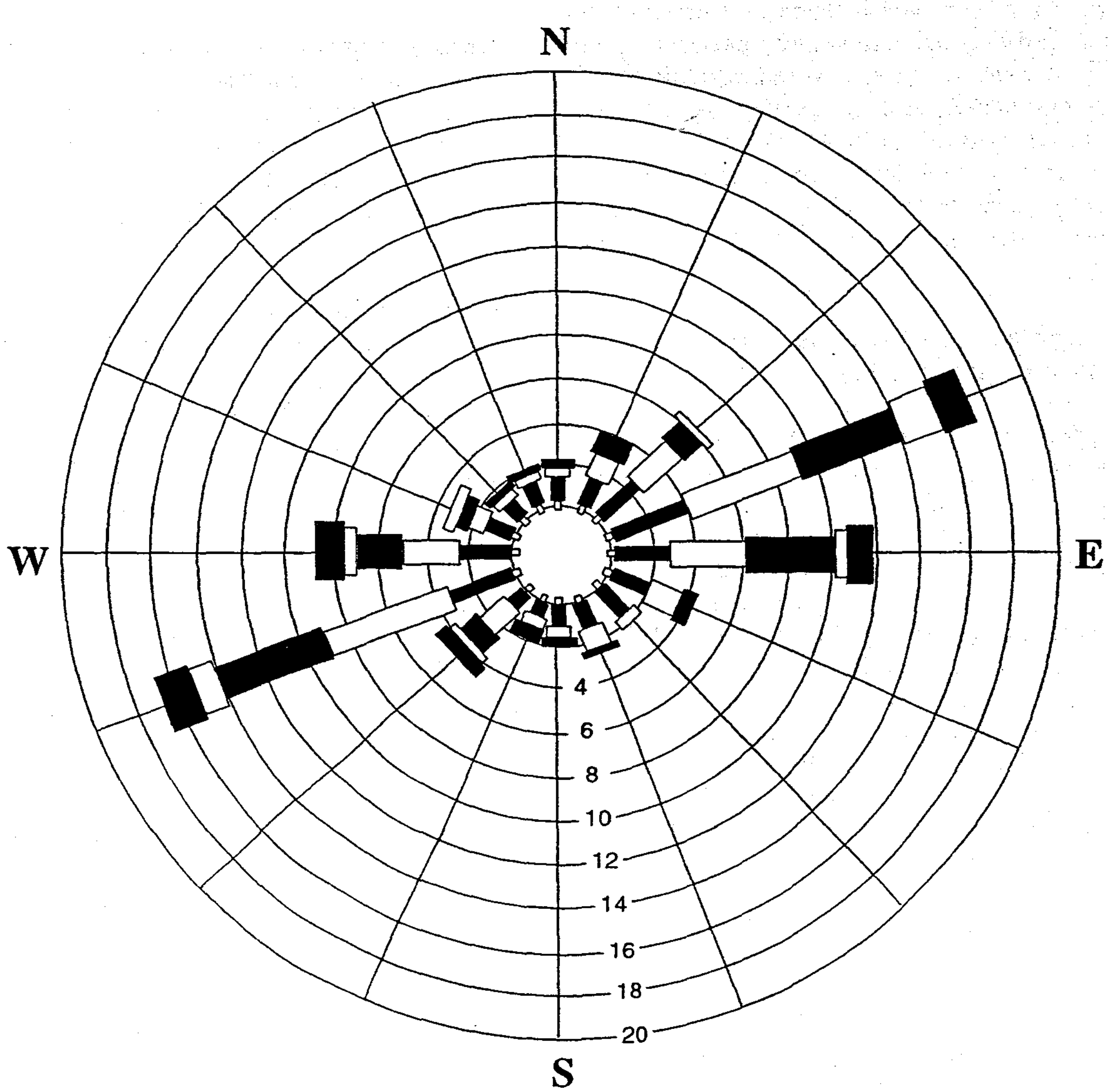
There is no weather observation station at the proposed in-field facility location; however, climate and atmospheric dispersion conditions can be characterized from the long-term weather observations collected on the North Slope of Alaska, at locations such as KRU, Prudhoe Bay, Barrow, and Barter Island (SECOR 1995).

The proposed in-field facility location, the Colville River Delta, is in the Arctic Climate zone. The climate is characterized by long, cold winters and short, cool summers. The annual mean temperature is about 10°F in the project area. Temperatures on the North Slope are generally below freezing from mid-October into May. February is the coldest month (average temperature equals -21°F) and July is the warmest (average temperature equals 46°F) (Thoman 1995). Precipitation is characteristically low, reaching a maximum in August. Snowfall can occur each month of the year, but it is greatest in October. The annual mean wind speed is about 13 mi per hour. December and January are the stormiest months (Thoman 1995). The prevailing wind direction is east-northeast from April through November. During winter seasons, wind direction is predominantly from the west-southwest (Figure 4.3.2-1) (ENSR 1992a).

The meteorological data collected at KRU, approximately 35 mi east of the in-field facility location, are representative of the average surface dispersion meteorological conditions of the project area. The wind rose analysis at KRU is presented in Figure 4.3.2-1 (ENSR 1992a). The frequency distributions of stability class, measured at KRU, appear in Table 4.3.2-1 (ENSR 1992a). The stability category is an indicator of the intensity of atmospheric turbulence at a given place and time. The classes range from "A" (extremely unstable) to "F" (stable). For the majority of the time, the air stability is neutral.

Existing Air Quality

Air quality is very good in this region owing to few pollution sources and good dispersion conditions. No major emission sources immediately surround the ADP in-field facility location. Major sources of emissions,



Source: ENSR 1992a

Wind Speed in m/s

Figure 4.3.2-1.
Kuparuk River Unit
Drill Site 1F Wind Rose
(November 1990-October 1991)

Table 4.3.2-1. Frequency distributions of atmospheric stability class measurements at KRU DS-1F.

Stability Category	Frequency (%)[1]		
	1986-1987[2]	1990-1991[3]	1991-1992[4]
Extremely Unstable (A)	4	3	3
Unstable (B)	4	2	2
Slightly Unstable (C)	9	4	7
Neutral (D)	58	61	64
Slightly Stable (E)	19	26	19
Stable (F)	7	5	5

[1] Does not sum to 100% because numbers are rounded.
[2] June 18, 1986 through June 17, 1987.
[3] November 1, 1990 through October 31, 1991.
[4] November 1, 1991 through October 31, 1992.

including large oil and gas production facilities, are at KRU and Prudhoe Bay 35 to 70 mi east of the ADP in-field facility location, respectively. Minor sources of emissions, including diesel-fired electric generators and heating units, open burning, and vehicular traffic are located in Nuiqsut approximately 8 mi south of the in-field facility location. Wind-generated dust contributes to temporary increases in particulates during the summer months.

Two ambient air pollution monitoring stations were operated within KRU in 1986-1987 and again in 1990-1992. One monitoring site was located immediately downwind of major combustion sources at Central Production Facility-1 (CPF-1). The other monitoring site, located at Drill Site-1F (DS-1F), was relatively isolated from major KRU emission sources. The data collected from DS-1F are, therefore, representative of background or regional air quality conditions in KRU area (ENSR 1992a). Conversely, the maximum concentrations of pollutants measured at CPF-1 reflect the impacts from these emission sources. The data collected from the monitoring stations CPF-1 and DS-1F show concentrations of air contaminants well below the national ambient air quality standards (NAAQS) and the state air quality standards for all pollutants (Table 4.3.2-2).

Currently, three ambient air monitoring stations are running at the PBU approximately 70 mi east of the ADP area. Data collected from PBU also indicate that the ambient air pollutant levels on the North Slope are well below the ambient air quality standards. A few elevated particulate loadings were detected at the Gathering Center 1 (GC-1) in 1992 and 1993. However, the results of an air quality analysis show these high particulate concentrations were caused by fugitive road dust and were not due to combustion sources in the field (ENSR 1993, 1994).

The project area is currently classified as an attainment area for all regulated pollutants under the Clean Air Act (CAA). An area is designated as "attainment" for a particular contaminant if its air quality meets NAAQS for that contaminant. If air quality is not in compliance with the NAAQS for a particular contaminant, that area is designated as "non-attainment" for that contaminant.

An attainment area is subject to PSD regulations. An owner or operator is required to obtain a PSD permit before construction of a major source, or modification of an existing major source, located in an attainment area. The ADP will constitute a "major new source," if potential emissions are over the threshold for any pollutant regulated under the CAA. PSD review will be required for all pollutants emitted from the ADP that cause a net increase greater than PSD significance levels.

Under the PSD rules, sources are allowed to consume only part of the allowable increment in ambient pollutant concentrations for new emissions that would cause an allowed "deterioration" of the ambient air quality. Alaska has adopted federal PSD increments that define the maximum allowable incremental change in baseline air quality levels from new sources (18 AAC50.020) (Table 4.3.2-3). PSD increments are specified for three designated class areas based on local land use goals. Class I areas (National Parks or

Table 4.3.2-2. Maximum concentrations of ambient pollutants monitored at KRU compared to federal and state ambient air quality standards (µg/m3).

Pollutant/Averaging Time	Maximum Monitored Concentration[1]		Air Quality Standards[2]	
	CPF-1	DS-1F	National	Alaska
Particulate Matter				
PM-10, annual	13.6	11.2	50	50
PM-10, 24-hour	108	63	150	150
Sulfur DioxideO_2				
SO_2, annual	5.2	2.6[3]	80	80
SO_2, 24-hr	26.2	13.1	365	365
SO_2, 3-hr	44.5	55.0	1,300	1,300
Nitrogen Dioxide (NO_2)				
NO_2, annual	16.0	4.9	100	100
Carbon Monoxide (CO)				
CO, 8-hour	920	575	10,000	10,000
CO, 1-hour	1,265	1,035	40,000	40,000
Ozone				
O_3, 1-hour	115.6	100.0	235	235
Lead				
Pb, calendar quarter	NA	NA	1.5	1.5
Reduced Sulfur				
As SO_2, 30-minute	18.1[4]	8.3[4]	NA	50

NA = Not applicable.

1 Maximum concentrations measured during November 1990 - October 1992. ENSR (1992b,c).

2 National and state standards, other than those based on annual average, are not to be exceeded more than once a year.

3 Minimum instrument detection level.

4 Maximum 1-hour average.

Table 4.3.2-3. Maximum allowable increases (PSD increments) for Class II areas in Alaska.

Air Contaminant	Class II (μg/m^3)
PM-10	
Annual arithmetic mean	17
24-hour maximum	30
Sulphur Dioxide	
Annual arithmetic mean	20
24-hour maximum	91
3-hour maximum	512
Nitrogen Dioxide	
Annual arithmetic mean	25

designated National Wilderness Areas) have the smallest increments, and allow only a small degree of air quality deterioration. Class II areas can accommodate normal well-managed industrial growth. Class III areas have the largest increments and provide for the greatest amount of development.

The project area is designated a Class II area for PSD purposes. The nearest Class I area, Denali National Park, is approximately 400 mi south of the Alpine in-field facility.

4.3.2.2 Environmental Consequences

Impacts of the Proposed Action (Alternative #2)

Site Construction and Operation. Site construction will cause a temporary impact on air quality at the development site. Air pollutants generated during construction generally consist of fugitive dust from topsoil disturbance and exhaust from heavy construction equipment. Moving and placing gravel may also generate fugitive dust emissions at the ADP site. However, major activities for pipeline and in-field facility construction will be conducted primarily in the winter, and therefore fugitive dust emissions will be negligible because of frozen soil and snow cover. The exhaust form heavy construction equipment may contain air pollutants, such as nitrogen oxides (NO_x), sulfur dioxide (SO_2), CO, volatile organic compounds (VOCs), and particulates. Air quality impacts from construction will not be significant and will be localized and temporary.

Production Facilities. Production facilities consisting of three or four dual-fuel (primarily natural gas-fired) gas turbines, and a gas-fired process heater, are primary emission sources at the in-field facility location. Turbines and heaters generate pollutant emissions from fuel combustion processes; emissions include NO_x, SO_2, CO, particulate matter, and VOCs. Natural gas is considered a clean fuel because it generates much less SO_2 and fine particulates than most other fuels. Nitrogen dioxide, a primary form of NO_x in the atmosphere, is of primary concern because of a large amount of NO_x emissions from gas turbines and diesel engines in this region. However, best available control technologies (BACT) will be applied to these production facilities to reduce emissions from the proposed development.

A diesel-fired backup generator will be used to provide supplemental power to the drilling and processing equipment when failures occur in main power generating units or during shutdown for maintenance. The diesel generator will generate the same criteria pollutants as the gas turbines, but emission rates are generally higher for SO_2 and particulates. BACT will be applied to the diesel engines.

Solid Waste Incinerator. Because of limited site access during summer, a solid waste incinerator would potentially be built on the production/drilling pad(s) for disposal of solid waste, especially putrescible waste, generated at the site. **Organic wastes may be composted at the site, depending on the success of a pilot program currently being conducted at PBU.** The incinerator would be rated less than 1,000 lbs of waste per hour. Impacts of primary concern from solid waste incineration are potential emissions of toxic air pollutants such as trace metals. To reduce potential toxic emissions, waste metals and toxic-containing materials generated from field operation and maintenance would be segregated from the combustible waste stream at the generation site and shipped off-site for recycling or disposal.

Drilling Rig Engines. Initially there may be two drilling rigs on the production/drilling pad(s) (facilities would not operate during startup). After startup, one rig will serve drilling activities on the two drilling pads in the in-field facility (one rig would be removed). A drilling rig will consist of five diesel rig engines to provide power for drilling equipment, two to three space heaters to keep the drilling from freezing up, and two boilers to generate steam for thawing and cleaning drilling equipment during periods of freezing temperatures. A rig will also include a diesel-fired backup generator to provide power for the drilling equipment when failures occur in the rig engines.

Potential emissions from diesel combustion equipment in a drilling rig include NO_x, SO_2, CO, particulate, and VOCs. As with the production facilities and its backup generator, BACT will be applied to minimize emissions. The rig engines in a drilling rig will operate intermittently and the space heaters and boilers will only be operated during periods of freezing temperatures; their impacts, therefore, will not be substantial.

Mobile Sources. Vehicles traveling on the gravel road between the drilling pad(s) and aircraft landing/takeoff on the airstrip will generate fugitive dust during ice-free seasons as well as emissions from engine exhaust. The exhaust pollutants will be similar to those from facility combustion equipment. However, the air quality impacts from these mobile sources are not expected to be significant and will be localized and temporary.

Emergency Flares. An emergency flare system consisting of two flares on the production facility pad will be used to dispose of unrecoverable gases. Flare emissions primarily include carbon particles (soot), unburned or partially burned and altered hydrocarbons, and CO. Soot emissions could form black smoke, which could impact visibility. To minimize soot emissions, BACT for flares will be used in the ADP. However, short-term emission of soot or black smoke may be inevitable under extreme emergency conditions. The emergency release generally will last less than an hour. Its impact to the visibility at the in-field airstrip and the airstrip in Nuiqsut would be temporary and insignificant.

Material Sites. Air quality impacts will be greater for development of the Nuiqsut Contractor Inc.'s mine site than for the KRU mine site. Exhaust from earth-moving equipment and associated vehicles will temporarily reduce air quality in the vicinity of the site. ARCO plans to complete gravel transport to the in-field facility during the first winter of construction.

Ambient Air Quality Impacts. The emissions from operating the production facilities will increase concentrations of regulated ambient air pollutants at the ADP site. However, net increases in ambient concentrations of nitrogen dioxide, SO_2, and fine particulates (PM-10) are expected to be below allowable PSD increments. This expectation is based on previous PSD permit applications for similar or identical facilities of larger capacities on the North Slope. To demonstrate compliance with the applicable NAAQS and the PSD increments, the ambient concentrations and increments of regulated air pollutants from the proposed project will be predicted by a PSD dispersion modeling analysis in the PSD permit application.

Impacts of Alternatives #3 - #8

Field Development. Air quality impacts of the alternatives would be similar to the proposed project except for the alternatives having support facilities based in Nuiqsut (#6 - #8). Sources of air emissions in the support facilities include gas turbines for electricity generation and aircraft. Moving the gas turbines from the in-field facility to Nuiqsut (#6 - #8) would place residents closer to the pollution sources. Increased air traffic would expose the Nuiqsut residents to higher levels of pollutants. In addition, elevated levels of vehicular use associated with servicing these operations would increase air emissions in Nuiqsut. Another source of increased air emissions would be road dust and traffic from vehicles travelling the gravel road connecting the in-field facility to Nuiqsut and the Colville River (#6 - #8). Road dust would be generated by vehicles during summer. Vehicle emissions like those of air traffic would be highest during construction and substantially less during oilfield production. Impacts associated with the alternative of moving the production facilities west of the Nechelik (Nigliq) Channel (#8) would be similar to the proposed alternative.

Pipeline Route. Air quality impacts of the route alternatives would be similar to the proposed project, except for alternatives having a permanent road (#4, #5 #7, #8). Vehicular traffic from these alternatives would increase exhaust and dust emissions. Emissions would be greatest during construction and substantially lower during operations for the project. However, emissions from privately owned vehicles would remain relatively high for the alternatives having a permanent gravel road connecting KRU to Nuiqsut (#7, #8). Vehicular traffic would likely increase each year from more residents owning vehicles and each resident taking more trips because of increased access.

River Crossing. Air quality impacts of the crossing options would be similar to the proposed project. Emissions from vehicles and heavy equipment would be produced during construction of each crossing alternative.

Site Access. Air quality impacts for site access have been addressed in the sections above, except for crossing the river by ferry (#7, #8). Exhaust emissions from the ferry engine would temporarily reduce air quality immediately near the crossing during the ice-free period.

4.3.2.3 Mitigation Measures for the Proposed Action (Alternative #2)

Major activities, including pipeline and facility construction, will be performed in winter. Frozen topsoil and snow cover on the ground will significantly limit fugitive dust generation. The proposed site access, using ice roads and ice bridges for access rather than building a permanent road, minimizes extra disturbance to native soil and the amount of gravel movement, thereby reducing fugitive dust emissions. Air quality impacts from engine exhaust will be minimized by maintaining air pollution control requirements for construction equipment and vehicles. Implementing these mitigation measures will minimize the temporary air quality impacts during construction.

The ADP will apply BACT during operations to reduce emissions from the gas turbines, the process heater, drilling equipment, flares, and backup generators. BACT for the proposed development will be determined by an analysis in the PSD permit application. Emissions of regulated pollutants from the production facilities will also meet applicable New Source Performance Standards (NSPS) and state emission standards. Waste metals and toxic materials generated in the field will be segregated from the general combustible waste stream before incineration to reduce air toxic emissions from the solid waste incinerator.

Air quality within the City of Nuiqsut will be monitored prior to construction to obtain information on existing air conditions within the City (see Appendix J for a description of the air quality monitoring program). ARCO will fund the air quality-monitoring device, and recommends that a Native-owned entity manage the placement, operation, and maintenance of the device to ensure an objective evaluation.

Chapter 4.4

4.4 BIOLOGICAL RESOURCES

4.4.1 Fisheries Resources

4.4.1.1 Affected Environment

Introduction

Fish populations in the Colville River and delta have been extensively studied because of increased resource use and potential industrial development in the area. Fish have been surveyed since 1970 primarily to describe their use of the Colville drainage and surrounding waterbodies (Kogl 1971; Alt and Kogl 1973; Kogl and Schell 1974; Bendock 1979a to 1983; Bendock and Burr 1984a, 1986). Freshwater fish distribution and habitat use between the Ikpikpuk and Colville rivers have been summarized by Bendock and Burr (1984b). Fish use of major channels and lakes of the lower Colville River and delta was studied in 1985 (Fawcett et al. 1986; Bendock and Burr 1986). Focus of studies has recently shifted to lakes in the delta (Moulton 1994). Research prompted by oil and gas leasing and development in the coastal region has provided substantial information on anadromous fish use of coastal habitats surrounding the Colville River Delta (Craig and Haldorson 1981; Dew 1983; Schmidt et al. 1983; Moulton and Fawcett 1984; Fawcett et al. 1986).

Studies conducted to date indicate the Colville River supports an abundance of fish, composed of at least twenty species dominated by whitefishes and ciscos (Table 4.4.1-1). Dolly Varden char and arctic grayling are also abundant. Eight marine species occur in adjacent coastal waters. Nine anadromous species use the Colville River, which range from species that only spawn in the river (Pacific salmon and rainbow smelt) to species that feed in the estuary during summer and overwinter and spawn in the river (humpback whitefish and broad whitefish), use the Beaufort Sea coastal region.

Residents of the Colville River Delta harvest fish for both subsistence and commercial uses (George and Kovalsky 1986; George and Nageak 1986; Moulton et al. 1986a; Craig 1987; Moulton 1995); the sport harvest level is low. The subsistence harvest includes ciscos, whitefishes, Dolly Varden char, lake trout, arctic grayling, chum salmon, and burbot (Moulton et al. 1986a). All these species, except lake trout, are commonly caught within the lower river and delta. Broad whitefish is the primary species taken during the summer subsistence fishery, while arctic cisco is the target species in the fall (George and Nageak 1986; Moulton et al. 1986a). The commercial fishery primarily targets arctic cisco and, secondarily, least cisco, broad whitefish, and humpback whitefish.

The following section reviews existing information on eight species, selected because of their abundance within the project area and their potential harvest value. The geographic area covered by the review lies between Ocean Point and the mouth of the Colville River.

Fish Habitats Within the Colville River Delta

The lower Colville River and delta are a maze of interconnected main and minor channels with numerous oxbows and lakes (Figure 4.4.1-1). The lakes are permanently, seasonally, or sporadically connected to the river channels. Seasonally connected lakes are flooded during break-up, while sporadically connected lakes are flooded only during high water years. The diversity of aquatic habitats provides substantial rearing, migration, overwintering, and spawning habitat for the fishes.

Major Channel Habitat. Major channel habitat is primarily the main Colville River between the Itkillik River and the mouths of the Kupigruak and East channels, and the Nechelik (Nigliq) Channel. These channels convey most of the summer flow and hold substantial volumes of water during winter. During summer, this habitat accounts for 47% of the water surface in the delta (Table 4.4.1-2). Major channel habitat provides important overwintering and spawning habitat and migration corridors for fish.

The thalweg through most of the major channel habitat downstream from the Itkillik River is in excess of 10 to 12 ft deep; this ensures abundant overwintering habitat throughout much of the delta. The water becomes saline as fresh water flow slackens after ice formation in the fall, and as marine water penetrates into the delta to replace fresh water. Species that are tolerant of, or dependent on, brackish water overwinter in the lower portions of the delta, while other species move upstream to fresher water. Salt-tolerant species in the lower delta include arctic cisco, rainbow smelt, and fourhorn sculpin. Species with moderate salinity

Table 4.4.1-1. Fish species identified from the Colville River drainage system, delta, and nearshore coast outside of the delta.

Common Name	Iñupiaq Name	Scientific Name
Anadromous Fishes		
Arctic cisco	Qaaktaq	*Coregonus autumnalis*
Least cisco	Iqalusaaq	*Coregonus sardinella*
Bering cisco	Qaaktaq	*Coregonus laurettae*
Broad whitefish	Aanaakłiq	*Coregonus nasus*
Humpback whitefish	Piquktuuq	*Coregonus pidschian*
Dolly Varden char	Iqalugaaq	*Salvelinus malma*
Rainbow smelt	Iłhuaġniq	*Osmerus mordax*
Pink salmon	Amaqtuuq	*Oncorhynchus gorbuscha*
Chum salmon	Iqalugruaqpak	*Oncorhynchus keta*
Freshwater Fishes		
Arctic grayling	Sulukpaugaq	*Thymallus arcticus*
Lake trout	Iqalugaaq	*Salvelinus namaycush*
Round whitefish		*Prosopium cylindraceum*
Burbot	Tittaaliq	*Lota lota*
Longnose sucker	Milugiaq	*Catostomus catostomus*
Northern pike	Siulik	*Esox lucius*
Alaska blackfish		*Dallia pectoralis*
Arctic lamprey		*Lampetra japonica*
Ninespine stickleback		*Pungittius pungittius*
Threespine stickleback		*Gasterosteus aculeatus*
Slimy sculpin		*Cottus cognatus*
Marine Species		
Fourhorn sculpin	Kanayuq	*Myococephalus quadricornis*
Arctic flounder	Puyyagiaq	*Liopsetta glacialis*
Arctic cod	Uugaq	*Boreogadus saida*
Saffron cod		*Eleginus gracilis*
Capelin	Paŋmagrak	*Mallotus villosus*
Pacific herring	Uqsruqtuuq	*Clupea harengus*
Pacific sandlance		*Ammodytes hexapterus*
Snail fish		*Liparis* sp.

Source: Moulton and Carpenter (1986).

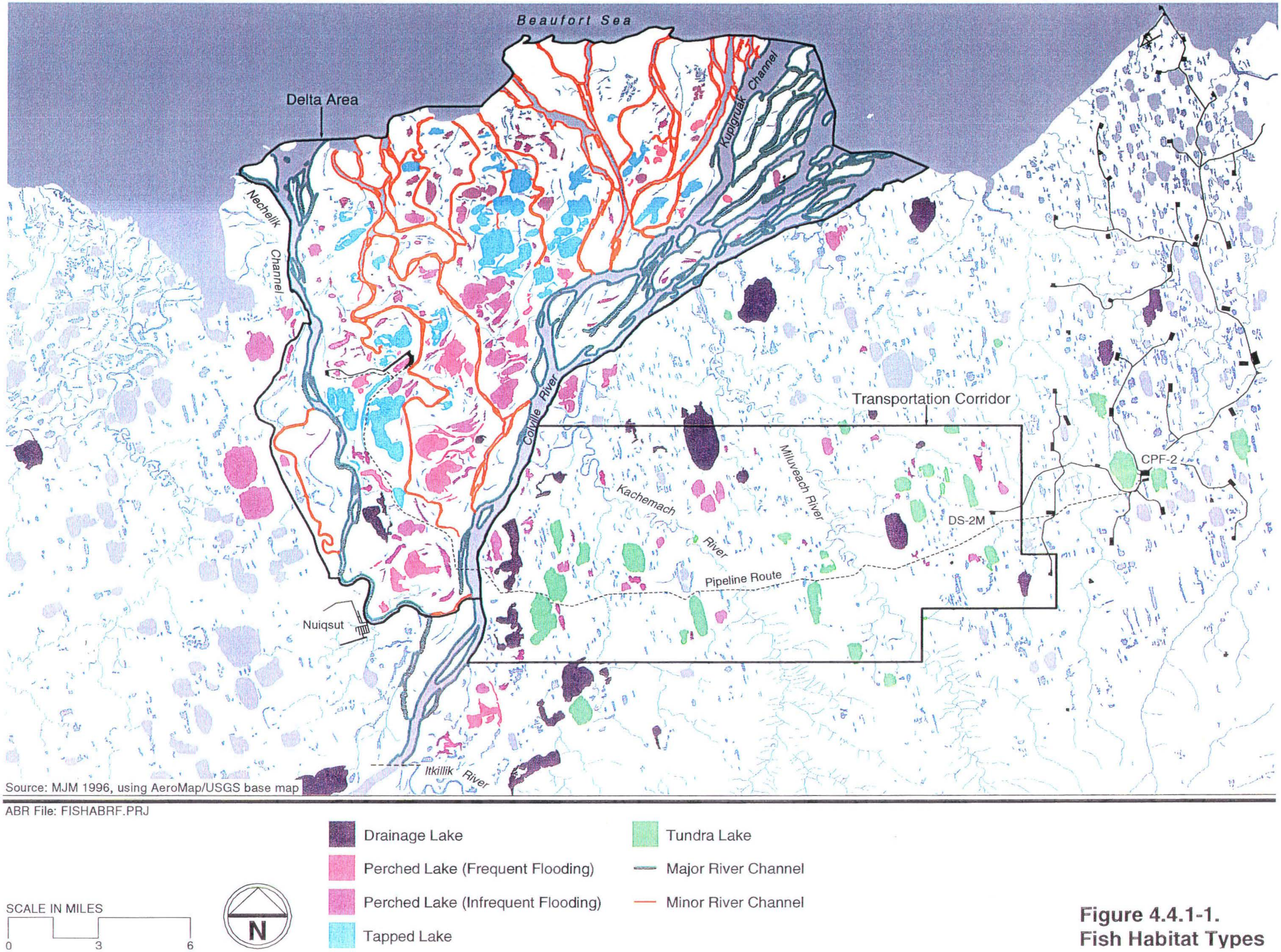


Figure 4.4.1-1.
Fish Habitat Types

Table 4.4.1-2. **Abundance of potential fish-bearing habitat within the Colville River Delta (between and including the Nechelik [Nigliq] Channel and Main Channel downstream from the Itkillik River).**

	Delta-Wide				Facilities Area			
Habitat Type	Surface Area (acres)	Number of Lakes	Average Area (acres)	Percent of Total Acreage	Surface Area (acres)	Number of Lakes	Average Area (acres)	Percent Area of Type
Channels								
Major	17,517			47.2	0			0.0
Minor	4,862			13.1	68			1.4
Lakes								
Tapped	5,470	39	140	14.7	497	3	166	9.1
Perched	8,843	141	63	23.8	290	7	41	3.3
Frequently Flooded	3,661	30	122	9.9	158	3	53	4.3
Infrequently Flooded	5,182	111	47	13.9	133	4	33	2.6
Drainage	455	4	114	1.2	0	0		0.0
Lake Totals	14,769	184	80	39.8	787	10	79	5.3
Total Water Surface (acres)	37,148				855			2.3

Source: Aerial Photographs, July 23, 1983.

tolerance include least cisco and humpback whitefish. Other species, including broad whitefish, arctic grayling, and burbot move upstream of the brackish water, often upstream from the mouth of the Itkillik River. The reach between Itkillik River and Ocean Point has the first significant freshwater overwintering areas. Thus, winter habitat use within the delta is segregated by species.

Broad whitefish, humpback whitefish, and least cisco spawn in major channels prior to overwintering (Table 4.4.1-3). Least cisco appear to move downstream into the delta after spawning, while the other two species remain near the spawning areas.

Minor Channels. The numerous minor distributary channels that lace the delta collectively convey substantial amounts of water during spring, but have low-to-no flow during summer. These channels warm rapidly and provide abundant rearing habitat during summer, but they offer little habitat during winter because of the shallow water. The minor channels account for 13% of the water surface during summer (see Table 4.4.1-2).

A portion of the Sakoonang Channel occurs immediately east of the in-field facility location. Sampling during summer of 1995 indicated that young least cisco and whitefishes were the most abundant species in the channel. Least cisco represented almost 38% of the catch (sticklebacks excluded), followed by

Table 4.4.1-3. **Habitat use by dominant fish species in the Colville River Delta.**

Species	Coastal Region	Major Channel	Minor Channel	Tapped Lake	Perched Lake	Drainage Lake
Arctic Cisco						
Juveniles	summer feeding	migration, wintering	migration	migration, (minor feeding)	--1	--
Least Cisco						
Juveniles	summer feeding	summer feeding, migration, wintering	summer feeding, migration	summer feeding	summer feeding, wintering	summer feeding, wintering
Adults	summer feeding	summer feeding, migration, wintering, spawning	summer feeding, migration	summer feeding	summer feeding, wintering, spawning	summer feeding, wintering, spawning
Broad Whitefish						
Juveniles	summer feeding	summer feeding, migration, wintering	summer feeding, migration	summer feeding	summer feeding, wintering	summer feeding, wintering
Adults	summer feeding	summer feeding, migration, wintering, spawning	summer feeding	summer feeding	summer feeding, wintering	summer feeding, wintering
Humpback Whitefish						
Juveniles	(minor feeding)	summer feeding, migration, wintering	summer feeding, migration	summer feeding	--	summer feeding, wintering
Adults	(minor feeding)	summer feeding, migration, wintering, spawning	summer feeding, migration	summer feeding	--	summer feeding, wintering
Dolly Varden Char						
Juveniles	summer feeding	migration	--	--	--	--
Adults	summer	migration	--	--	--	--

Table 4.4.1-3. Habitat use by dominant fish species in the Colville River Delta.

	Habitat Type					
Species	Coastal Region	Major Channel	Minor Channel	Tapped Lake	Perched Lake	Drainage Lake
	feeding					
Rainbow Smelt						
Juveniles	summer feeding	wintering (in lower portion)	--	--	--	--
Adults	summer feeding	wintering (in lower portion)	migration, spawning?	spawning	--	--
Arctic Grayling						
Juveniles	--	summer feeding, wintering	summer feeding	summer feeding	--	summer feeding
Adults	--	summer feeding, wintering			--	summer feeding
Burbot						
Juveniles	--	summer feeding, wintering	Summer feeding	summer feeding	--	summer feeding
Adults	--	summer feeding, wintering, spawning			--	summer feeding

[1] = Scarce or not present in this habitat.

Table 4.4.1-4. Species composition from project area habitats during 1995 (% of catch).

Species	Channel Major	Channel Minor	Lake Tapped	Lake Perched Low[1]	Lake Perched High[2]	Lake Drainage
Summer Fyke Net						
Broad whitefish	--	32.3	41.8	0.0	16.7	1.0
Humpback whitefish	--	5.4	5.7	0.4	0.0	2.0
Round whitefish	--	16.7	10.4	0.0	1.0	6.0
Least cisco	--	37.8	35.8	95.8	50.0	30.0
Arctic cisco	--	0.0	0.0	0.8	0.0	0.0
Arctic grayling	--	1.9	0.6	0.0	1.0	49.0
Rainbow smelt	--	2.2	3.3	0.0	0.0	0.0
Burbot	--	0.3	0.1	0.0	0.0	0.0
Alaska blackfish	--	0.1	0.0	2.5	22.9	12.0
Longnose sucker	--	0.8	0.9	0.0	2.1	0.0
Arctic flounder	--	0.0	0.0	0.0	0.0	0.0
Fourhorn sculpin	--	2.4	1.3	0.4	0.0	0.0
Slimy sculpin	--	0.0	0.0	0.0	6.3	0.0
Total Catch (excluding sticklebacks)	Not Sampled	2,915	5,574	236	96	100
Fall Gill Net						
Broad whitefish	9.1	72.7	--	4.0	2.3	--
Humpback whitefish	8.1	0.0	--	0.0	0.0	--
Round whitefish	2.0	0.0	--	0.0	0.0	--
Least cisco	46.5	15.2	--	96.0	96.8	--
Arctic cisco	4.0	9.1	--	0.0	0.0	--
Arctic grayling	11.1	0.0	--	0.0	0.0	--
Rainbow smelt	0.0	0.0	--	0.0	0.0	--
Burbot	7.1	0.0	--	0.0	0.0	--
Alaska blackfish	0.0	0.0	--	0.0	0.9	--
Longnose sucker	2.0	0.0	--	0.0	0.0	--
Arctic flounder	0.0	0.0	--	0.0	0.0	--
Fourhorn sculpin	10.1	3.0	--	0.0	0.0	--
Slimy sculpin	0.0	0.0	--	0.0	0.0	--
Total Catch	99	33	Not Sampled	25	342	Not Sampled

Source: Moulton data files (1995).

[1] Perched lake likely to be flooded on an annual basis, often with a high water channel.

[2] Perched lake flooded on less than an annual basis, no obvious high water channel.

broad whitefish (32%), round whitefish (17%) and humpback whitefish (5%) (Table 4.4.1-4). During fall 1995, after ice formation, few fish were caught within the Sakoonang Channel, but most were juvenile broad whitefish, least cisco, and arctic cisco (see Table 4.4.1-4). Sampling during prior years in minor channel habitat indicated that rainbow smelt may be abundant (Table 4.4.1-5).

<u>Delta Lakes</u>. Delta lakes provide about 40% of freshwater habitat. Only waterbodies greater than about 7 ft deep are considered potential fish habitat because they do not freeze to the bottom during winter.

Table 4.4.1-5. Fish use of Colville River Delta habitats as indicated from gill net and fyke net sampling during 1979, 1985 and 1991-1993 (percent of catch).

	Major Channel		.1Minor Channel	Lake							
				Tapped		Low Perched[1]		High Perched[2]		Drainage	
	Summer		Fall	Summer	Fall	Summer	Fall	Summer	Fall	Summer	Fall
Species	1985[3]	1985	1991-1993	1979	1991-1993	1979	1991-1993	1979	1991-1993	1979	1991-1993
Broad whitefish	12.1	13.4	0.0	25.0	16.4	2.2	2.2	1.1	5.2	16.4	--
Humpback whitefish	10.7	11.1	0.0	0.6	2.7	0.4	0.0	0.0	0.3	0.0	--
Round whitefish	7.1	4.8	0.0	0.6	0.0	1.3	0.0	0.0	0.7	6.6	--
Least cisco	45.2	24.6	23.3	41.9	39.7	96.0	81.3	93.3	87.9	67.2	--
Arctic cisco	8.5	12.4	62.3	2.2	19.2	0.0	6.0	0.0	2.4	0.0	--
Arctic grayling	1.7	11.8	0.0	0.0	0.0	0.0	0.0	1.1	0.0	8.2	--
Dolly Varden char	0.8	10.9	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	--
Pink salmon	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Rainbow smelt	1.6	2.8	14.5	3.7	20.5	0.0	0.0	0.0	0.0	0.0	--
Burbot	0.3	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	--
Saffron cod	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	--
Alaska blackfish	0.0	0.0	0.0	0.0	0.0	0.0	10.4	4.5	3.5	0.8	--
Longnose sucker	1.6	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	--
Fourhorn sculpin	9.7	0.8	0.0	25.3	1.4	0.0	0.0	0.0	0.0	0.0	--
Slimy sculpin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Arctic lamprey	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Arctic flounder	0.6	0.1	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	--
Ninespine stickleback	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
Total Catch	49,433	1,205	159	356	73	226	134	89	593	256	NS

[1] Perched lake likely to be flooded on an annual basis.
[2] Perched lake flooded on less than an annual basis.
[3] Fyke Net.

Sources:
1979 Gill Net: McElderry and Craig (1981)
1985 Fyke Net: Fawcett et al. (1986)
1985 Gill Net: Bendock and Burr (1986)
1991-1993 Gill Net: Moulton (1994)

Fish entering lakes less than 7 ft deep generally do not survive the winter.

There are three types of delta lakes, based on the extent to which they are connected to an active channel: tapped, perched, and drainage lakes. Tapped lakes have year-round connecting channels that fish can pass through during summer. Most of these lakes are shallow, typically less than 6 ft deep. Tapped lakes account for about 15% of the water surface during summer. The surface area of tapped lakes within the facilities area is around 9% of the delta-wide total for this habitat (see Table 4.4.1-2). Tapped lakes are heavily used by fish as rearing habitat. The lakes are commonly used by broad whitefish, which are traditionally harvested in the larger tapped lakes by local fishermen. During 1995, tapped lakes connected to the Sakoonang Channel provided rearing habitat for broad whitefish (42% of the catch), least cisco (36%), round whitefish (10%), humpback whitefish (6%) and rainbow smelt (3%), with the remaining 3% was scattered among several other species (see Table 4.4.1-4). Fall sampling indicated that arctic cisco inhabit these areas before overwintering (Moulton 1994).

Perched lakes often lack well-defined connections. The low-elevation lakes flood every spring during break-up, while others flood infrequently during unusually high water. Perched lakes account for 24% of the water surface area within the delta during summer; of these 10% flood frequently and 14% flood infrequently (see Table 4.4.1-2). The surface area of perched lakes within the facilities area represents 3.3% of the delta-wide total of this habitat type. Least cisco, broad whitefish, and Alaska blackfish typically use perched lakes, although other species (humpback whitefish, arctic cisco and arctic grayling) also use these habitats. Many of the perched lakes support reproducing populations of least cisco, while broad whitefish appear to immigrate from the main river (see Table 4.4.1-3). There are no reports of broad whitefish spawning in these lakes. Use by species other than least cisco, Alaska blackfish, and ninespine stickleback tends to be higher in the annually flooded perched lakes than in other perched lakes.

Drainage lakes are connected to streams that drain into the Colville River or its tributaries. One complex of drainage lakes occurs within the delta and accounts for 1.2% of the water surface area within the delta during summer. Drainage lakes are more common along the pipeline corridor between the Colville River and KRU facilities. The degree to which a lake is connected to the river channel determines the species that use the drainage lakes. Arctic grayling use drainage lakes more heavily than other types of lakes. Drainage lakes contained over 50% of the arctic grayling sampled in 1995. Least cisco, Alaska blackfish, round whitefish, broad whitefish, and humpback whitefish were also present (see Table 4.4.1-4).

Tributary Streams. Two well-defined tributaries cross the transportation corridor: the Miluveach and Kachemach rivers. Both are used for spawning and juvenile rearing by arctic grayling, and feeding by round whitefish. Aside from ninespine stickleback, few other species occur upstream from the point where these rivers connect to the Colville River. Overwintering habitat is limited or non-existent; thus, fish using these rivers during summer must return to the Colville River prior to freeze-up to overwinter.

Description of Anadromous Species Harvested by Subsistence Users

Arctic Cisco (Qaaktaq). In coastal areas of the Beaufort Sea near the Colville River, the arctic cisco is one of the most abundant species during the open-water season, often representing 30 to 50% of the anadromous fish captured by gill net or fyke net (Bendock 1979a; Craig and Haldorson 1981; Dew 1983; Moulton and Fawcett 1984). The species is abundant in river deltas as well, accounting for 13% of the catch of anadromous fishes in the Colville River Delta in 1985 and 29% of the fyke net catch at the Sagavanirktok River in 1982 (Griffiths et al. 1983; Fawcett et al. 1986).

During summer, arctic cisco are not abundant in the Colville River, as most are feeding in coastal waters. During 1985, arctic cisco represented only 0.7% of the anadromous fish catch at fyke nets in the lower river (Fawcett et al. 1986). Summer feeding movements range westward into Harrison Bay, but apparently not much beyond Cape Halkett. Few fish were taken west of Pitt Point (Schmidt et al. 1983). Eastward movements reach beyond the Sagavanirktok delta; thus, the fish pass the area of coastal development associated with Prudhoe Bay and other oilfields (LGL Alaska 1994).

Arctic cisco return to the Colville River Delta during September and October to overwinter (Moulton et al. 1990). The village and commercial fishery intercept fish moving into the major channels at this time. After wintering in the delta, the fish return to coastal waters during or immediately after break-up. Arctic cisco distribution in the Colville River appears to be essentially confined to the lower river and delta area downstream from Ocean Point (Bendock and Burr 1986).

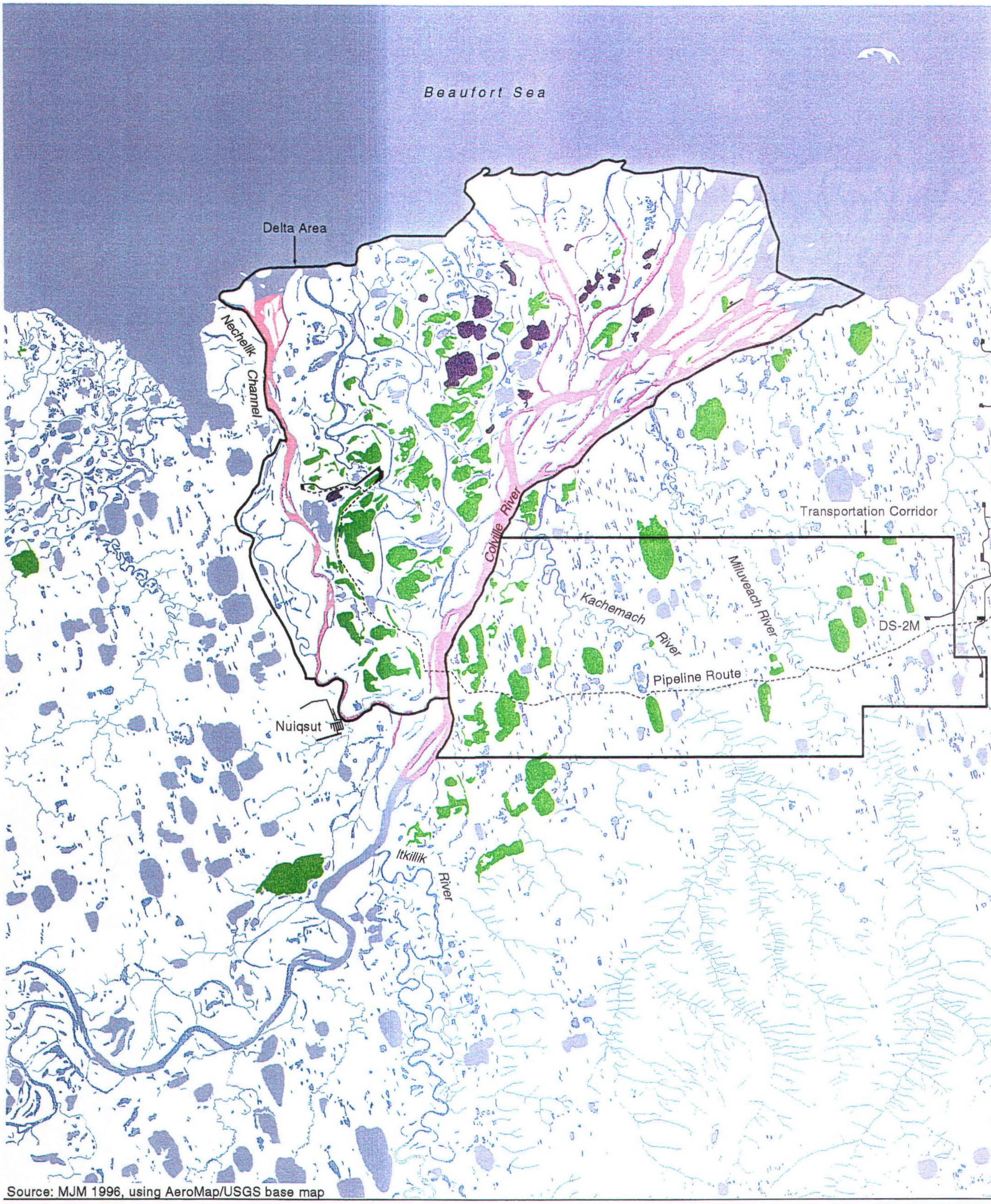
Within the Colville River Delta, arctic cisco are primarily associated with habitats connected to marine waters that show elevated salinities (15-25 ppt) during the late summer or fall (Figure 4.4.1-2). Typically, these habitats are the river channels and tapped lakes (Bendock and Burr 1986; Moulton 1994). Few arctic cisco occur within perched lakes. Arctic cisco represented 3% of the catch in perched lakes during both summer of 1985 and in the fall from 1991 to 1993 (Bendock and Burr 1986; Moulton 1994). Sampling of perched lakes within the project in-field facilities vicinity, in 1995, yielded two arctic cisco during summer sampling using fyke nets and no fish during fall sampling with gillnets (see Table 4.4.1-4). The few arctic cisco found in perched lakes likely became stranded after entering the lakes during high water.

Arctic cisco in the Colville River originate from spawning stocks in the MacKenzie River (Gallaway et al. 1983, 1989; Moulton 1989; Fechhelm and Griffiths 1990). Young-of-the-year arctic cisco from the MacKenzie River Delta move westward into the Alaskan Beaufort Sea during late July to early August, particularly during years with predominantly easterly winds (Fechhelm and Fissel 1988; Fechhelm and Griffiths 1990; Schmidt et al. 1991). During their first fall in the Alaskan Beaufort Sea, the young fish reaching the Colville River Delta return to overwinter in the delta for the next 7 to 8 years. The summers are spent feeding in coastal waters. The strength of the westward migration appears to depend highly on the duration and intensity of easterly winds during July and early August (Fechhelm and Griffiths 1990). Recruitment of young into the Colville River Delta is strong in years with persistent easterly winds, but low in years with more westerly winds. This pattern creates extreme cycles of abundance for this species in the Colville region, which is reflected in the catch patterns when the fish reach harvestable size. At maturity, the surviving arctic cisco migrate back to the MacKenzie River to spawn.

__Least Cisco (Iqalusaaq)__. Least cisco are abundant throughout the Colville River drainage and coastal plain lakes and streams (Bendock 1979b, 1982; McElderry and Craig 1981; Bendock and Burr 1984a, 1986; Moulton 1994). Some least cisco populations are anadromous, while others never leave fresh water. The least cisco was the most abundant species in lakes within the delta (Bendock and Burr 1986) and coastal plain lakes and streams north and west of the Colville River (McElderry and Craig 1981; Bendock 1982; Bendock and Burr 1984a,b). Least cisco were the dominant fish in perched lakes, representing nearly 90% of the catch (Tables 4.4.1-4 and 4.4.1-5).

The lake-dwelling least cisco exhibits at least three growth forms: a large form (Cohen 1954; Wohlschlag 1954; Lawrence et al. 1984), a form showing growth similar to the anadromous population, and a stunted form (Moulton 1994). The anadromous form is most common and occurs in frequently flooded lakes. This form likely represents immigrants from the anadromous population. The stunted form is the least common, having been identified from about four lakes (Moulton 1994, 1995 project data). The large lacustrine form occurs in perched lakes that are infrequently flooded. This form demonstrates a rapid growth rate compared to the other forms, reaching over 13 inches (330 millimeters [mm]) in length by age 11, compared to lengths of less than 10.8 inches (275 mm) and between 10.8 to 13 inches (275-330 mm) for the stunted and anadromous forms at the same age (Moulton 1994).

During summer, least cisco are one of the three most abundant species (along with arctic cisco and Dolly Varden char) in the nearshore coastal areas and lagoons in Harrison Bay and east of the Colville River Delta (Kogl 1971; Furniss 1975; Craig and Haldorson 1981; Dew 1983; Schmidt et al. 1983; Moulton and Fawcett 1984; LGL Alaska 1994). There is a gradation in size, with the younger fish remaining near the delta and the sequentially older fish ranging more widely along the coast as they increase in size. For example, least cisco occurring in minor channel and tapped lake habitat in 1995 were almost all juveniles; few exceeded 10 inches (250 mm) (Figure 4.4.1-3). Juveniles staying within or near the delta during summer are a dominant component of fish populations within the delta. In



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SCALE IN MILES

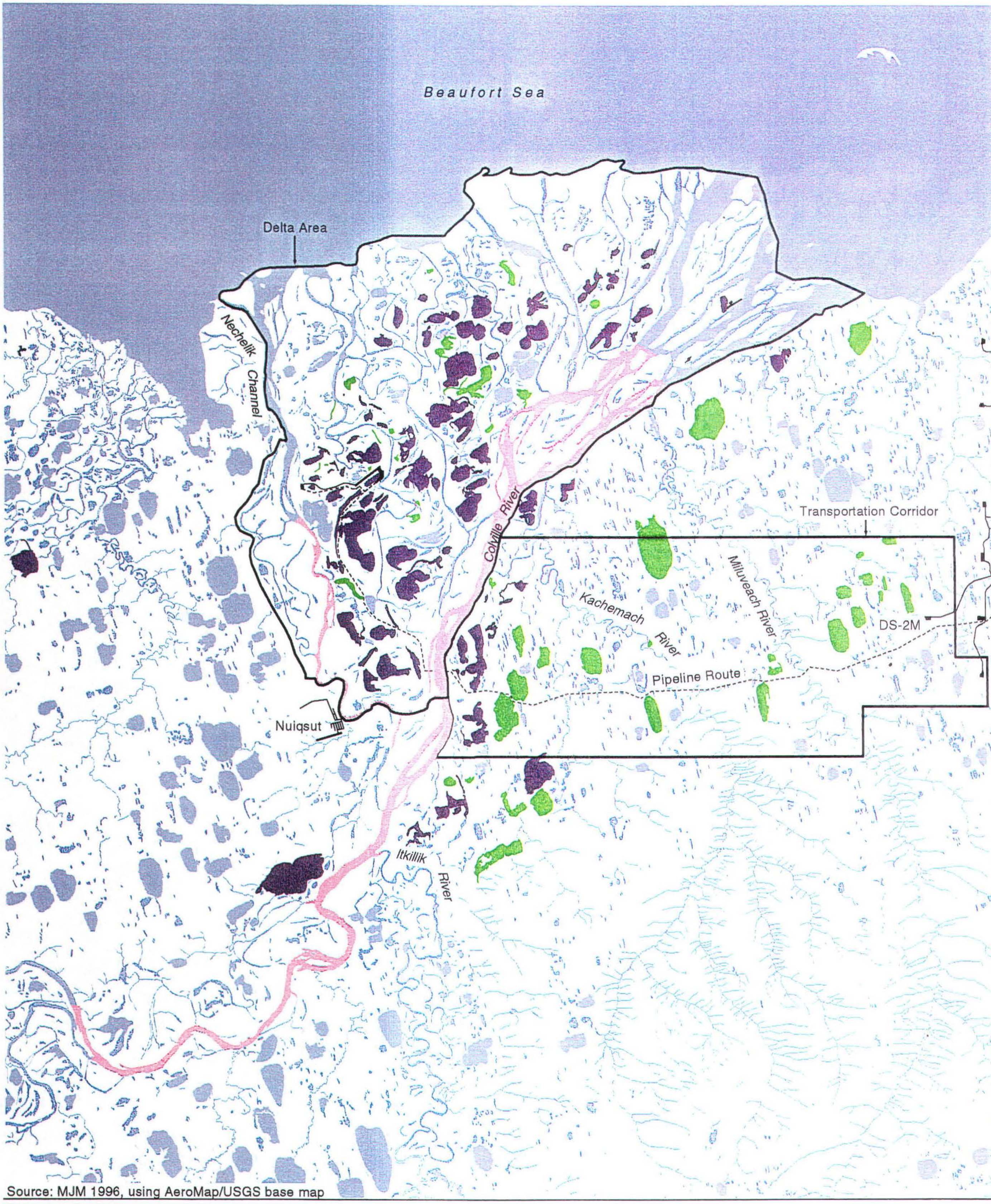
0 3 6

Sampled, Arctic Cisco Caught

Sampled, None Caught

Fall and Winter

Figure 4.4.1-2.
Arctic Cisco Distribution



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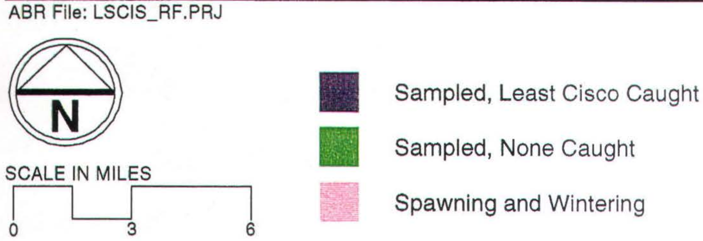
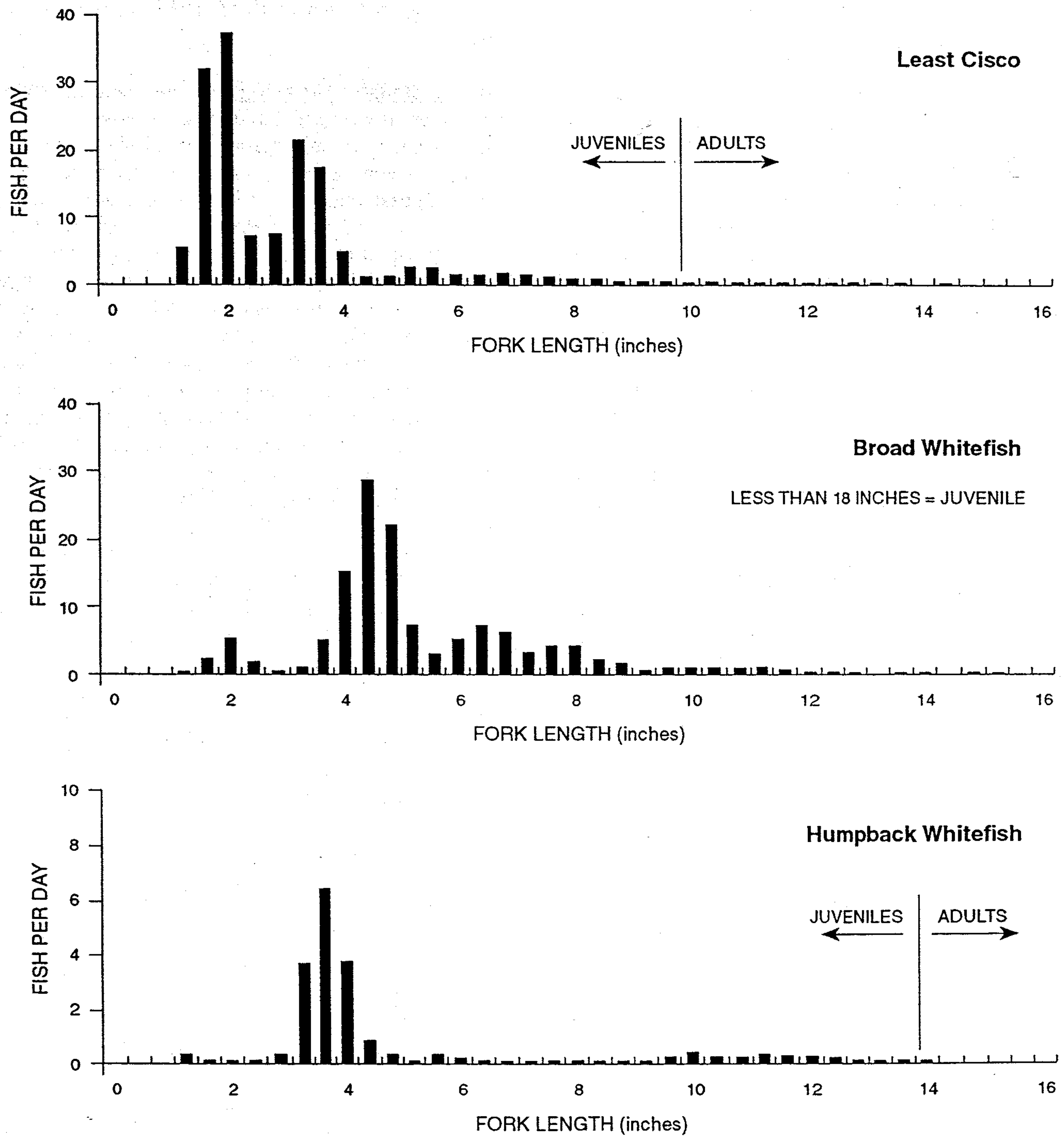


Figure 4.4.1-4.
Least Cisco Distribution



Source: Moulton 1996

Figure 4.4.1-3.
Length Frequencies of Least Cisco, Broad Whitefish and Humpback Whitefish Caught by Fyke Net From Tapped Lake and Minor Channel Habitat Within the 1995 Study Area (July 9-August 4)

1985, least cisco represented 60% of the anadromous fish caught in the major channels of the outer delta and 48% of the catch in major channels of the lower river (Fawcett et al. 1986).

During the same year, Bendock and Burr (1986) reported least cisco were the most numerous fish captured in the lower 60 mi of the Colville River. Anadromous least cisco are also abundant in the minor channels, comprising 38% of the fish sampled in this habitat within the project area during summer 1995 (see Table 4.4.1-4). Similarly, least cisco represented 35% of the catch in tapped lakes.

Least cisco spawn in the Colville River, channels, and perched lakes of the delta during fall. Anadromous least cisco return to the Colville River Delta in August and September to spawn and overwinter (Figure 4.4.1-4). The lower Colville River (between Itkillik River and Ocean Point) and delta apparently contain the most important spawning areas for anadromous least cisco (McElderry and Craig 1981). Least cisco spawn in fresh water in late September to early November (Morrow 1980; Moulton and Field 1988, Moulton 1994). As many as 75 to 86% of the least cisco collected downstream from Ocean Point in late summer and fall were ripe or spent (Alt and Kogl 1973; McElderry and Craig 1981). Spawning least cisco were in the channel near Nuiqsut during early October in 1985 to 1987 (Moulton and Field 1988). Least cisco populations within the perched lakes spawn at a similar time with pre-spawning, ripe, and spent fish observed in late October through early November (Moulton 1994, 1995 project data). In fall 1995, 67% of the males and 51% of the females of age 6 or greater sampled in perched lakes were in spawning condition, indicating these lakes supported reproducing populations.

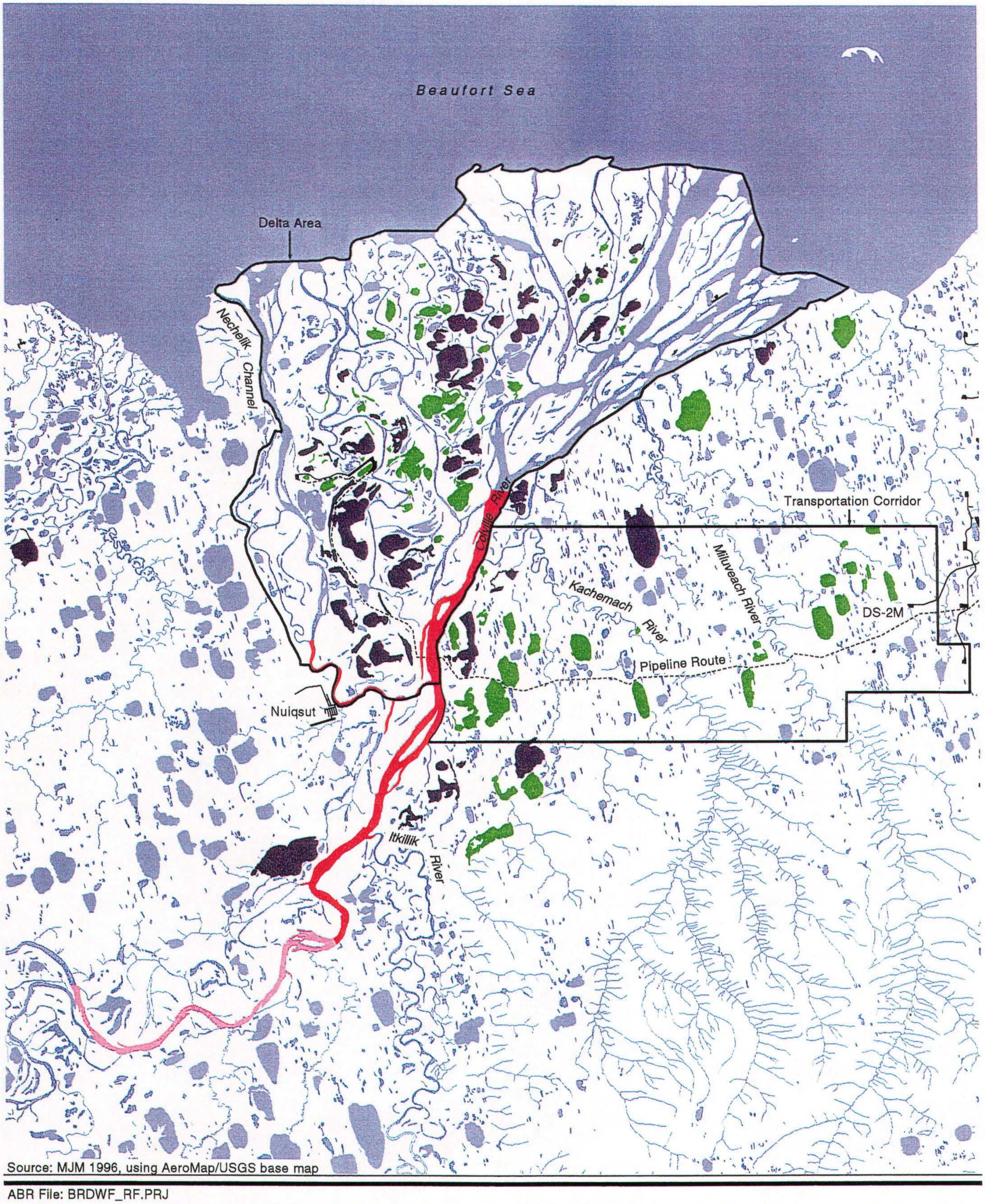
During winter, least cisco appear to use water with lower salinity than do arctic cisco, and they may move upstream to avoid high-salinity water (greater than 20 ppt). They appear to be most abundant in water with salinity less than 15 ppt (Moulton and Field 1988).

Following break-up, anadromous least cisco move from overwintering areas in the river and delta into feeding areas in the brackish coastal waters of Harrison Bay, Simpson Lagoon, and eastward past Prudhoe Bay and the Sagavanirktok River (Craig and Haldorson 1981; Griffiths et al. 1983; Moulton et al. 1986b; Cannon et al. 1987; LGL Alaska 1994). They return to the Colville River Delta around the third week of August (Moulton and Fawcett 1984; Fawcett et al. 1986).

Broad Whitefish (Anaakliq). During summer, broad whitefish are distributed throughout the Colville River drainage and coastal plain waterbodies and are common in coastal waters near the Colville River Delta. Highest abundances in coastal marine waters are near river deltas (Furniss 1975; Griffiths et al. 1983; Schmidt et al. 1983; Moulton and Fawcett 1984; Moulton et al. 1986b), although tag returns show large fish move at least between the Colville River and Prudhoe Bay region. Broad whitefish show a strong preference for nearshore habitats when in coastal waters, appearing only rarely in offshore or barrier island locations (Craig and Haldorson 1981; Moulton et al. 1986b). During the open-water season, broad whitefish also occur in the major and minor channels and main tributaries of the Colville River (Kogl and Schell 1974; Bendock 1979b, 1982; Bendock and Burr 1984a, 1986; Fawcett et al. 1986). Juvenile broad whitefish rear in minor channels, tapped lakes, frequently flooded perched lakes, and other low velocity areas throughout the lower river and delta.

Broad whitefish were the second most abundant fish caught in major channels in 1985, representing 15% of the anadromous fish caught in the outer delta region and 18% in the lower river (Fawcett et al. 1986). During the same year, they were also the second most abundant fish caught throughout the lower river and delta (Bendock and Burr 1986). During 1995 sampling within the project area, broad whitefish were the second most abundant species caught in minor channels (32% of the catch) and the most abundant species in tapped lakes (42%) (see Table 4.4.1-4). These habitats appear to represent important rearing areas, because all broad whitefish caught in minor channels and tapped lakes were juveniles, with none exceeding about 16 inches (400 mm) (see Figure 4.4.1-3). Broad whitefish typically reach maturity at around 18 inches (450 mm) or greater (Fawcett et al. 1986). The larger fish are associated with major channels.

Following a summer of foraging in coastal and delta areas, broad whitefish migrate upstream to overwinter and spawn in major channels during September and October (Figure 4.4.1-5). Most spawning likely occurs upstream of Ocean Point, although some broad



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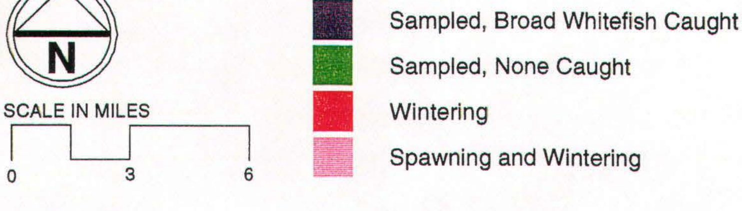


Figure 4.4.1-5. Broad Whitefish Distribution

whitefish spawn within the delta (Kogl and Schell 1974; Bendock and Burr 1986). Age at first maturity is 9, with most of the fish maturing around ages 10 to 12 (Bendock and Burr 1984b, 1986).

The main overwintering areas are likely upstream from the Itkillik River (see Figure 4.4.1-5). Most broad whitefish leave the delta after ice forms and likely move upstream beyond the influence of salt water. Few broad whitefish are caught in the delta during fall, with the highest catches occurring in early October and decreasing rapidly thereafter as salinity levels increase (Moulton and Field 1988).

Humpback Whitefish (Piquktuuq). Humpback whitefish occur throughout the lower Colville River and delta during the open-water season, with some portion of the population feeding in the coastal waters. A few humpback whitefish move through Simpson Lagoon to Prudhoe Bay during the summer feeding period (Craig and Haldorson 1981; Moulton et al. 1986b; LGL Alaska 1994).

Humpback whitefish reside within the delta throughout the year. During summer, they are abundant in major channel habitat. For example, during 1985, humpback whitefish comprised 35% of the catch (second in abundance) of anadromous fish in major channels of the lower river and 9% of the catch (fourth in abundance) in major channels of the outer delta (Fawcett et al. 1986). Humpback whitefish were the fifth most abundant fish caught in the delta during the same year, accounting for 11% of the catch (Bendock and Burr 1986). In contrast, humpback whitefish appeared to be less abundant in minor channels and tapped lakes within the project area in 1995, representing 5 and 6% of the catch, respectively. As with least cisco, few large humpback whitefish were within minor channel and tapped lake habitat (see Figure 4.4.1-3), indicating that these areas are not heavily used for migration or spawning. Mature humpback whitefish generally exceed 14 inches (350 mm) (Fawcett et al. 1986); this is the upper end of the size range observed in the project area in 1995.

During fall, humpback whitefish spawn in the upper Colville River (upstream from Umiat) (Alt and Kogl 1973; Bendock 1979b; Kogl and Schell 1974). Spawning also occurs in the major channels of the Colville River Delta and lower river at the same time (Figure 4.4.1-6; Kogl and Schell 1974). Humpback whitefish may be the most abundant species in some Colville River Delta channels during the spawning season, with higher abundance in the deeper Kupigruak Channel than in the East Channel (Kogl and Schell 1974). As with broad whitefish, the age at first maturity is 9, with most fish maturing at ages 10 to 12. Humpback whitefish likely overwinter in major channels throughout the lower Colville River and delta (see Figure 4.4.1-6). Adult humpback whitefish, including spent fish, are regularly captured near the confluence of the Kupigruak and East Channels of the outer delta in October and November. It is not known if these fish winter here or if they move upstream as salinity increases in the delta.

Humpback whitefish use of coastal habitats outside the Colville River Delta is relatively small compared to cisco and broad whitefish. While many use the outer portion of the delta and the shallow water of Harrison Bay, few humpback whitefish move east of Oliktok Point (Moulton and Fawcett 1984; LGL Alaska 1994).

This species was present but not a dominant species in minor channel, tapped lake, and drainage lake habitats during 1995 sampling in the project area (see Table 4.4.1-4). Few were caught in perched lakes (see Figure 4.4.1-6).

Dolly Varden Char (Iqalugaaq). Dolly Varden char are distributed widely in the Colville River drainage, including major and minor tributaries and lakes upstream from and including the Anaktuvuk River (Kogl 1971; Bendock 1979b; Morrow 1980). The anadromous Dolly Varden uses major channels along the east side of the delta to move between feeding, overwintering, and spawning areas. Residence time within the delta and lower river is low, likely on the order of several days or less because of the migratory nature of this species. During 1985, char comprised 2% of the anadromous fish caught in the lower river and less than 1% of the catch in the delta (Fawcett et al. 1986). This species has not been caught within the project area, but migrates in channels crossed by the pipeline alternatives.

Dolly Varden char overwinter far upstream of Ocean Point in spring-fed mountain streams. Following break-up in June, they move rapidly to coastal waters to feed along the barrier islands. Pre-spawning adult char return to the river in early to mid-August, with

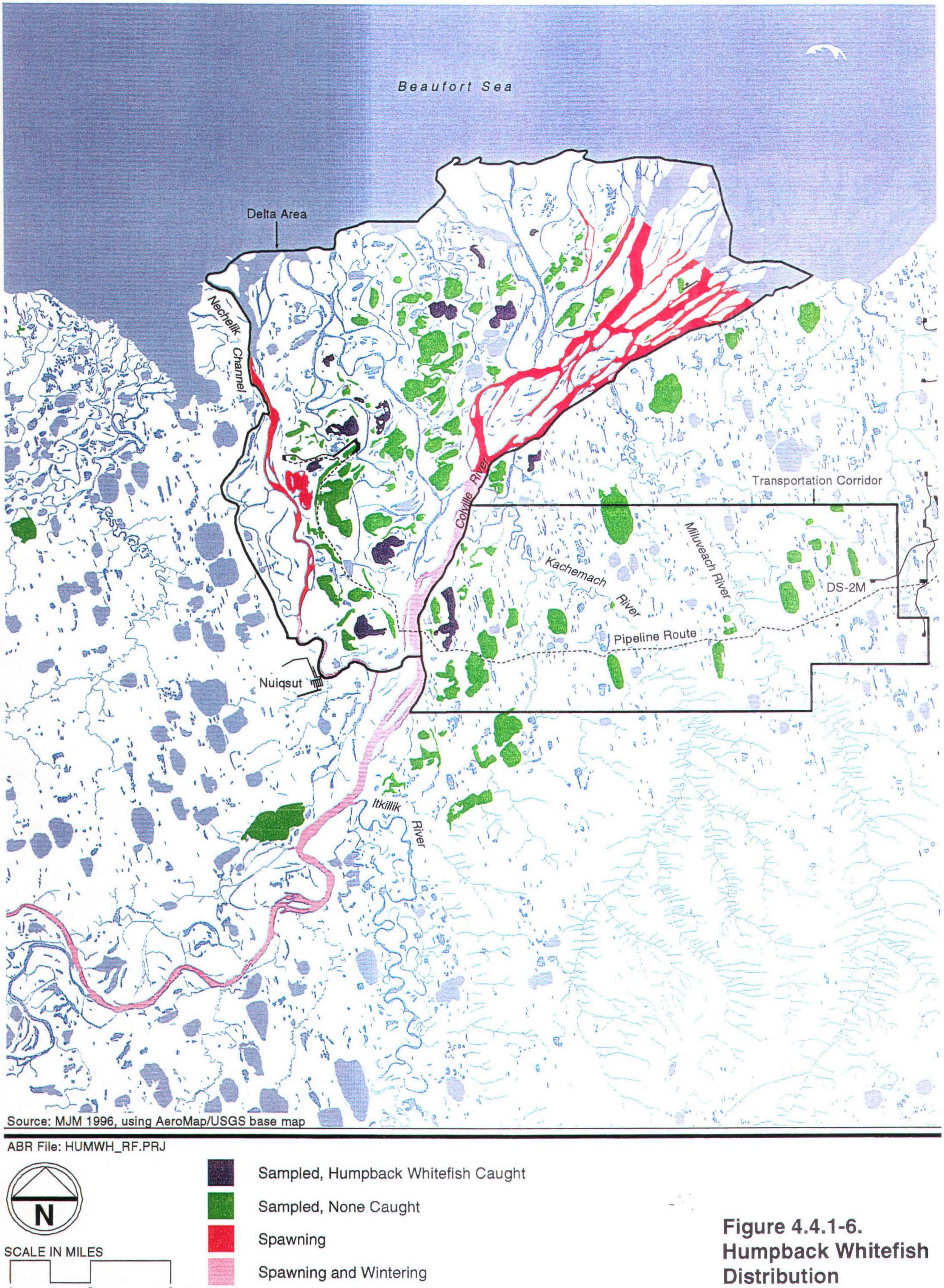


Figure 4.4.1-6. Humpback Whitefish Distribution

non-spawning adults and juveniles returning later in August and early September.

Rainbow Smelt (Ilhuağniq). The rainbow smelt is an anadromous species that inhabits marine waters most of its life, in contrast to cisco and whitefish that enter the delta to overwinter. The Colville River apparently supports a substantial population of rainbow smelt because they are often abundant in samples taken from, in, and adjacent to the Colville River Delta throughout the year (Craig and Haldorson 1981; Dew 1983; Moulton and Fawcett 1984; Fawcett et al. 1986).

During winter, rainbow smelt inhabit major and minor channels of the Colville River Delta (Figure 4.4.1-7). They become abundant in major channels of the Colville River Delta, when salinity increases beyond about 20 ppt and are often caught incidentally during the fall fishery. They appear to move in and out with higher salinity water and are rarely caught when salinity is below 15 ppt. Most of the rainbow smelt population likely remain outside the delta in Harrison Bay, as evidenced by high smelt catches during the winter near Thetis Island (Craig and Haldorson 1981). Rainbow smelt are also caught in minor channels and tapped lakes during summer, but their numbers are relatively small (see Tables 4.4.1-4 and 4.4.1-5).

In contrast to other anadromous fishes in the arctic, rainbow smelt spawn in spring (Morrow 1980). Spawning fish move from marine water into the Colville River Delta when break-up occurs or while ice is still present (Morrow 1980; Craig and Haldorson 1981; Haldorson and Craig 1984). Specific spawning areas for rainbow smelt are not known in the Colville River but are likely near the mouths of streams or tapped lakes that are connected to both major and minor channels or other similar areas containing pockets of clean sand or gravel (see Figure 4.4.1-7). Many larval rainbow smelt were caught in tapped lakes within the proposed in-field facility vicinity in 1995, indicating that spawning and incubation had likely occurred in or near the lakes sampled.

Rainbow smelt in the Colville River are slow-growing and long-lived compared to populations in more southerly locations, reflecting the generally lower productivity of northern populations. Males mature at age 5 and females at age 5 to 7, compared to age 2 on the east coast of Canada and Maine. Rainbow smelt in the Colville River reach 15 years of age (Craig and Haldorson 1981; Haldorson and Craig 1984) compared to maximums of 5 to 6 years in southern populations.

Description of Freshwater Species Used by Subsistence Users

Arctic Grayling (Sulukpaugaq). The arctic grayling is one of the most abundant and widespread species found in the Colville River upstream from the confluence of the Nechelik (Nigliq) Channel and the main channel. Grayling are abundant in the main channel, major and minor tributaries, and lakes (Bendock 1979b; Kogl 1971). They are caught incidentally in coastal waters, usually in early summer during periods of low salinity (Craig and Haldorson 1981; Dew 1983; Moulton and Fawcett 1984).

Within the project area, arctic grayling were most abundant in drainage lakes and tributaries within the transportation corridor (see Table 4.4.1-4, Figure 4.4.1-8). Small numbers of grayling were caught in minor channels, tapped lakes and perched lakes within the transportation corridor. They were not captured from perched lakes in or near the facilities area.

Arctic grayling spawn in tributaries throughout the Colville River drainage. Spawning occurs between mid-June and mid-July. Age at first maturity is 4 to 6 years (Bendock and Burr 1984b). Spawning occurs in the Kachemach and Miluveach rivers within the transportation corridor, as evidenced by an abundance of young-of-the-year arctic grayling in July and August (Moulton 1980; 1995 project data).

Arctic grayling overwinter in the mainstem of the Colville River, often near the mouths of tributary streams. Overwintering is primarily upstream from the delta region, since arctic grayling avoid saline water.

Burbot (Tittaaliq). Burbot are abundant in the lower Colville River (Bendock 1979b) and also in the delta throughout the year (Furniss 1974; Kogl and Schell 1974; Bendock 1979b). Burbot are rarely reported in coastal waters, apparently because they do not tolerate high salinity (Griffiths and Gallaway 1982; Moulton et al. 1986b).

Adult burbot do not appear to be in or near the in-field facilities location. In 1995, 18 burbot, all juveniles (4 to 10 in, or 100 to 260 mm), were captured in minor channels and tapped lakes, but not perched or drainage

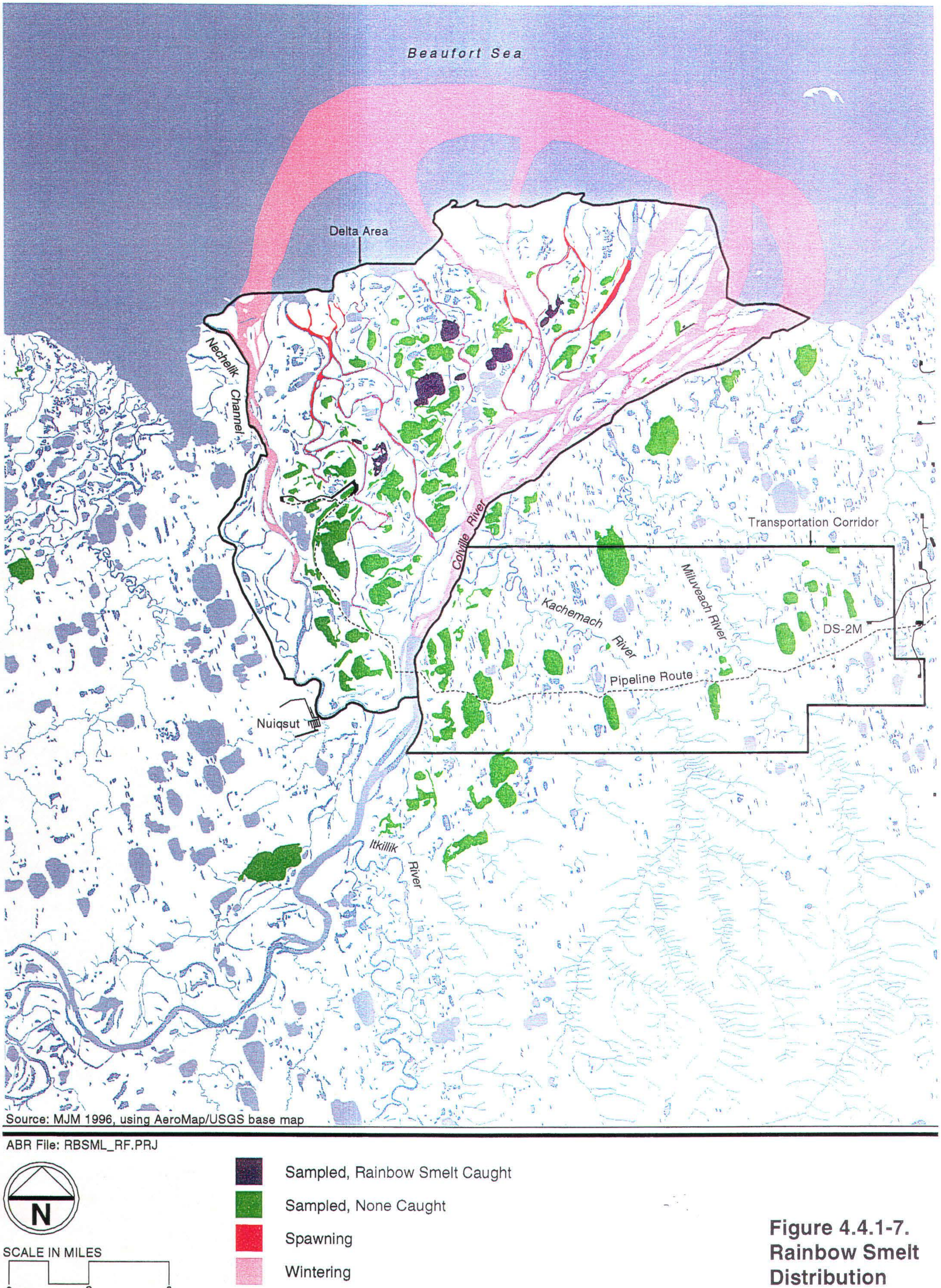


Figure 4.4.1-7. Rainbow Smelt Distribution

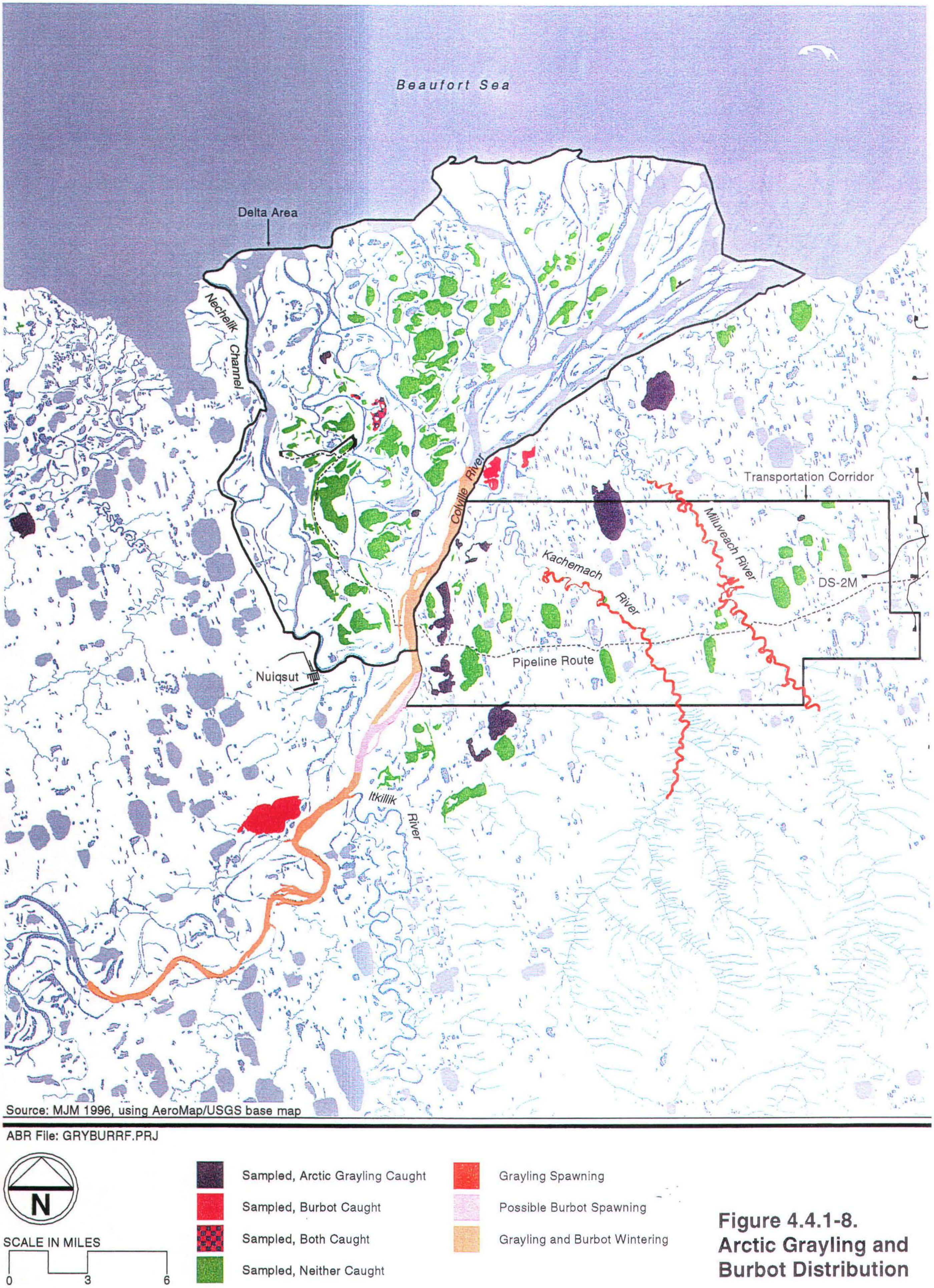


Figure 4.4.1-8. Arctic Grayling and Burbot Distribution

lakes (see Figure 4.4.1-8). Adults (20 to 33 inches, or 500 to 840 mm) were captured only during fall in major river channels near the alternative pipeline crossings.

Burbot overwinter in deep holes along the main Colville River and near tributary mouths where other species congregate. Spawning occurs in mid-winter, probably January and February. One area near Nuiqsut, fished through winter, may represent both a spawning and overwintering area, since large burbot are consistently caught there in mid-winter (see Figure 4.4.1-8).

Harvest Levels

Fish populations within the Colville River Delta and lower river are harvested by sport, commercial, and subsistence fishers. The sport harvest is currently light and essentially undocumented (Howe et al. 1995). Commercial fishing has been conducted since the 1950s by the Helmericks family. Subsistence fishing along the Colville drainage has been conducted for many generations. One of the first written descriptions of the subsistence fishery was by Stefansson (1913), who observed local residents harvesting fish at the mouth of the Itkillik River in 1909.

Commercial Fishery. Commercial fishing, which was originally conducted on the Nechelik (Nigliq) Channel, is now confined to the eastern portion of the outer delta (Figure 4.4.1-9). The fishery operates under a harvest quota of 50,000 ciscos and whitefish. The fishery targets the arctic cisco, which is the most desirable species, because it commands a higher price than the other species and is concentrated in the outer delta after fall freeze-up. The timing of the fishery is important because fish can be quickly frozen by placing them on the ice. Over the last ten years, the harvest has averaged 22,500 arctic cisco, although variation around this average is substantial (Table 4.4.1-6). Much of the variation is caused by variability in recruitment of young fish from the MacKenzie River, as discussed above. Least cisco are a by-catch of the arctic cisco fishery, with a ten-year average catch of 12,985 fish. There is little market for the least cisco and most are shipped to Fairbanks for use as dog food. Humpback whitefish and broad whitefish are taken in smaller numbers during most years; there is little market for them.

Subsistence Fishery. Subsistence fishing occurs throughout the year. Broad whitefish are harvested through summer as they move between feeding areas and migrate towards spawning grounds (Moulton et al. 1986a). The pre-spawning females are fished until freeze-up, and they are highly prized by the Native people. An estimated 4,000 to 8,000 broad whitefish were harvested in 1985, the only year that detailed studies were conducted of the summer fishery (Craig 1987). Arctic grayling, Dolly Varden char, and salmon (mostly pink and chum salmon) are also part of the summer harvest. About 4,000 grayling, 1,000 char, and 400 salmon were harvested in 1985. Most fishing occurs on the main channels, including the Nechelik (Nigliq) Channel. Gill nets are the preferred fishing gear, although many grayling are taken by hook and line.

The fall subsistence fishery is conducted after freeze-up primarily along the Nechelik (Nigliq) Channel, although some people also fish the outer delta (Moulton 1995). As in the commercial fishery, subsistence fishers target arctic cisco and incidentally harvest least cisco, broad whitefish, humpback whitefish, and rainbow smelt. During the last ten years, the average annual subsistence harvest of arctic cisco (24,284 fish) has been similar to the commercial harvest (see Table 4.4.1-6), and the harvest of least cisco (6,831 fish) has been about half the commercial harvest. Fish are caught in gill nets set under the ice.

There is a small winter fishery for burbot. One popular location is the east side of the main Colville River slightly upstream from the head end of the Nechelik (Nigliq) Channel. Burbot annually gather here in mid- to late winter. They also occur at other locations along the main channel, where they are harvested almost year-round. Craig (1987) reports 570 burbot were harvested in 1985. Burbot are fished with hook and line.

4.4.1.2 Environmental Consequences

Impacts of the Proposed Action (Alternative #2)

Critical factors necessary to maintain fish populations include adequate wintering areas, suitable feeding and spawning areas, and the ability to access these areas—since they are often in different geographical locations. For example, drainage and low perched lakes provide overwintering and rearing areas for broad

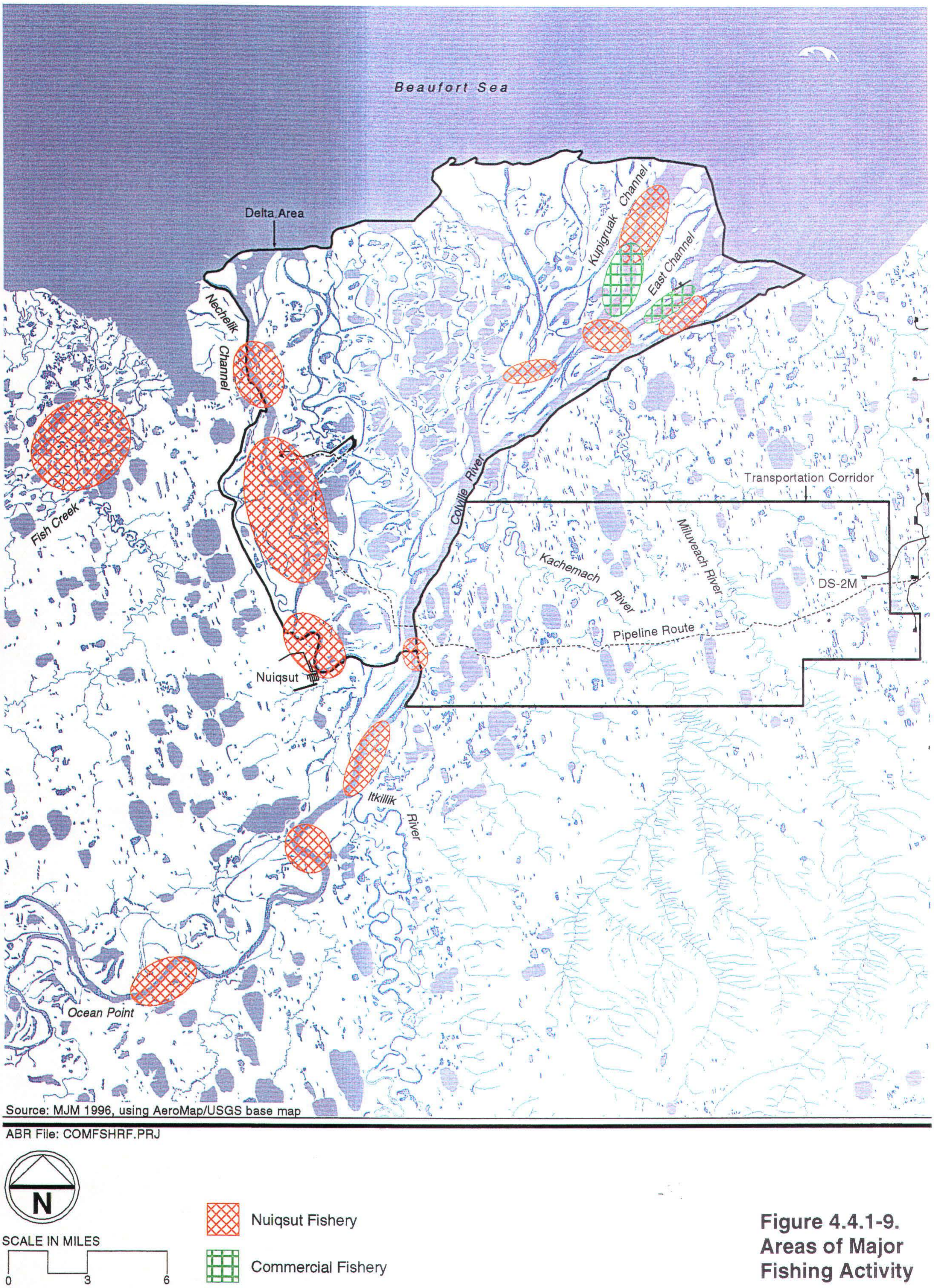


Figure 4.4.1-9. Areas of Major Fishing Activity

Table 4.4.1-6. Harvest of arctic cisco and least cisco in the fall gill net fisheries conducted within the Colville River Delta.

Year	Arctic Cisco Commercial Harvest	Arctic Cisco Nuiqsut Harvest	Arctic Cisco Total Harvest	Least Cisco Commercial Harvest	Least Cisco Nuiqsut Harvest	Least Cisco Total Harvest
1967	21,904			15,982		
1968	41,948			19,086		
1969	19,593			35,001		
1970	22,685			30,650		
1971	41,312			23,887		
1972	37,101			12,183		
1973	71,575			25,191		
1974	44,937			14,122		
1975	30,953			22,476		
1976	31,659			37,046		
1977	31,796			14,961		
1978	18,058			25,761		
1979	9,268			25,097		
1980	14,753			30,982		
1981	38,176			15,504		
1982	15,975			27,085		
1983	18,162			37,909		
1984	27,686			13,076		
1985	23,678	46,681	70,359	17,383	15,814	33,197
1986	29,595	33,523	63,118	9,444	6,805	16,249
1987	27,948	20,847	48,795	11,930	6,114	18,044
1988	10,470	6,098	16,568	23,196	2,320	25,516
1989	24,802	12,892	37,694	19,595	6,035	25,630
1990	21,772	11,224	32,996	17,064	9,100	26,164
1991	23,731	8,269	32,000	7,743	3,193	10,936
1992	22,754	45,401	68,155	7,284	2,659	9,943
1993	31,310	46,944	78,254	6,037	7,599	13,636
1994	8,958	10,956	19,914	10,176	8,669	18,845
Average 1985-1994:	22,502	24,284	46,785	12,985	6,831	19,816

Source: Moulton (1995).

whitefish, but spawning occurs within the river channel. Broad whitefish must have access to and from the lakes on a predictable basis to efficiently use them. Similarly, drainage and low perched lakes contain populations of least cisco that are likely extensions of the anadromous population. Least cisco likely enter and leave these lakes on an annual basis but may also reside year-round and spawn within them. Arctic grayling that use drainage lakes, particularly in the transportation corridor, need access to stream spawning areas in spring and may move to the major channels of the Colville River for wintering. In contrast, high perched lakes have resident populations of least cisco that complete their entire life cycle within the lake.

The primary concern with fish populations within the delta or transportation corridor is maintaining overwintering habitat, which is the most critical habitat to arctic fishes (Craig 1989). The next highest priority is to maintain access to the other seasonally used habitats. Key issues related to fish populations and habitats within the project area include: (1) water withdrawal; (2) alteration of flow patterns; (3) release of contaminants during the life of the project; and (4) oil spill.

Water Withdrawal. During both construction and operation, water will be needed for building ice roads, drilling, and camp operation. Because the project does not have a permanent road, ice roads would be built during the construction period and then as needed for operational support and maintenance. Since these activities necessarily remove water from lakes, the volume of water available for overwintering fish habitat would be reduced. **Potential water source lakes with and without fish populations are provided in Appendix K, Issue 5.**

There is a perched lake near the camp and processing area that will likely be used as a freshwater reservoir. The lake, L9313, is 12 to 14 ft deep, contains 10,183,033 **ft** more than the 3 million ft^3 of water needed to service the in-field facilities, and has produced the lowest catches of evaluation species (five least cisco were captured during summer fyke net sampling, none during gillnet sampling in the fall) compared to other nearby lakes. Water withdrawals from this lake will have the lowest impact on fish.

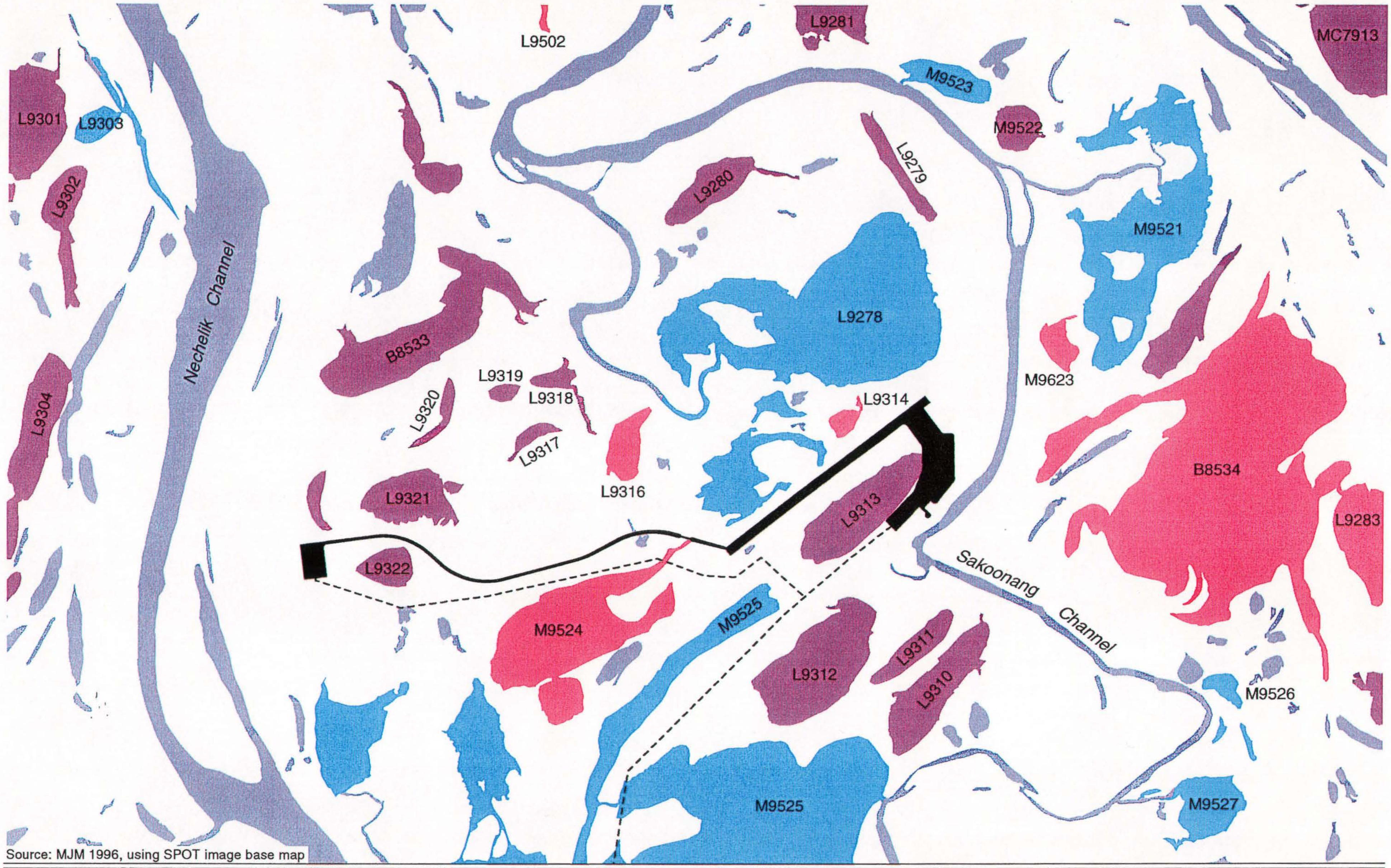
Five perched or drainage lakes in the transportation corridor are potential water sources for building ice roads and pads. They have a combined 4.13 million gallons of water. All these lakes are on the eastern bank along the Colville River near the proposed pipeline crossing. An additional nine perched lakes on the west side of the Colville River, between the facilities area and the main channel, contain approximately 36 million gallons of water.

Water **removal from lakes** could potentially affect the fish populations. Water removal is especially critical in late winter, when water volumes are lowest under the ice cover and water quality and dissolved oxygen concentrations are low. Excessive water withdrawal or disturbance at this time could potentially eliminate fish populations in these lakes.

Alteration of Flow Patterns. Flow patterns are altered when roads are constructed across wetlands and streams, or the stream beds are altered through construction activities. Fish migrate into and out of lakes during or shortly after break-up when wetlands are flooded. There is rarely a defined channel connecting the perched lakes to the river channel. Often the connection is through a low-lying wetland. Changing the flow patterns could prevent fish access to some habitats.

The facilities area contains seven perched lakes, adjacent to or downstream from the proposed **drill** pad locations, that could alter flow patterns (Figure 4.4.1-10). Six of the lakes contain fish, with five containing least cisco, **four containing broad whitefish** and one (M9524) humpback whitefish. The likely dispersal route of cisco and whitefish to the lakes **in the western portion of the project area and lakes connected by the swale passing from Nanuk Lake to Lake L9378** is through drainage areas crossed by the road. Whitefish enter the lakes as juveniles and remain there until reaching maturity in 8 to 10 years. At that time, the mature adults return to the river, most likely during high water at break-up. Least cisco from the anadromous population also enter low perched lakes at this time. Thus, any changes in flow patterns that disrupt the migration route, particularly during break-up, could reduce the number of whitefish and cisco entering or leaving the lakes for the duration of the project. The lowest fish densities appear to be in the lake nearest to **in-field** facilities, lake L9313. Fyke net sampling in summer 1995 caught five least cisco, while gill net sampling in fall 1995 did not catch fish. Since the lake appears to support marginal populations of fish other than ninespine stickleback and Alaska blackfish, impacts to fish in perched lakes will likely be minor.

Chronic Release of Contaminants. Any industrial site has the potential over time to release contaminants into the environment through low-level spills. Such releases can build up contaminant levels and impair the productivity of the receiving environment. In addition, contaminants can be incorporated into the food web. The proximity of the drill pad(s), airstrip, and gravel road increases the chances of spilled contaminants entering nearby waterbodies and aquatic food chains. **Information on baseline levels of metals in broad whitefish was obtained in the summer of 1997 and is currently being analyzed.**



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Habitat Types

- Perched Lake (frequent flooding)
- Perched Lake (infrequent flooding)
- Tapped Lake

SCALE IN MILES
0 0.5 1

N

Proposed Project

- In-field Facilities
- --- Pipelines

Figure 4.4.1-10.
Lakes Adjacent to Project Facilities, by Fish Habitat Classification

Impacts of the Alternatives #3 - #8

Field Development. Impacts from the various in-field facility layout alternatives would be similar to the proposed project, except for those with the airstrip in Nuiqsut and a gravel road connecting the in-field facility to Nuiqsut (#6 - #8). Using the airstrip in Nuiqsut would reduce the potential disruption of drainage patterns at the facilities because less area would be filled with gravel. However, this benefit would be eliminated by drainage problems created by building the gravel road to Nuiqsut. Consequently, the impacts of the alternative (of roads on fish), would substantially exceed those of the proposed project (#2).

Pipeline Route. Impacts from the different pipeline routes would be similar to the proposed route, except for the alternative with the pipeline buried in a permanent gravel road connecting the Colville River with KRU (#5, #7, #8). The gravel road, which is oriented perpendicularly to the direction of drainage, would substantially alter the drainage pattern in the pipeline corridor, and this could affect fish habitat. Drainage impacts would be exacerbated in the alternatives where the pipeline is in the road (#5, #7, #8) because of the wider road bed and greater difficulty of successfully passing culverted water under a hot oil pipeline buried in the gravel road.

River Crossing. The impacts to fish from the various methods of crossing the river with the pipeline are low, except for trenching and bridge methods. Trenching across the Colville River (#4, #5) would substantially increase turbidity during construction. After construction, the trenched pipeline would increase the risk of introducing oil into the river channel if the pipeline broke. This is the only crossing method that could lead to a winter spill within the river, since under the other options, an oil spill would either end up on the surface of the ice or contained below the river channel (HDD). A winter oil spill from a trenched pipeline could adversely impact overwintering fish species. The cable bridge span (#3) and the vehicular pile-supported bridge options (#7, #8) would have minor impacts to fish populations. However, the span of open pipe across the bridges could break and introduce large volumes of oil into the Colville River. The likelihood of this kind of spill occurring would be higher for the options having multiple channels crossed by bridges (#6 - #8).

Site Access. Impacts to fish caused by site-access alternatives have been addressed in the preceding sections, except for the gravel road without a buried pipeline (#4) and the ferry options (#7, #8). The impacts from these options would be intermediate to the proposed project and the pipeline-buried-in-road method, while the ferry approach would have considerably less impact than building a permanent gravel road. A ferry would require constructing a permanent or break-away dock that would impact near-shore fish habitat. Construction of the dock would also increase turbidity. The dock could attract some fish and expose them to predation. A permanent dock would cause less impact to fish than a break-away dock, because sediment/shoreline disturbance would be confined to one construction season. A gravel road between KRU and the in-field facility (#4, #5, #7, #8) would create a considerably greater impact to fish, because it would alter drainage patterns and potentially affect one perched lake (M9524). Alteration of drainage patterns could disrupt fish movement to and from perched lakes.

4.4.1.3 Mitigation Measures for the Proposed Action (Alternative #2)

Water Source Lakes

Mitigation measures to avoid impacting fish would include monitoring to ensure that the water volume removed from lakes does not exceed amounts allowed by state regulations. In addition, large and deep lakes would be targeted as water sources to guarantee a margin of safety for maintaining sufficient water volumes to minimize impacts to fish.

Alteration of Flow Patterns

The effects of altered flow patterns on fish movements through the road connecting the two pads will be minimized by designing drainage structures to meet fish passage criteria. A complex of bridge and culverts will be used to cross the swale area, and culverts will be used to connect the two lakes and associated wetlands near the western drill pad. Fish passage will be provided in these two areas (also see Section 2.9, Mitigation Measures, and Appendix Q, Hydrology and Drainage Proposal).

Chronic Release of Contaminants

The release of contaminants into the environment can be reduced through a strong commitment to spill control as evidenced through proper training in handling toxic materials, rapid cleanup techniques, and education. Environmental awareness and training programs, as those in place in KRU, would help avoid or minimize the contaminant load to waterbodies in the project area.

4.4.2 Wildlife

The Colville River Delta has been the site of wildlife research conducted during the past 25 years. Smith et al. (1993) provided a chronological overview of these research programs, which have demonstrated that the Colville River Delta is regionally important to birds and mammals. The Colville River Delta is the largest and most complex river delta on the Arctic Coastal Plain of Alaska; it provides high-quality breeding habitats for waterbirds such as the spectacled eider (a threatened species), brant, tundra swan, and yellow-billed loon, as well as other waterbirds, shorebirds, songbirds, and predatory birds. The Colville River Delta provides some of the earliest open-water and snow-free areas for migrating birds during spring. The extensive salt marshes and mudflats on the delta are used by geese and shorebirds as staging areas during fall migration and by many other birds during spring and summer, but by only a few species year-round. The delta is also used seasonally by caribou for foraging and insect-relief habitat, and by foxes and polar bears for denning habitat. Many of these wildlife resources are hunted by local residents (primarily Iñupiat Eskimos) as an essential element of their subsistence lifestyle.

ARCO has sponsored a research program every year since 1992 to establish a baseline of data on wildlife use of the Colville River Delta (Smith et al. 1993, 1994; Johnson 1995; Johnson et al. 1996, 1997); the 1994 research program was limited to spectacled eider surveys. In 1992 and 1993, ARCO, in consultation with the USFWS and ADFG, selected the following focal wildlife species for detailed study: spectacled eider, tundra swan, brant, yellow-billed loon, caribou, and arctic fox. Criteria for selection included threatened or sensitive status, regional importance of the Colville River Delta as breeding habitat, or special agency concern. Other species recorded while conducting surveys of the above-mentioned species, included greater white-fronted goose, king eider, Pacific loon, red-throated loon, muskox, grizzly bear, and red fox. Key issues of concern for these and other wildlife species include potential loss or degradation of rare, high-use habitats; displacement; and disturbance of important life-cycle events. The following sections discuss the results of the studies conducted since 1992, combined with additional information from the scientific literature and agency contacts.

4.4.2.1 Affected Environment

Wildlife Habitats and Wetlands

The project area contains a diverse array of habitats used by wildlife for feeding, breeding, and shelter. The habitats also provide other important ecological functions. Wetlands are particularly important because of their influences on surface- and ground-water hydrology, water quality, bird nesting and feeding, and fish production. Estuarine wetlands produce nutrients that are exported to marine and river systems where they provide food for a wide variety of plants and animals. River channels serve as transportation corridors for hunting, fishing, and recreation. The habitat types in the project area constitute a complex mosaic of biological communities that support a rich diversity of plant and animal resources.

Twenty-four habitat types were classified in the project area (Johnson et al. 1996), based on the ecological land classification developed by Jorgenson et al. (1997b). That classification system integrates terrain features (surface geology), surface-forms (related to ice content), and vegetation (plant assemblages [Viereck et al. 1992]) into ecological types for classifying the landscape. The 24 habitat types were derived from a larger number by combining habitats with similar functions or life-forms relative to their use by wildlife.

Habitats were described (Appendix I-1, Table 1), quantified (Table 4.4.2-1), and mapped (Figure 4.4.2-1) in the Colville River Delta and transportation corridor. The most abundant and widespread habitat classes in the project area are wet and moist tundra, which comprise four different habitat types that cover an aggregate 29% and 65% of the delta and corridor, respectively (Figure 4.4.2-2). The most prominent habitat types in these classes are Wet Sedge-Willow Meadow on the delta (19%), and Moist Sedge-Shrub Meadow and Moist Tussock Tundra in the transportation corridor (25 and 28%, respectively). Other prominent habitat classes on the delta include Estuarine (five types, 21%), River/Stream (15%), Barrens (14%), and Lake/Pond (six types; 13%). Although these classes (except Estuarine) are present in the transportation corridor, only Lake/Pond (16%) is relatively abundant there. Artificial (human-influenced) habitats (<1%) are scarce on the delta and corridor. Study results show that the complexity of habitats is greater in the delta than in the transportation corridor, and the region is largely undisturbed by development.

Table 4.4.2-1. Description and abundance of wildlife habitat types on the Colville River Delta and transportation corridor.

Habitat Type, Grouped by Habitat Class[1]	Brief Description[2]	Delta Acres	Delta Percent	Corridor Acres	Corridor Percent
Estuarine (estuarine)					
• Open Nearshore Water	Shallow estuaries, lagoons, embayments, and coastal waters. Regionally common.	2,585	1.9	NA	NA
• Brackish Water	Ponds and lakes connected to open nearshore water or flooded by saltwater during storm surges. Regionally common.	1,606	1.2	NA	NA
• Salt-killed Tundra	Areas along coastline where storm surges flood tundra with saltwater and kill most plants. Regionally uncommon.	6,333	4.6	NA	NA
• Tidal Flats	Unvegetated areas regularly inundated by marine waters. Regionally uncommon.	13,849	10.2	NA	NA
• Salt Marsh	Distributed sporadically in brackish tidal pools and bare mudflats. Regionally uncommon.	4,040	3.0	NA	NA
	Subtotal	**28,413**	**20.9**	**0**	**0**
River/Stream (riverine)	Channels and tributaries of Colville River including Kachemach and Miluveach rivers. Regionally common.	20,204	14.8	570	0.7
	Subtotal	**20,204**	**14.8**	**570**	**0.7**
Lake/Pond (lacustrine/palustrine)					
• Deep Open Water	Waterbodies over 6 ft deep, which do not freeze to the bottom. Includes both perched and drainage lakes, as described in Section 4.4.1, Fisheries Resources. Regionally common.				
▪ Without Islands		5,760	4.2	7,601	9.0
▪ With Islands or Polygonized Margins		1,272	0.9	1,611	1.9
• Tapped Lake with High-Water Connection	Waterbodies connected to rivers by seasonally flooded channels. Lakes over 6 ft deep that do not freeze to the bottom. Regionally uncommon.	5,032	3.7	25	<0.1
• Tapped Lake with Low-Water Connection	Waterbodies connected to rivers by permanently flooded channels. Lakes over 6 ft deep that do not freeze to the bottom. Regionally uncommon.	5,293	3.9	NA	NA
• Shallow Open Water (lake/pond)	Waterbodies less than 6 ft deep, which freeze to the bottom. Emergent vegetation covers less than 5% of waterbody. Regionally common.				
▪ Without Islands		568	0.4	2,679	3.2
▪ With Islands or Polygonized Margins		136	0.1	1,820	2.1
	Subtotal	**18,061**	**13.2**	**13,736**	**16.2**
Marsh (palustrine)					
• Aquatic Sedge Marsh (sedge marsh)	Waterbodies less than 1 ft deep and dominated by emergent vegetation. Regionally uncommon.	NA	NA	240	0.3
• Aquatic Sedge with Deep Polygons (sedge marsh)	Waterbodies formed in deep polygon basins where water depth exceeds 3 ft. Occur only near Beaufort Sea. Regionally uncommon.	3,360	2.5	8	<0.1

Table 4.4.2-1.Description and abundance of wildlife habitat types on the Colville River Delta and transportation corridor (continued).

Habitat Type, Grouped by Habitat Class[1]	Brief Description[2]	Delta		Corridor	
		Acres	Percent	Acres	Percent
• Aquatic Grass Marsh (grass marsh)	Ponds within dry lake basins and along lake margins less than 3 ft deep. Regionally uncommon.	339	0.2	162	0.2
	Subtotal	**3,699**	**2.7**	**410**	**0.5**
Basin Wetland Complex (palustrine)					
• Young Basin Wetland Complex	Formed in naturally drained lake basins featuring a mosaic of open water, emergent vegetation, and wet meadows. Lack of patterned ground indicates younger and more productive communities. Regionally common.	<1	<0.1	3,516	4.1
• Old Basin Wetland Complex	Wet and moist areas within older drained lake basins with either low-center (raised ridges around central depressions) or high-center (raised domes separated by narrow troughs) polygons. Differ from young basins by having smoother shorelines, more rectangular shapes, and fewer interconnections. Regionally common.	2	<0.1	8,796	10.4
	Subtotal	**2**	**0.2**	**12,312**	**14.5**
Wet Tundra (palustrine)					
• Wet Sedge-Willow Meadow	Wet areas with low-center polygons (<20 inches deep) dominated by sedges and willows. Typically found in drained lake basins, low-lying areas, and floodplains. Regionally common.	25,292	18.6	4,911	5.8
• Nonpatterned Wet Meadow	Narrow margins of receding waterbodies, edges of small stream channels, and in young, drained lake basins dominated by sedges. Standing water is less than 4 inches deep. More water movement than in polygonized areas. Regionally common.	10,358	7.6	6,048	7.1
	Subtotal	**35,650**	**26.2**	**10,959**	**12.9**
Moist Tundra (palustrine)					
• Moist Sedge-Shrub Meadow	Well-drained upland areas between lakes, on riverbanks and bluffs, ridges, and old thaw-lake plains dominated by sedges and low/dwarf shrubs. Surface water usually absent. Regionally common.	3,301	2.4	20,922	24.7
• Moist Tussock Tundra	Broad ridges of coastal plain deposits and within ice-rich basins dominated by sedge tussocks and low/dwarf shrubs. Regionally common.	622	0.5	23,379	27.6
	Subtotal	**3,923**	**2.9**	**44,301**	**52.3**
Riverine or Upland Shrub[c] (riverine and upland)	Willow stands along river and stream borders, and on stabilized sand dunes. Also, *Dryas* tundra on well-drained, exposed ridges and pingos in transportation corridor. Regionally common.	6,771	5.0	1,913	2.3
	Subtotal	**6,771**	**5.0**	**1,913**	**2.3**

Table 4.4.2-1.Description and abundance of wildlife habitat types on the Colville River Delta and transportation corridor (continued).

Habitat Type, Grouped by Habitat Class[1]	Brief Description[2]	Delta		Corridor	
		Acres	Percent	Acres	Percent
Barrens—Riverine, Eolian, Lacustrine[d] (riverine, lacustrine, and upland)	Unvegetated and partially vegetated (<30% plant cover) seasonally flooded river flats/bars, lake/pond margins, and also active sand dunes. Included also are barren flats of recently drained lake basins. Regionally common.	**19,496**	14.3	**478**	0.6
	Subtotal	**19,496**	**14.3**	**478**	**0.6**
Artificial—Water, Fill, Peat Road (palustrine and upland)	Human-disturbed areas including impoundments, gravel fill, and sewage lagoon.	**6**	<0.1	**117**	0.1
	Subtotal	**6**	**<0.1**	**117**	**0.1**
	TOTAL	**136,225**		**84,795**	

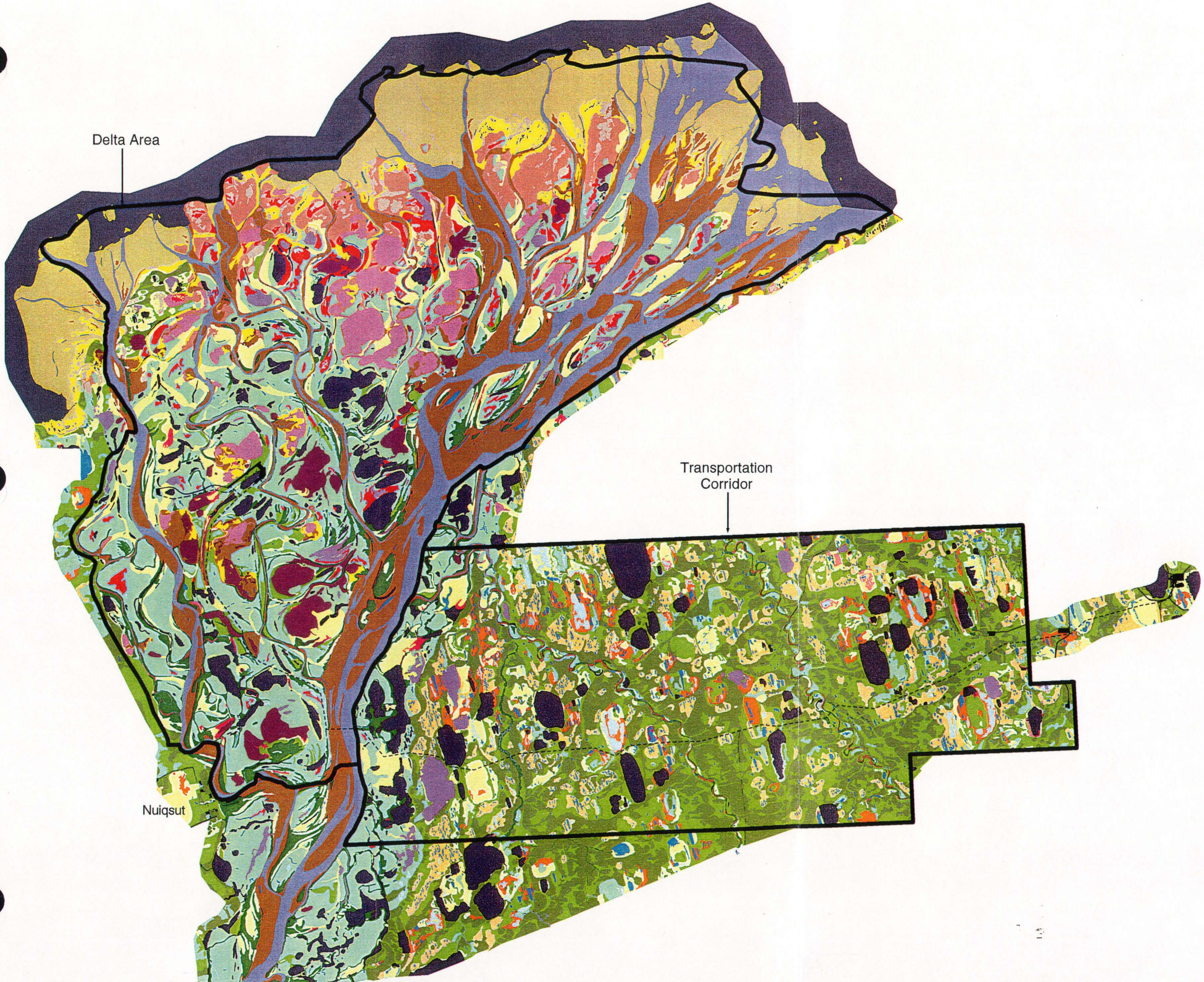
NA = Not applicable.

1 Parentheses enclose equivalent wetland systems in classification by Cowardin et al. (1979). **Refer to Appendix S for the National Wetlands Inventory Habitat Equivalent.**

2 More detailed descriptions are presented in Appendix I-1, Table 1.

3 Upland Shrub communities are well-drained and classified as uplands, but were lumped with seasonally flooded Riverine Shrub for habitat mapping and analysis.

4 Eolian Barrens are well-drained and classified as uplands, but were lumped with Riverine and Lacustrine Barren wetland types for habitat mapping and analysis.



Source: Photo-interpretation of habitat types based on 1992 CIR photography (Johnson et al. 1996). Map registered to SPOT image base map. Projection: UTM Zone 5, Datum NAD 27

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SCALE IN MILES
0 2 4

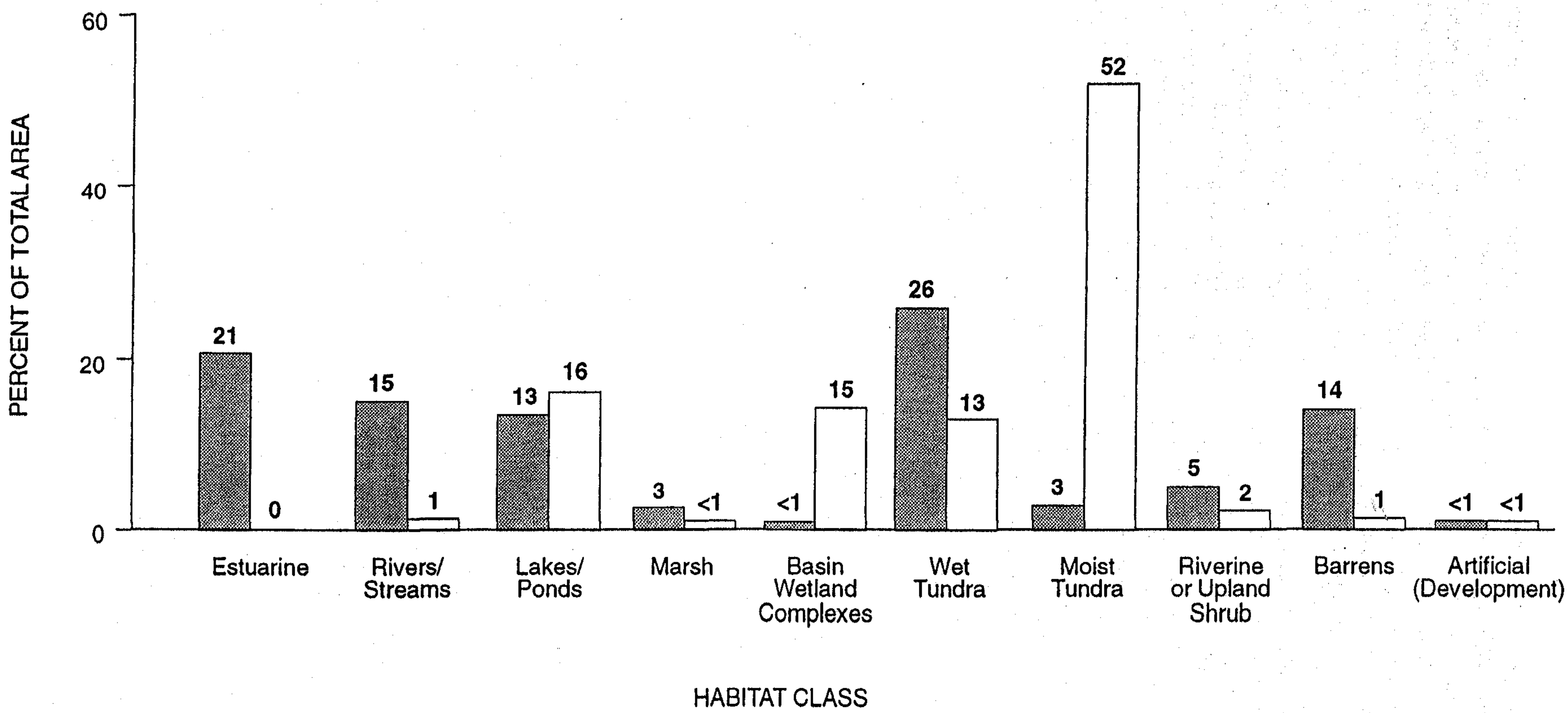
Habitat Types

- Open Nearshore Water (marine)
- Brackish Water
- Tapped Lake w/ Low-water Connection
- Tapped Lake w/ High-water Connection
- Salt Marsh
- Tidal Flats
- Salt-killed Tundra
- Deep Open Water w/o Islands
- Deep Open Water w/ Islands or Polygonized Margins
- Shallow Open Water w/o Islands
- Shallow Open Water w/ Islands or Polygonized Margins
- River or Stream
- Aquatic Sedge Marsh
- Aquatic Sedge w/ Deep Polygons
- Aquatic Grass Marsh
- Young Basin Wetland Complex
- Old Basin Wetland Complex
- Nonpatterned Wet Meadow
- Wet Sedge-Willow Meadow
- Moist Sedge-Shrub Meadow
- Moist Tussock Tundra
- Riverine or Upland Shrub
- Barrens (riverine, eolian, lacustrine)
- Artificial (water, fill, peat road)

Proposed Project

- In-field Facilities
- ------ Pipelines

Figure 4.4.2-1.
Wildlife Habitat Types



Source: ABR 1996

Figure 4.4.2-2.
Relative Abundance of Wildlife Habitats on the Colville River Delta and Transportation Corridor for Alpine Project

Birds

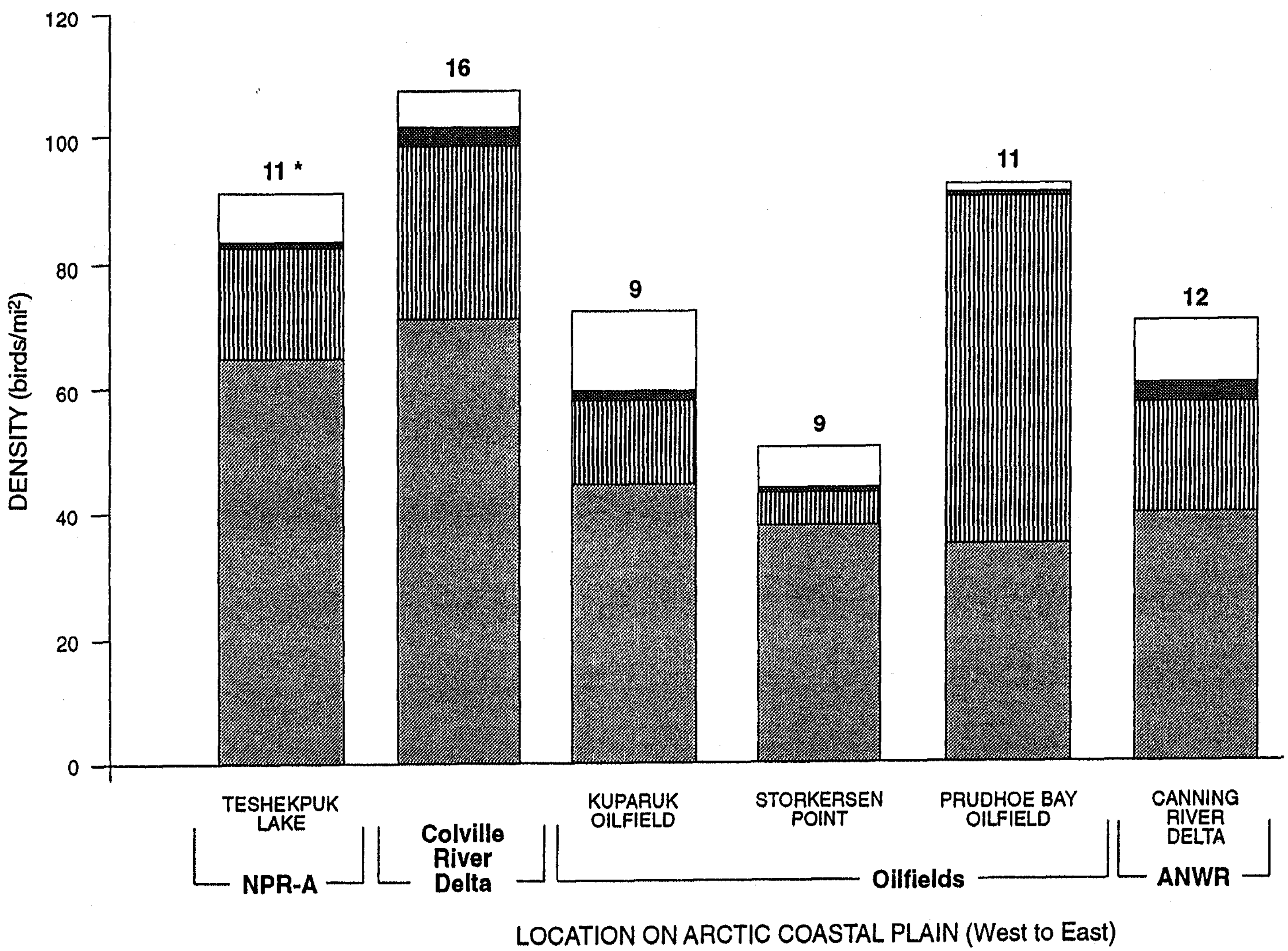
The following section describes use of the project area by the prominent bird species. Birds are divided into three major groups: waterbirds, tundra-nesting birds, and predatory birds. Abundance, distribution, and habitat use are addressed for the species in each group, based largely on information from baseline studies summarized by Johnson et al. (1997) (Appendix I). In each year of those studies, bird surveys were conducted in locations where oil development was expected, given the best information that was available at the time. The location of the oil reservoir has been defined more reliably over time, based on continued exploration and testing. In 1992, ground surveys of birds were not conducted in the currently proposed project area, but surveys were conducted on three plots (3 x 6 mi each) where development was considered likely to occur at that time. In 1993, brood surveys were conducted around the lakes south of the proposed airstrip (thus, in the southern portion of the project area). In 1995, nest and brood surveys were conducted in the proposed project area. Although the proposed location of the footprint that year was not the same as is currently proposed, the area searched on the ground encompassed the current footprint including the 650-ft and 3,300-ft buffers around the footprint (i.e., the proposed in-field facility area). In 1996 and 1997, the ground-search area encompassed the current proposed in-field facility area. In addition to the three years of ground surveys in the proposed facility area, aerial surveys have been conducted over the entire project area since 1992.

Prior to initiating studies on the Colville River Delta in 1992, ARCO, and USFWS conferred on the scope of bird studies that should be conducted. The group agreed that baseline data would be collected on the distribution and abundance of species of regional importance, rare or sensitive status, and those for which government agencies had special concerns. At that time, shorebirds, passerines, and waterbirds other than tundra swans, brant, yellow-billed loons, and spectacled eiders did not meet the criteria for inclusion in the study. Nonetheless, information was collected on many of these other species during aerial and ground surveys. In 1995, ARCO systematically collected nesting information on all waterbirds in the proposed in-field facility area. Beginning in 1996, separate aerial surveys were flown for brood-rearing and fall-staging geese on the delta. In 1996, an intensive ground-based breeding bird survey was initiated to enumerate birds of all species that nest in the project footprint. This survey was designed specifically to investigate species diversity in the footprint area.

Because of the critical role habitat plays in the life cycle of birds, the descriptions for yellow-billed loons, tundra swans, brant, and spectacled and king eiders include results of statistical analyses of habitat selection reported by Johnson et al. (1997). For other species, habitat use was summarized from research conducted on the Colville River Delta in the 1980s (Simpson et al. 1982; Rothe et al. 1983; North et al. 1984; North 1986; Nickles et al. 1987; Gerhardt et al. 1988), and studies conducted in the oilfields and in the Arctic National Wildlife Refuge (ANWR) since the late 1970s (Spindler 1976; Martin and Moitoret 1981; Troy 1986; TERA 1993; Moitoret et al. 1996). Appendix I-2, Table 1 lists all bird species (over 100) observed on the Colville River Delta, along with Iñupiaq bird names and terms used in the text to describe species abundance and status (e.g., common breeder or uncommon resident).

__Waterbirds__. The Colville River Delta supports 29 species of waterbirds (loons, tundra swan, geese, and ducks) including 16 species that breed there (Appendix I-2, Table 1). Because of the relatively large number of species, combined with the diversity of habitats, the Colville River Delta hosts some of the highest densities of waterbirds on the Arctic Coastal Plain during the breeding season (June—July) (Figure 4.4.2-3).

Yellow-billed Loon. The yellow-billed loon is one of three species of loons (the other two are Pacific and red-throated) breeding on the Colville River Delta; common loons are casual visitors (Appendix I-2, Table 1). Yellow-billed loons are uncommon breeders on most of the Arctic Coastal Plain, and are common breeders only near the Alaktak and Chipp rivers and on the Colville River Delta (Sjolander and Agren 1976; Johnson and Herter 1989). Aerial surveys (Smith et al. 1993, 1994; Johnson et al. 1996, 1997) have demonstrated that lakes in the central region of the Colville River Delta provide most of the nesting habitat for yellow-billed loons (10 to 15 nests/year) (Figure 4.4.2-4). Small numbers (<10) of yellow-billed loons have been seen in the transportation corridor, but no nests or broods have been located during aerial surveys (Smith et al. 1994; Johnson et al. 1996). One nest was located in the transportation corridor, however, during ground searches near the proposed ASRC gravel mine in 1996 (Johnson et al. 1997).



Source: ABR 1996

Loons
Tundra Swan
Geese
Ducks and Eiders

* Number of species observed at each location.

Figure 4.4.2-3.
Breeding-Season Densities (birds/mi^2) of Waterbird Groups in NPR-A, the Oilfields, and ANWR on the Arctic Coastal Plain of Alaska

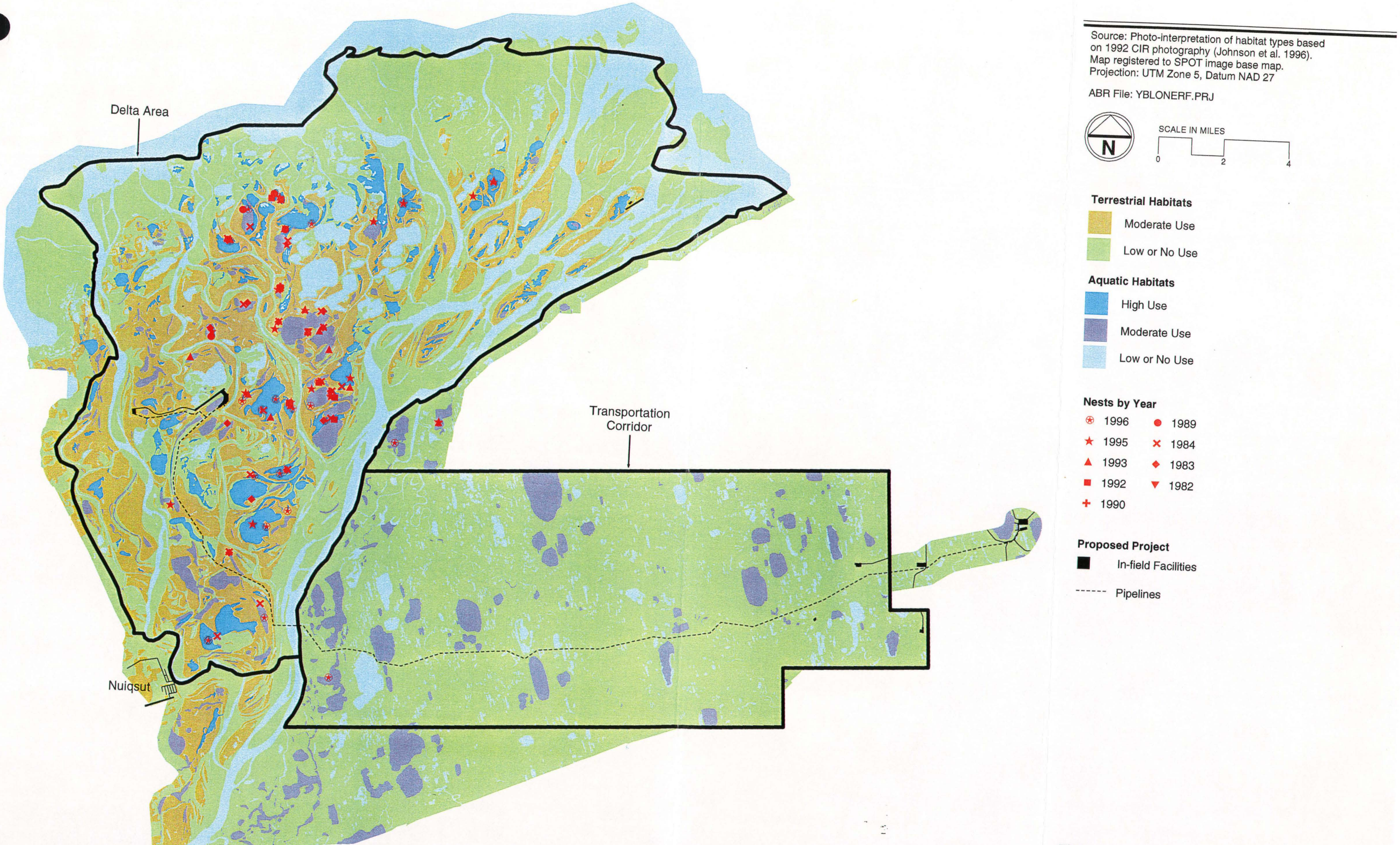


Figure 4.4.2-4.
Yellow-Billed Loon Nesting Habitat

Yellow-billed loons occupy the project area from early May through September. Loons arrive on the Colville River Delta in early May, once open water is available in river channels, and nesting begins in mid-June when open water appears on the lakes (Rothe et al. 1983; North 1986). After the young hatch in mid-July, broods may move to adjacent larger lakes if the nesting lake is small (North 1986; North and Ryan 1988; Johnson and Herter 1989). Fall migration peaks during early September along the Beaufort Sea (Johnson and Herter 1989), but family groups (adults with young) stay until the young can fly, which may be as late as mid-September.

Because of their territorial behavior and fidelity to nesting lakes, habitat use by yellow-billed loons on the Colville River Delta has been studied in detail (North 1986; North and Ryan 1988, 1989; Johnson et al. 1996). Yellow-billed loons nest on various sized lakes (range 0.2 to 566 acres) on the Colville River Delta, particularly smaller lakes (<25 acres) (North and Ryan 1989). Johnson et al. (1997) confirmed North's (1986) findings that loons preferred deep lakes on the Colville River Delta (see Figure 4.4.2-4), particularly three deep-water habitat types (7 % of the total area) that contained 44% of the nests: Tapped Lake with High-water Connection (17% of 39 nests), Deep Open Water with Islands or Polygonized Margins (13%), and Aquatic Sedge with Deep Polygons (13%). The remaining nests were in four other habitats; Wet Sedge-Willow Meadow (31%), Deep Open Water Without Islands (15%), Nonpatterned Wet Meadow (8%), and Aquatic Grass Marsh (3%). These habitats were not preferred, primarily because use by nesting loons was proportional to the availability of these habitats (Johnson et al. 1997). Only three habitats were used by brood-rearing loons: Deep Open Water without Islands (71% of 17 broods), Tapped Lake with High-water Connection (18%), and Deep Open Water with Islands or Polygonized Margins (12%). Both of the deep open water habitats were preferred by brood-rearing loons, whereas the tapped lake type was not preferred. These results demonstrate that deep lakes and ponds provide preferred habitats for nesting and brood-rearing yellow-billed loons in the delta area.

The foods eaten by yellow-billed loons have not been well-studied, but they likely include aquatic invertebrates and small fish caught in nesting or nearby lakes. North (1986) found that fishes were more abundant in the types of lakes used by nesting loons than in other lakes on the delta, and that the presence of emergent vegetation (particularly *Arctophila fulva*) was indicative of abundant invertebrate populations.

Pacific Loon. Pacific loons are common breeders across the entire coastal plain (Johnson and Herter 1989). They were the most abundant loons seen during aerial surveys of the Colville River Delta (Smith et al. 1993, 1994; Johnson et al 1996, 1997), and they appear to be equally abundant in the transportation corridor (Johnson et al. 1996, 1997). Pacific loons arrive on the delta in late May as open water appears in the river channels; they move to nesting lakes as ice disappears in early to mid-June. The timing of breeding events and fall migration is similar to those described for the yellow-billed loon. Seven Pacific loon nests were found in the ADP in-field facility area in 1996 during ground-based nesting surveys (Johnson et al. 1997). One nest was found in the search area for the ASRC gravel mine site in the transportation corridor (Johnson et al. 1997).

Habitat use by Pacific loons was not analyzed quantitatively for the project area because only limited surveys were conducted for this species (Johnson et al.1997). Other studies have generally described habitat use in the study area and on the coastal plain (Bergman and Derksen 1977; Rothe et al. 1983; Johnson and Herter 1989; Kertell 1994). Pacific loons usually nest on shorelines or on islands in lakes about half the size of those used by yellow-billed loons (Johnson and Herter 1989; McIntyre 1994). On the Colville River Delta, Pacific loons nest in sedge and grass marshes, deep open lakes, and brackish ponds (Rothe et al. 1983). During brood rearing, Pacific loons also use sedge and grass ponds (Simpson et al. 1982; Rothe et al. 1983). Pacific loons feed primarily on aquatic invertebrates available in their breeding lakes (Bergman and Derksen 1977; North 1986; Kertell 1994) but also in the nearshore waters (Andres 1993).

Red-throated Loon. The red-throated loon is a common breeder on the Arctic Coastal Plain, including the project area (Johnson and Herter 1989). Abundance was not quantified in the project area because aerial surveys focused on lakes larger than ones used by red-throated loons (Smith et al. 1993, 1994; Johnson et al. 1996). Ground observations suggested, however, that red-throated loons were less abundant than Pacific loons, but more abundant than yellow-billed loons on the Colville River Delta (Johnson et al. 1996). Red-throated loons were about three to four times more abundant on the delta than in the transportation corridor in 1995 (Johnson et al.

1996). One red-throated loon nest was found in the ADP in-field facility area and one nest was found in the ASRC gravel mine site area during ground-based searches in 1996 (Johnson et al. 1997).

The breeding cycle and habitat use of red-throated loons differs from that of other loons. Red-throated loons arrive on the Colville River Delta later than the other species, usually not until early June when open water appears in tundra ponds. The timing of other breeding events, however, is similar to that of yellow-billed and Pacific loons. Red-throated loons nest on smaller (often <3 acres), shallower ponds than do the other species (Johnson and Herter 1989; Dickson 1994; McIntyre 1994). Habitats used by red-throated loons include both sedge and grass marshes, but they also use basin wetland complexes, especially during brood-rearing (Bergman et al. 1977; Derksen et al. 1981).

In contrast to the other loons, which mostly feed in the nesting lakes, red-throated loons fly to nearshore marine waters on the Colville River Delta to hunt fishes for their young (Bergman and Derksen 1977). Nesting lakes are not used for feeding, probably because few fish survive when these shallow lakes freeze to the bottom in winter.

Tundra Swan. Tundra swans are common breeders on the Arctic Coastal Plain and in the project area (Johnson and Herter 1989, Johnson et al. 1997). Tundra swans have served as indicators of the health of the region's ecosystem because they are sensitive to human disturbance, they mate for life, and they return annually to nest at specific locations (King 1973; Ritchie et al. 1990). Changes in these activities can provide a measure of the effects of development projects. Tundra swans nest in much lower densities across the entire coastal plain than on the major river deltas (Colville, Sagavanirktok, and Canning) (see Figure 4.4.2-3). The Colville River Delta supports one of the largest breeding concentrations of tundra swans in northern Alaska (Rothe and Hawkins 1982). Aerial surveys show that swan nests and broods are widespread in the project area (Figures 4.4.2-5 and 4.4.2-6), but the delta, on average, supports six times more adults (319 vs. 49) and twice as many nests (29 vs. 12) as the transportation corridor (Table 4.4.2-2).

Tundra swans inhabit the project area from May through September. Although the first swans arrive while the Colville River Delta is largely snow-covered (mid-May), most arrive 1 to 2 weeks later (Hawkins 1986). As snow melts, pairs move to breeding territories to nest by early June. After eggs hatch in early July, family groups remain together, but often range widely to find food (Johnson and Herter 1989). Before the young fly in mid- to late-September, adults become flightless (molt) for about 3 weeks. During this flightless period swans are most vulnerable to predators, and broods are sensitive to disturbance. Nonbreeding swans form large staging flocks of up to several hundred birds in the East Channel of the Colville River and along the lower reaches of the Miluveach and Kachemach rivers. Fall staging usually takes place during early to mid-September (Rothe et al. 1983; Smith et al. 1994). The fall migration peaks along the Beaufort Sea coast in late September and early October (Johnson and Herter 1989).

Tundra swans nest in most habitats on the Colville River Delta (13 of 23 habitats) and transportation corridor (13 of 18 habitats) (Johnson et al. 1997). Wet Sedge-Willow Meadow (49 of 117 nests), Nonpatterned Wet Meadow (17 nests), Salt-Killed Tundra (14 nests), Aquatic Sedge with Deep Polygons (8 nests) were the habitats preferred by swans nesting in the delta (Johnson et al. 1997). Four habitats in the transportation corridor were preferred by nesting swans: Young Basin Wetland Complex (14 of 83 nests), Deep Open Water with Islands or Polygonized Margins (10 nests), Aquatic Sedge Marsh (4 nests), and Aquatic Grass Marsh (1 nest). Nests typically are close to waterbodies, averaging 0.06 mi in the transportation corridor and 0.10 mi on the delta (Johnson et al. 1997). These results indicate that tundra swans nest throughout the project area, usually near lakes or ponds.

Similarly, brood-rearing tundra swans used a variety of habitats in the project area (see Figure 4.4.2-6). Tundra swans used coastally influenced habitats (Brackish Water, Salt Marsh, and Tapped Lake with Low-Water Connection) more during brood rearing (30% of broods) than nesting (8% of nests), suggesting a shift in habitat use on the delta (Johnson et al. 1997). Brood-rearing swans preferred four habitats on the delta: Tapped Lake with Low-water Connection, Tapped Lake with High-water Connection, Deep Open Waters with Islands or Polygonized Margins, and Aquatic Grass Marsh (Johnson et al. 1997). In the transportation corridor (where coastal habitats do not occur), Aquatic Grass Marsh, Aquatic Sedge Marsh, and deep open water were preferred by swans with broods (Johnson et al. 1997). Other studies

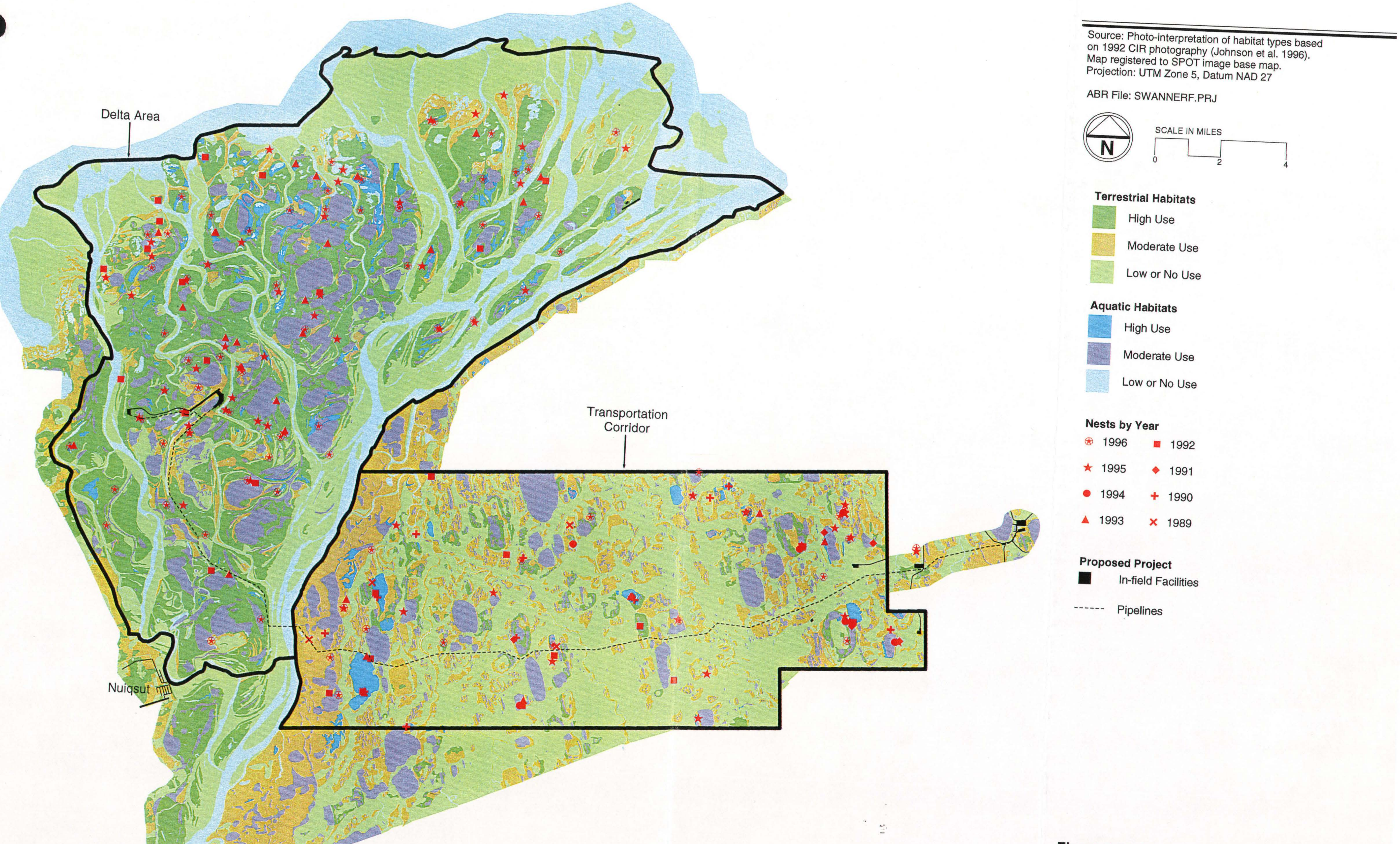


Figure 4.4.2-5.
Tundra Swan Nesting Habitat

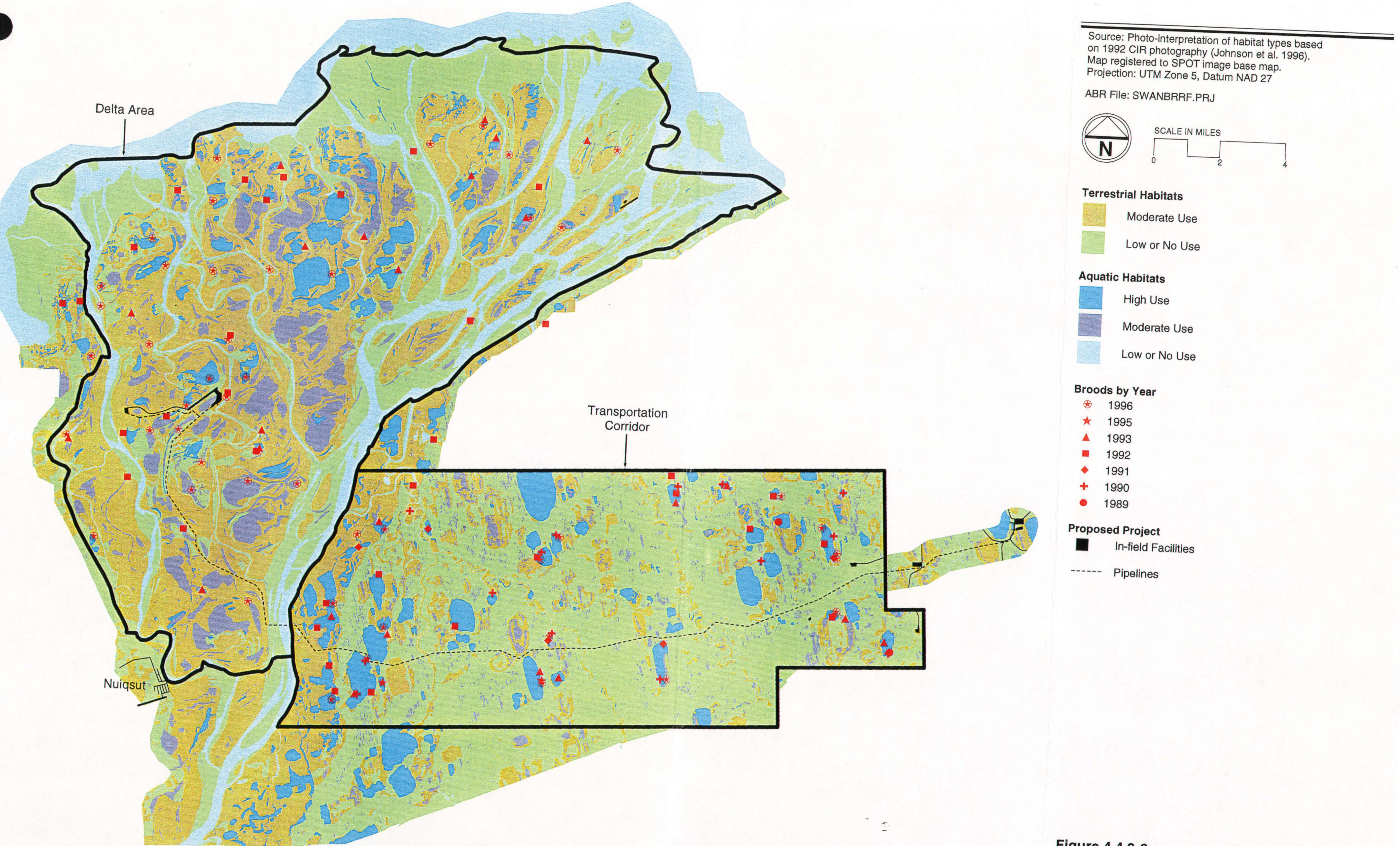


Figure 4.4.2-6.
Tundra Swan Brood-Rearing Habitat

Table 4.4.2-2. **Numbers and densities (birds/mi²) of tundra swan counted during nesting and brood-rearing aerial surveys on the Colville River Delta and transportation corridor.**

		Nesting		Brood-Rearing		
		Nests	Adults	Adults	Young	Total Swans
Area	Year	No. (/mi²)	No. (/mi²)	No. (/mi²)	No. (/mi²)	No. (/mi²)
Colville River Delta						
	1992	14 (0.07)	249 (1.17)	259 (1.22)	38 (0.18)	297 (1.40)
	1993	20 (0.09)	240 (1.13)	200 (0.95)	37 (0.18)	237 (1.12)
	1995	38 (0.18)	208 (0.98)	169 (0.79)	92 (0.44)	261 (1.23)
	1996	45 (0.21)	579 (2.72)	250 (0.81)	108 (0.44)	358 (1.25)
Average		29 (0.14)	319 (1.50)	220(1.03)	69 (0.32)	288 (1.35)
Transportation Corridor						
	1989	6 (0.05)	38 (0.29)	63 (0.48)	6 (0.05)	69 (0.52)
	1990	11 (0.08)	33 (0.25)	56 (0.42)	45 (0.34)	101 (0.77)
	1991	7 (0.05)	40 (0.30)	67 (0.52)	17 (0.13)	84 (0.66)
	1992	12 (0.09)	46 (0.35)	72 (0.55)	33 (0.25)	105 (0.80)
	1993	10 (0.08)	50 (0.38)	60 (0.47)	23 (0.17)	83 (0.64)
	1995	18 (0.16)	87 (0.66)	66 (0.50)	27 (0.21)	93 (0.73)
	1996	19 (0.16)	52 (0.39)	57 (0.42)	28 (0.22)	105 (0.82)
Average		12 (0.09)	49 (0.37)	63 (0.49)	26 (0.19)	91 (0.69)

Sources: Colville River Delta (Smith et al. 1993, 1994; Johnson et al. 1996, 1997). Transportation corridor (Ritchie et al. 1990, 1991; Stickney et al. 1992, 1994; Anderson et al. 1996; Johnson et al. 1996, 1997).

on the coastal plain have shown that tundra swans occur frequently in habitats supporting the emergent grass *Arctophila fulva*, which is a primary food for adults and young (Bergman et al. 1977; Derksen et al. 1981). These results demonstrate that brood-rearing tundra swans prefer aquatic habitats probably because they provide food for adults and young, as well as escape cover for the young.

Geese. Four species of geese (Canada goose, greater white-fronted goose, snow goose, and brant) nest on the Arctic Coastal Plain and in the project area (Johnson and Herter 1989). The distribution of each species differs across the coastal plain and is influenced by their nesting habits. Greater white-fronted and Canada geese nest in isolated pairs on the tundra or on small islands in lakes and ponds. In contrast, brant and snow geese nest primarily in colonies at traditional sites, ranging from a few to several hundred pairs; they infrequently nest in isolated pairs. Thus, brant and snow goose nesting locations are generally predictable each year, whereas those of greater white-fronted and Canada geese are less predictable.

Greater White-fronted Goose. This species is the most common goose on the Arctic Coastal Plain, becoming less common east of Prudhoe Bay (Johnson and Herter 1989). Greater white-fronted geese are the most common breeders on the Colville River Delta and in the transportation corridor (Rothe et al. 1983; Johnson et al. 1996). The Colville River Delta is a regionally important breeding area for greater white-fronted geese on the coastal plain, as evidenced by the high density (16.3 birds/mi²) of nesting geese (Simpson et al. 1982; Renken et al. 1983; Rothe et al. 1983; North et al. 1984; Meehan and Jennings 1988; Johnson and Herter 1989).

Greater white-fronted geese are present in the project area from approximately mid-May to mid-September. They arrive on the Colville River Delta when open tundra appears and begin nesting within 1 to 2 weeks, usually by late May (Rothe et al. 1983; Johnson and Herter 1989). Eggs hatch in late June and early July.

Before the young can fly, adults (breeding and nonbreeding) molt and are flightless for 2 to 3 weeks. During brood-rearing, family groups form larger flocks near deep lakes that provide protection from predators. Once adults and young can fly, they form large staging flocks before the migration, which begins in mid-August and ends about mid-September (Johnson and Herter 1989).

On the Colville River Delta, greater white-fronted geese usually nest on islands in lakes and on polygon ridges near water (Rothe et al. 1983). Brood-rearing groups feed on emergent sedges and grasses in a variety of habitats (marshes, basin wetland complexes, and the margins of deep open lakes), but they also use Wet Sedge-Willow Meadows and Riverine Shrub. Molting groups use these habitats and the salt-marsh habitats on the outer delta north of the ADP site (Smith et al. 1993). A systematic aerial survey (25% coverage) was flown for brood-rearing greater white-fronted geese in 1996 to determine general distribution and abundance in the study area (Johnson et al. 1997). Of the 553 birds in 16 groups seen during this survey, 379 birds (69%) in 12 groups were seen on the delta and 174 birds (31%) in 4 groups were in the transportation corridor. On the delta, groups typically were in Brackish Water or both types of deep open water, whereas all the groups on the transportation corridor were in the deep open water types. During fall staging, greater white-fronted geese are concentrated around river channels and large lakes on the delta (Johnson et al. 1997). Conversely, the transportation corridor appears to receive little use by fall-staging geese (Johnson et al. 1997).

Canada Goose. This species has a patchy distribution across the Arctic Coastal Plain, with the highest densities in the Prudhoe Bay area (Johnson and Herter 1989). Canada geese do not nest on the Colville River Delta but are common upstream in the Colville River drainage (Derksen et al. 1981; Johnson and Herter 1989). Their use of the transportation corridor is undetermined, but some nesting is possible because a few geese (<10 pairs) nest each year in the Kuparuk oilfield. Ten Canada goose nests were located just west of the delta in the NPR-A in 1996; the first record of nesting there (Johnson et al. 1997). The Colville River Delta is an important staging area for geese to rest and feed during the fall migration along the Beaufort Sea coast (Johnson and Richardson 1981; Garner and Reynolds 1986). In 1996, 1,486 Canada geese were seen on the delta during fall; most (71%) were on the outer delta (Johnson et al. 1997). This number exceeded those seen in 1991 (310 birds), 1993 (825 birds), and 1995 (848 birds) but fell considerably short of the numbers seen in 1992 (10,957 birds) (Smith et al. 1993, 1994; Johnson et al. 1996). These data show that the project area is not an important nesting or brood-rearing area for Canada geese, but the delta is an important staging area during fall.

Brant. The Colville River Delta has the largest concentration of nesting brant on the Arctic Coastal Plain of Alaska (Simpson et al. 1982; Renken et al. 1983; Rothe et al. 1983; Bayha et al. 1992). Brant nest in lower concentrations elsewhere on the coastal plain (Johnson and Herter 1989). The delta also is an important stopover in spring for birds migrating eastward to nesting colonies in arctic Canada (Rothe et al. 1983).

Brant occur in the project area from late May through late August. They arrive on the delta in late May and move to nesting colonies soon afterwards (Kiera 1979; Rothe et al. 1983). Hatching begins in late June, and brant form large brood-rearing flocks shortly thereafter. Brant depart the delta soon after the young can fly, usually by mid-August. Thus, brant spend less time in the project area than do other species of geese.

Brant nest primarily at colony sites on the outer Colville River Delta. Most nests (>950) are within a colony complex of at least 10 islands around Anachlik Island (Figure 4.4.2-7) at the mouth of the East Channel (Simpson et al. 1982; Renken et al. 1983; Bayha et al. 1992; Groves and Conant 1995). Small colonies and single nests also are scattered across the northern half of the delta (Smith et al. 1993, 1994). Most colonies are used each year. Only a few small colonies (2 - 3 locations, <5 pairs each) have been found in the transportation corridor. Two habitats on the delta are preferred by nesting brant: Brackish Water (3 of 10 colonies) and Aquatic Grass Marsh (1 of 10 colonies) (Johnson et al. 1997). Other habitats that support brant colonies (but were not preferred based on the statistical analyses) included Salt-killed Tundra (3 colonies), Salt Marsh (1 colony), Deep Open Water with Islands or Polygonized Margins (1 colony), and Wet Sedge-Willow Meadow (1 colony). These results demonstrate the importance of the delta to nesting brant, particularly the islands in the Anachlik colony complex.

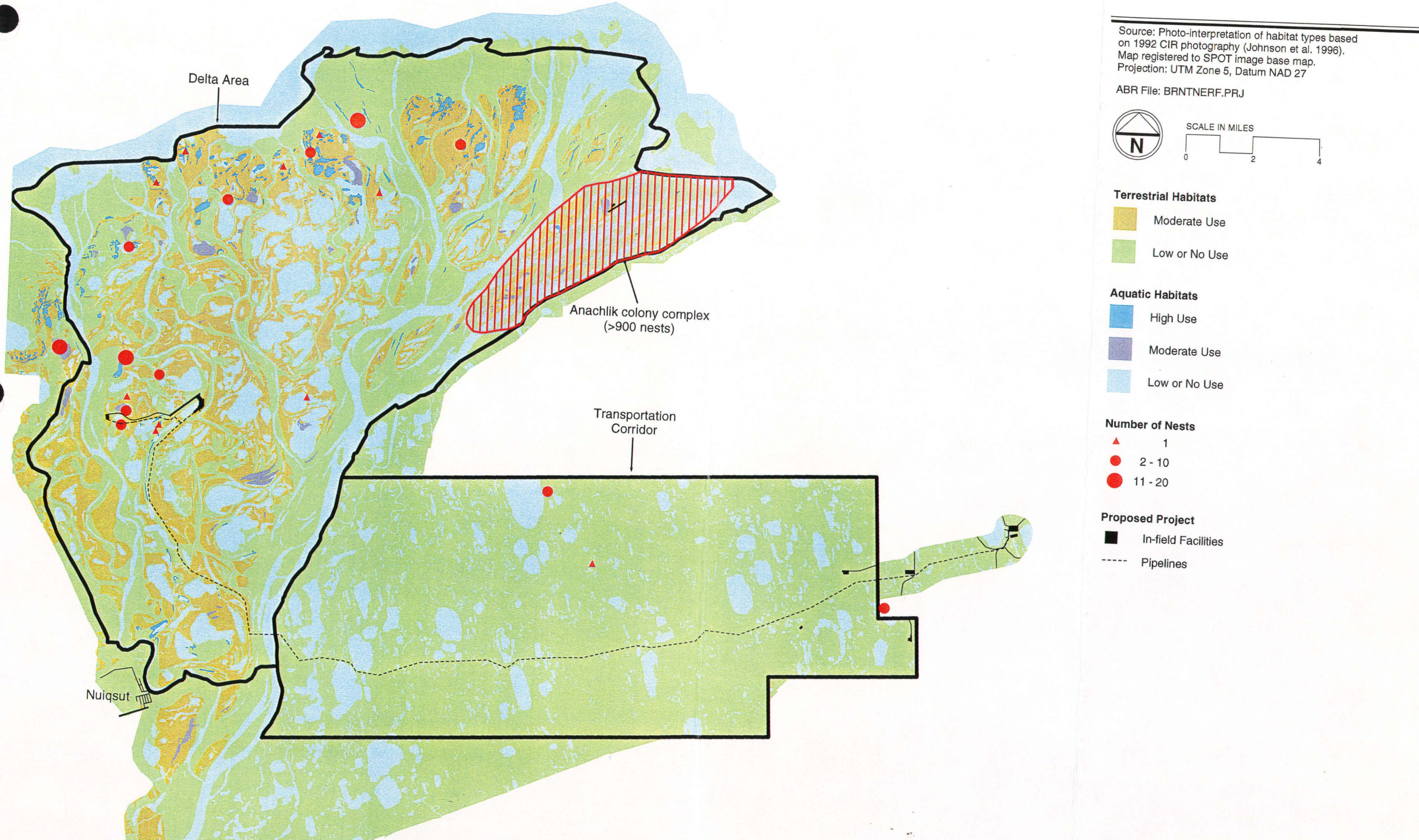


Figure 4.4.2-7.
Brant Nesting Habitat

Large numbers of brood-rearing brant also use the outer Colville River Delta, whereas most nonbreeding brant move from the delta to the Teshekpuk Lake area in NPR-A, or to Oliktok Point, to molt (Derksen et al. 1981; Rothe et al. 1983; Stickney et al. 1992). In 1996, 993 brant (478 adults and subadults and 515 goslings) were observed along the delta coast (Figure 4.4.2-8). This total was a decrease from the 1995 total (1,480 brant: 768 adults and subadults and 712 goslings), which was the largest number recorded since surveys were begun in 1988 (Bayha et al. 1992; Smith et al. 1993, 1994; Johnson et al. 1996). Brood distribution on the delta has been similar in most years surveyed, with more broods occurring between the East Channel and the Elaktoveach Channel than elsewhere (Bayha et al. 1992; Smith et al. 1993, 1994; Johnson et al. 1996). In 1996, slightly more brant were seen between the Elaktoveach Channel and the Nechelik (Nigliq) Channel (503) than between the East Channel and the Elaktoveach Channel (490) (Johnson et al. 1997). Observations of color-marked brant indicate that some brood-rearing flocks move from the delta eastward to Oliktok Point and elsewhere in the Kuparuk and Milne Point oilfields during late July (Anderson et al. 1995). Broods have also been recorded in the Fish Creek and Kalubik Creek areas (USFWS, unpublished data). No broods were seen in the transportation corridor in 1992-1993 and 1995-96 (Johnson et al. 1997). Brood-rearing (and molting) flocks have a strong affinity for coastal habitats (Brackish Water, Salt Marsh, Aquatic Sedge with Deep Polygons) (see Figure 4.4.2-8), but only the Brackish Water type was preferred by brood-rearing brant (Johnson et al. 1997). This affinity for coastal habitats occurs because brant feed primarily on *Puccinellia phryganoides* and *Carex subspathacea*, which are found only in saline habitats (Kiera 1979). These findings indicate that the outer delta, provides the most important brood-rearing habitats in the project area.

Snow Goose. This species nests in several colonies and in scattered pairs across the Arctic Coastal Plain; the largest colony (300 to 400 nests) is on Howe Island near Prudhoe Bay (Johnson and Herter 1989). Several smaller colonies (40 to 50 nests) occur on the Ikpikpuk and Kukpowruk river deltas on the western coastal plain (Ritchie et al. in prep.). Although no breeding colonies have been reported on the Colville River Delta or transportation corridor, nests have been found in the Fish Creek area of the western delta (Johnson et al. 1997; Ritchie et al. in prep.) and east of the delta and north of the transportation corridor, near the Miluveach River (Gerhardt et al. 1988). No nests were located on the delta in 1996, but three nests were located on the outer Colville River Delta, within 3 mi of the coast, during aerial (1995) and ground searches (1993, 1994) of the project area (ABR, Inc. unpublished data). Several additional nests were found (1993) on an island in the East Channel of the Colville River (ABR, Inc. unpublished data). The timing of breeding is similar to that of brant. Twenty-four snow geese were observed during a brood-rearing survey of the outer delta in late July 1996 (Johnson et al. 1997). In 1995, 12 snow geese were seen, but no brood-rearing snow geese were observed during 1992 or 1993 surveys of the delta (Smith et al. 1993, 1994; Johnson et al. 1996). Snow geese were observed during fall staging in 1991 (6 birds in the corridor) 1995 (20 birds on the outer delta and 12 birds in the corridor), and 1996 (3 birds on the outer delta), but not in 1992 or 1993 (Smith et al. 1993, 1994; Johnson et al. 1996, 1997). In general, the project area is not an important nesting or brood-rearing area for snow geese.

Ducks. Ducks on the Arctic Coastal Plain of Alaska can be separated into three groups: arctic breeders (eiders and oldsquaw); breeders on the edge of their range (green-winged teal, northern pintail, greater scaup, American wigeon, and red-breasted merganser); and non-breeders (northern shoveler, scoters, and common goldeneye). Of the 18 species of ducks recorded in the Colville River Delta, nine are confirmed or probable breeders (Appendix I-2, Table 1).

Of the ducks breeding in the project area, the most common are northern pintails, oldsquaw, and king and spectacled eiders (spectacled eiders are discussed in Section 4.4.3) (Rothe et al. 1983; Smith et al. 1993, 1994; Johnson et al. 1996). The northern pintail is the most abundant, and the oldsquaw is second in abundance on the Colville River Delta (Appendix I-3, Table 1) (Rothe et al. 1983; Johnson and Herter 1989). Their abundance has not been assessed in the transportation corridor, but probably is similar to that in the Kuparuk oilfield (see Appendix I-3, Table 2). King eiders are abundant in the transportation corridor, but not on the Colville River Delta (Table 4.4.2-3; Johnson et al. 1997). King eider densities in the corridor increased almost four-fold from 1993 to 1995, but decreased somewhat in 1996 (see Table 4.4.2-3), and relatively large numbers were seen in the eastern portion of the corridor (Johnson et al. 1996). Many of the other duck species are abundant in the project area only during years when they are displaced by

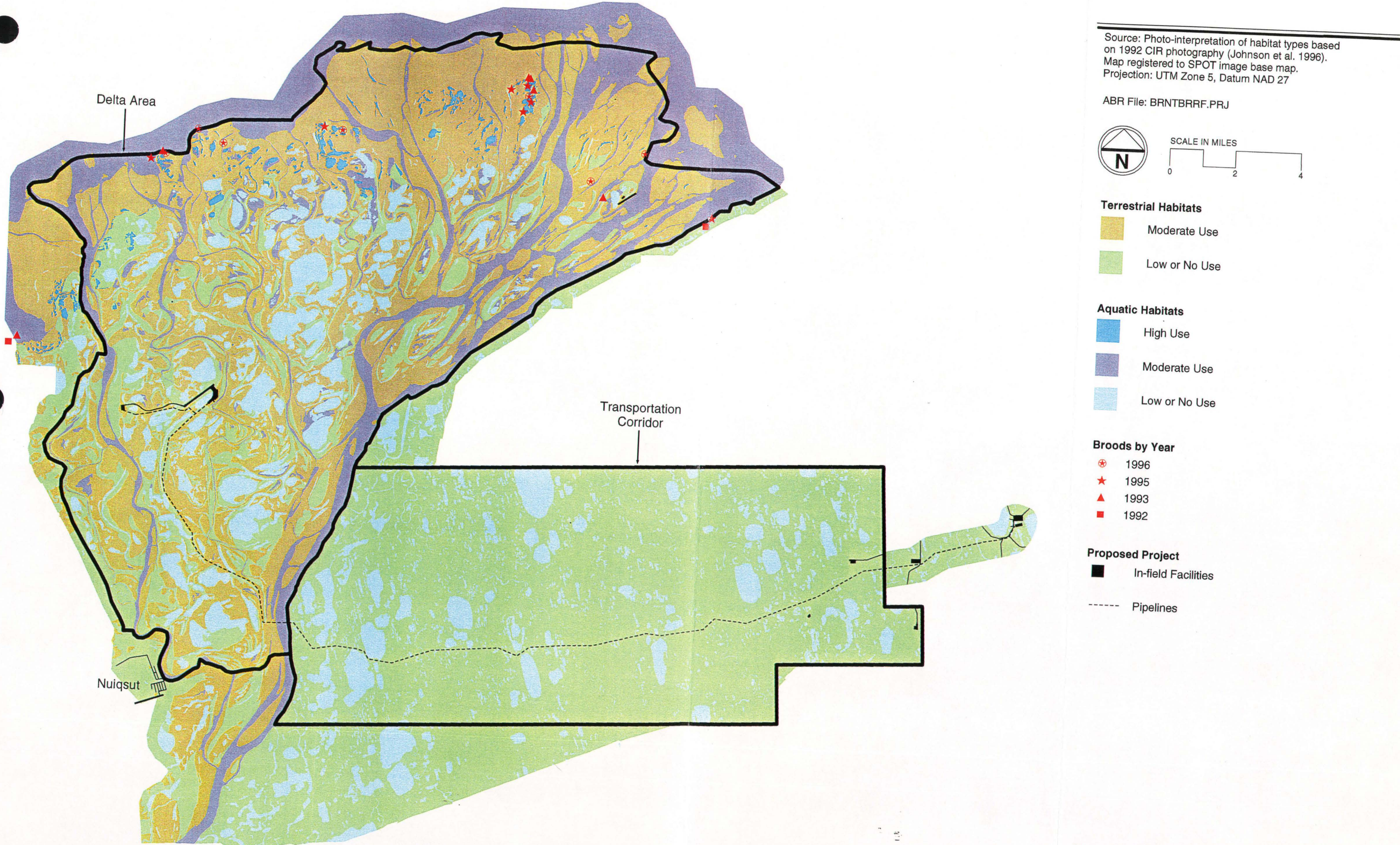


Figure 4.4.2-8.
Brant Brood-Rearing Habitat

Table 4.4.2-3. Numbers and densities (birds/mi²) of king eiders during pre-nesting and brood rearing on the Colville River Delta and transportation corridor.

Area	Year	Pre-nesting No. (/mi²)	Brood-Rearing Adults No. (/mi²)	Brood-Rearing Young No. (/mi²)
Colville River Delta				
	1993[1]	34 (0.37)	--	--
	1994	58 (0.31)	--	--
	1995	30 (0.16)	1 (<0.01)	7 (0.03)
	1996	53 (0.28)		
Transportation Corridor				
	1993[a]	31 (0.59)	--	--
	1995	240 (1.82)	51 (0.39)	156 (1.18)
	1996	162 (1.53)		

Sources: Colville River Delta—1993 (Smith et al. 1994), 1994 (Johnson 1995), 1995-96 (Johnson et al. 1996, 1997).
Transportation corridor—1993 (Anderson and Cooper 1994), 1995-96 (Johnson et al. 1996).

1 Aerial surveys in 1993 covered 50% of the area; therefore, densities are calculated only for the area searched (92 mi² on the Colville River Delta and 52 mi² in the transportation corridor).

drought in the prairie regions of North America (Derksen and Eldridge 1980). The Colville River Delta has the greatest diversity of duck species on the coastal plain, and densities are higher than elsewhere for some species (northern pintail and oldsquaw).

Like most waterbirds, ducks occur in the project area between May and September, when tundra ponds are ice-free. Ducks arrive on the Colville River Delta in mid- to late May, begin nesting within one to two weeks, and depart by late August (Rothe et al. 1983; North et al. 1984). Male king eiders and oldsquaws leave the breeding grounds by mid-June after females commence incubation, whereas male pintails molt in small flocks on the delta (Rothe et al. 1983). Duck broods first appear in early to mid-July, and most young can fly by late August (Rothe et al. 1983; North et al. 1984). Eider broods probably remain on the delta longer than other duck species, because their larger size requires more time for young to fledge (become capable of flight). Eider broods have been seen in the Prudhoe Bay oilfield until late August (TERA 1995).

For most activities except nesting, ducks primarily use aquatic habitats on the Colville River Delta. Northern pintails use aquatic sedge and grass marshes, flooded tundra, and brackish ponds; they nest in willow clumps, on small sedge islands, and on the edges of streams and polygons with permanent water. Broods and molting birds use aquatic sedge and grass marshes, brackish ponds, and salt marshes.

Oldsquaws use aquatic grass marshes and deep, open lakes, but nest in both dry (upland tundra and polygon ridges) and wet habitats (islands in small ponds and salt-killed tundra). Brood-rearing oldsquaws use aquatic sedge marshes, small lakes, and river channels, and molting groups occur more often on large, deep open lakes, tapped lakes, and coastal lagoons. In general, all aquatic habitats in the project area receive some use by ducks for nesting, brood-rearing, and foraging.

Habitat use was analyzed by Johnson et al. (1997) only for king eiders and only during the pre-nesting (delta and corridor) and brood-rearing periods (corridor only), due to sample size limitations. Too few observations were recorded for other species or other eider activities to warrant quantitative analysis. For instance, only seven king eider nests (four on the delta and three in the corridor, in five habitat types) were located in the project area and two broods (in two habitats) were counted in the delta (Johnson et al. 1996, 1997). Pre-nesting king eiders preferred the River or Stream habitat type on the delta, although they also used other open-water habitats (Johnson et al. 1997). In the transportation corridor, king eiders preferred Deep Open Water without Islands, both shallow water types, and River or Stream during pre-nesting (Johnson et al. 1997). These same habitats (except River or Stream) also were preferred by brood-rearing king eiders in the transportation corridor (Johnson et al. 1997). The information on habitat use by king eiders in the project area indicates a strong affinity for aquatic habitats for nesting and brood-rearing activities. These habitats also provide food for eiders during the breeding season (Kondratyev and Zadorina 1992).

__Tundra-nesting Birds__. Tundra-nesting birds in the project area include shorebirds, ptarmigan, and songbirds (Appendix I-2, Table 1). These species nest in terrestrial habitats, rather than in association with aquatic habitats.

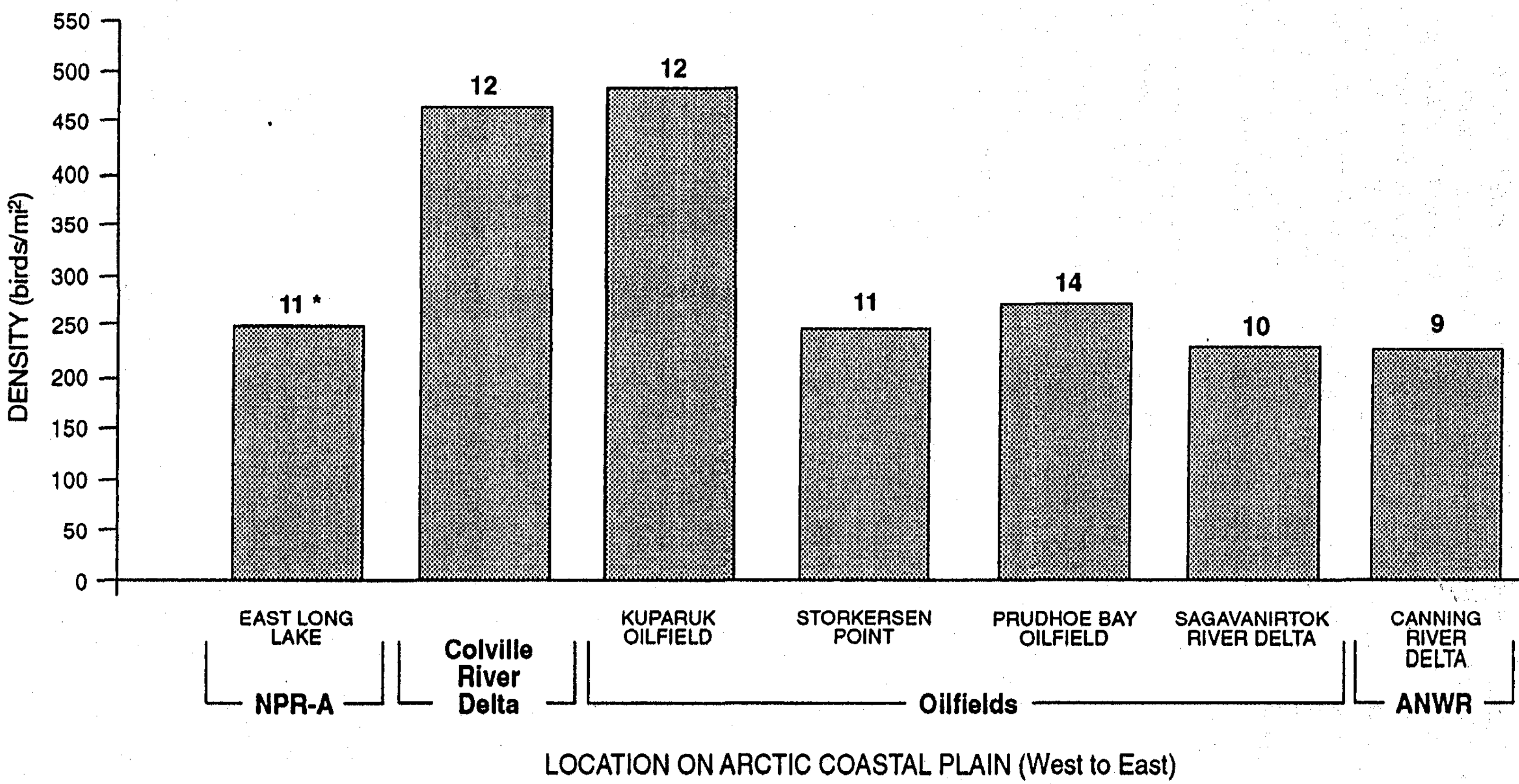
Shorebirds. Of the 31 species of shorebirds recorded on the delta, 17 are confirmed or probable breeders (Appendix I-2, Table 1). Studies conducted on the Colville River Delta assessed breeding shorebirds in 1982 (Rothe et al. 1983) and summer use (June-September) of the delta in 1986-87 (Nickles et al. 1987; Field et al. 1988; Gerhardt et al. 1988; Field 1993). These studies show that the most common shorebirds on the delta (in decreasing relative abundance) are the semipalmated sandpiper, pectoral sandpiper, red-necked phalarope, dunlin, and red phalarope (Rothe et al. 1983; Field 1993). These four were the most abundant species observed during a systematic ground survey of the in-field facility area on the delta in 1996 (Johnson et al. 1997). Several of these species (semipalmated sandpiper, red-necked phalarope, and dunlin) and the western sandpiper dominate the post-breeding bird aggregations that occur on the delta, and dunlins comprise almost 60% of the observations (Andres 1989, 1994). Both the shorebird diversity and density on the Colville River Delta during the breeding season equal or exceed those elsewhere on the Arctic Coastal Plain (Figure 4.4.2-9; Appendix I-3, Table 1).

Shorebirds are present in the project area from May to September. They begin to arrive in late May, and most are present by mid-June. Nesting usually begins 7 to 10 days after arrival. The young hatch during late June to mid-July, and fledge 3 to 4 weeks later. After the breeding season, many shorebirds move to the coast to feed in shoreline habitats before beginning migration in August (Rothe et al. 1983; Andres 1989, 1994; Smith and Connors 1993).

Shorebirds breeding in the project area use many habitats for nesting and brood-rearing. Plovers nest on the drier upland habitats, and phalaropes and other sandpiper species nest in wet sedge meadows and aquatic sedge and grass marshes. Some shorebirds (e.g., dunlins, semipalmated sandpipers) also nest in moist tussock tundra. Brood-rearing shorebirds move to tundra and aquatic habitats adjacent to the nest sites. After the young fledge, many shorebirds form large feeding flocks, often of mixed species, that tend to congregate in coastal habitats (Smith and Connors 1993). Shorebirds aggregate on marine shorelines of the Colville River Delta after the breeding season. The silt barrens on the outer delta were preferred by dunlins and sanderlings, whereas all other shorebirds preferred salt marshes (Andres 1989, 1994). The abundance of shorebirds on silt barrens ranks the Colville River Delta as one of the most heavily used areas on the coastal plain by post-breeding aggregations of shorebirds (Andres 1994). This habitat, along with the others used for breeding activities, are the primary source of food (small invertebrates and insects) for the birds (Andres 1989; Johnson and Herter 1989).

Ptarmigan. Rock and willow ptarmigan are widespread on the Arctic Coastal Plain, particularly inland from the coast (Johnson and Herter 1989). Willow ptarmigan, which are two to three times more abundant than rock ptarmigan on the Colville River Delta, are common breeders; Rock ptarmigan are uncommon breeders (Rothe et al. 1983; Nickles et al. 1987; Gerhardt et al. 1988). The relative abundance of ptarmigan has not been assessed in the transportation corridor, but rock ptarmigan appear to be more abundant than willow ptarmigan in the adjacent Kuparuk oilfield (Appendix I-3, Table 1). The reason for this variation in abundance between the delta and the Kuparuk oilfield is unclear, but it may be due to differences in habitat availability. A few ptarmigan of either species may overwinter on the Colville River Delta, but most winter in the foothills of the Brooks Range (Johnson and Herter 1989).

Songbirds. Songbirds occur on the Arctic Coastal Plain only during summer, because most winter in temperate and tropical regions in the Americas, and some winter in southern Asia. Of the 33 species recorded on the delta, eight are known or probable breeders (Appendix I-2, Table 1); the other species occur on the delta during migration or as summer vagrants. The most abundant breeding species in the project area is the Lapland longspur (Appendix I-3, Table 1). Highest densities of Lapland longspur nests occur in polygonized wet and moist meadows (Troy



Source: ABR 1996

Figure 4.4.2-9.
Breeding-Season Densities (birds/mi²) of Shorebirds in NPR-A, the Oilfields, and ANWR on the Arctic Coastal Plain of Alaska

* Number of species observed at each location.

1988). Other prominent breeding species on the delta are the yellow wagtail (an Asiatic migrant), sparrows (American tree, savannah, and white-crowned), hoary and common redpolls, and snow bunting. Their nesting phenology is similar to many of the other groups described above. Songbirds primarily use terrestrial habitats in the project area, and shrub habitats on the delta support the most species.

Predatory Birds. Predatory birds recorded on the Colville River Delta include raptors (nine species), gulls (seven species), jaegers (three species), arctic tern, and common raven (Appendix I-2 Table 1). Except for the raven, which is a year-round resident, all of these species winter farther south (Johnson and Herter 1989).

Raptors. None of the raptors (eagles, hawks, falcons, and owls) is a regular breeder on the Colville River Delta. Snowy and short-eared owls are locally common breeders on the coastal plain during years when small mammals are abundant. They nest in the project area during those times (ABR, Inc. unpublished data). Most raptors that breed regularly in northern Alaska are more common inland than on the outer coastal plain (Johnson and Herter 1989). Many raptors seen near the coast are juveniles, failed breeders, or birds having completed breeding activities. A few peregrine falcons (discussed in Section 4.4.3, Threatened and Endangered Species) and rough-legged hawks nest in coastal areas (Ritchie 1991). Bluffs along the central Colville River provide important breeding habitat for these species and gyrfalcons (White and Cade 1971). Golden eagles, which occur regularly on the delta and transportation corridor during summer, also nest on tributaries of the Colville River (Ritchie 1979). Thus, although the delta and transportation corridor are used by raptors, they are not important nesting areas.

Gulls, Jaegers, and Terns. Other predatory birds that occur in the project area include gulls, jaegers, and the arctic tern. Two species of gull (glaucous and Sabine's) breed in the project area; both are common to uncommon breeders on the Arctic Coastal Plain (Johnson and Herter 1989). Both species nest either as isolated pairs or in small colonies; several colonies of Sabine's Gulls occur on the delta and transportation corridor. Glaucous gulls also have been observed nesting in larger colonies (>15 pairs) near Prudhoe Bay (Murphy et al. 1987). All three species of jaegers occur in the project area, but only the parasitic jaeger is a regular breeder (Appendix I-2, Table 1). Pomarine jaegers are common only during spring migration (early June), when as many as 800 birds may pass through the delta (Renken et al. 1983). Long-tailed jaegers nest occasionally, but are more common inland. Arctic terns, a common breeder across the coastal plain, breed in the project area (Johnson and Herter 1989). June densities of gulls, jaegers, and terns are higher on the delta than elsewhere on the coastal plain (Appendix I-2, Table 2). The breeding phenology for all of these birds is similar (May-September) to that described for other species, except that gulls arrive somewhat earlier (Simpson et al. 1982; Renken et al. 1983; Rothe et al. 1983; Johnson and Herter 1989).

Nesting and feeding habitats used in the project area differ among species. Glaucous gulls nest on islands and peninsulas in the following habitat types: small ponds with emergent vegetation, basin wetland complexes, and deep open waters. Sabine's gulls and arctic terns nest in similar habitats but also use ponds whose margins include eroding polygons. Jaegers nest on polygon ridges in basin wetland complexes and in polygonized wet meadows. All species range widely over the tundra in search of food, with glaucous gulls and jaegers eating small birds, small mammals, and the eggs and young of waterfowl. Sabine's gulls and arctic terns feed on aquatic invertebrates and small fishes in deep open lakes, deep ponds with emergents, and ponds in basin wetland complexes (Rothe et al. 1983). Arctic terns also eat fishes caught in the channels of the Colville River. In mid-summer, groups of more than 100 Sabine's gulls have been observed feeding, probably on invertebrates (Rothe et al. 1983), in brackish habitats on the outer delta (ABR, Inc. unpublished data). Gulls, jaegers, and terns occur throughout the project area, given their broad habitat use and diverse prey.

Common Raven. Common ravens are uncommon residents on the Arctic Coastal Plain, where they closely associate with human habitation (Johnson and Herter 1989). Ravens may breed on the Colville River Delta (Simpson et al. 1982; Renken et al. 1983) but more commonly nest on cliffs and bluffs farther up the Colville River (Kessel and Cade 1958; White and Cade 1971). Small numbers of ravens use the project area during summer. Ravens occasionally nest near the coast, primarily on buildings and other structures, including oilfield facilities (Johnson and Herter 1989; Ritchie 1991). Common ravens are the earliest breeding species on the coastal plain; nesting begins by early April and young fledge by mid-June (Johnson and Herter 1989). Ravens range widely across the tundra in search of food (bird eggs, small mammals, carrion).

Mammals

Based on published reports and general knowledge of species distribution, at least 34 species of mammals occur in the region surrounding the Colville River Delta (Table 4.4.2-4). About one-third of these species are common or abundant, one-third are uncommon, and the remaining species are rare or accidental in occurrence. Most of the mammals (25 species) are terrestrial, but nine species (including polar bear) are marine mammals. Subsistence harvest of caribou, whales, and seals by local residents constitutes the principal uses of mammals by humans in the region. Species accounts are presented below.

Caribou. One of the most abundant mammal species in the region is the caribou. Of the four herds (Central Arctic, Teshekpuk Lake, Western Arctic, and Porcupine herds) recognized in arctic Alaska, two inhabit the project area and are described below (population numbers are from Abbott 1993, Hicks 1994, Bente 1996, and ADFG unpublished data):

- The Central Arctic Herd (CAH), the principal caribou herd using the Colville River Delta and adjacent area to the east, ranges from the Colville and Itkillik rivers on the west to the Canning and Tamayariak rivers in the Arctic National Wildlife Refuge (ANWR) on the east. In most years, calving is concentrated in two general areas: one west of the Sagavanirktok River, in the vicinity of the Kuparuk oilfield, and the other east of the Sagavanirktok River, south of Bullen Point (Whitten and Cameron 1985; Lawhead and Cameron 1988). This herd increased steadily from about 5,000 in the mid-1970s (when it was first described by the ADFG as a distinct herd) to a high of 23,444 in 1993. By July 1995, however, the Central Arctic herd had decreased 23% to 18,093 caribou.
- The Teshekpuk Lake herd (TLH) ranges across the Arctic Coastal Plain west of the Colville River Delta; the principal calving area is located around Teshekpuk Lake, approximately 50 mi west of the Colville River Delta. Since the late 1970s, the herd increased steadily to 11,822 caribou in 1984, 16,649 in 1989, and 27,686 caribou in 1993. A 1995 census totaled 25,076 caribou, a 9% decrease since 1993.

The Colville River Delta is at the western edge of the CAH range and the eastern edge of the TLH range, and both herds may use the delta during summer. There is no evidence to suggest that caribou from the Western Arctic or Porcupine herds occur on the Colville River Delta (other than rare instances of dispersing individuals). The greatest use by caribou occurs during July and August, when CAH caribou seek relief on the delta from parasitic insects. Caribou from the TLH use the Colville River Delta infrequently during periods of intense insect harassment and easterly winds, which cause caribou to move onto the delta from the west.

Most CAH caribou occur on the northern coastal plain during the calving and insect seasons; the western segment of the CAH (at least half of the herd) regularly encounters oilfield development during those seasons (Lawhead and Curatolo 1984). By May, pregnant cows move north and disperse widely over the coastal plain to calve (late May-early June). Each cow bears one calf. Few cows with calves occur near oilfield facilities during the calving season (Dau and Cameron 1986; Lawhead 1988; Johnson and Lawhead 1989; Cameron et al. 1992), presumably because they are sensitive to human activity and disturbance.

Aerial surveys during late May and early June in 1992–93 and in 1995–96 (Smith et al. 1993, 1994; Johnson et al. 1996, 1997) found that most calving in the Alpine project vicinity occurred in the uplands southeast of the transportation corridor and southwest of the Kuparuk oilfield (Appendix I-4, Figures 1-4). Densities in the transportation corridor, and north of it, were relatively high each year, however. This distribution is consistent with the general calving distribution of the western segment of the CAH, which appears to have shifted south and west of the Kuparuk River and Milne Point oilfields since the late 1980s (Lawhead and Cameron 1988; Smith et al. 1994; Cameron 1995 personal communication). Very few caribou used the Colville River Delta in the 1992-93 and 1995 calving seasons (Smith et al. 1993, 1994; Johnson et al. 1996), consistent with past ADFG surveys. Thus, calving by caribou in the project area occurs much more commonly in the transportation corridor than on the delta.

Table 4.4.2-4. Mammal species known or suspected to occur in the region of the Colville River Delta.

Common Name	Scientific Name	Iñupiaq Name	Status[1]
Barrenground shrew	*Sorex ugyunak*	Ugrugnaq	C?
Tundra shrew	*Sorex tundrensis*	Ugrugnaq	U?
Snowshoe hare	*Lepus americanus*	Ukalliatchiaq	R[2]
Tundra hare	*Lepus othus*	Ukallisugruk	R
Arctic ground squirrel	*Spermophilus parryii*	siksrik, sigrik	A
Northern red-backed vole	*Clethrionomys rutilus*	aviŋŋaq	R?
Tundra vole	*Microtus oeconomus*	aviŋŋaq	U
Singing vole	*Microtus miurus*	aviŋŋaq	C
Brown lemming	*Lemmus sibiricus*	aviŋŋapiaq	U
Collared lemming	*Dicrostonyx rubricatus*	qilaŋmiutaq	C
Porcupine	*Erethizon dorsatum*	qiŋağluk	R
Coyote	*Canis latrans*	amağuuraq	R
Gray wolf	*Canis lupus*	amağuq	R
Arctic fox	*Alopex lagopus*	tiğiganniaq	C
Red fox	*Vulpes vulpes*	Kayuqtuq	U
Grizzly (brown) bear	*Ursus arctos*	akłaq	U
Polar bear	*Ursus maritimus*	Nanuq	U
Ermine, short-tailed weasel	*Mustela erminea*	itiğiaq	C
Least weasel	*Mustela nivalis*	Naulayuq	U
Mink	*Mustela vison*	itiğiaqpak	R
River otter	*Lontra canadensis*	Pamiuqtuuq	R
Wolverine	*Gulo gulo*	Qavvik	U
Lynx	*Lynx canadensis*	Niutuiyiq	R
Pacific walrus	*Odobenus rosmarus*	Aiviq	R
Spotted seal	*Phoca largha*	Qasigiaq	C
Ringed seal	*Phoca hispida*	qayağulik, natchiq	C
Bearded seal	*Erignathus barbatus*	Ugruk	U
Hooded seal	*Cystophora cristata*		R
Moose	*Alces alces*	Tuttuvak	U
Caribou	*Rangifer tarandus*	Tuttu	A
Muskox	*Ovibos moschatus*	umiŋmak	U
Bowhead whale	*Balaena mysticetus*	ağviq	C
Narwhal	*Monodon monoceros*	qil alugaq tuugaalik	R
Beluga, belukha, white whale	*Delphinapterus leucas*	qil alugaq, sisuaq	C

Sources: Rausch (1953), Bee and Hall (1956), Manville and Young (1965), Garrott (1980), van Zyll de Jong (1983); Common and scientific Iñupiaq names follow Wilson and Reeder (1993), Jarrell et al. (1994), and NSB (1996), Webster and Zibell (1970), MacLean (1980) and Kaplan (1996 personal communication),

[1] A = abundant; C = common; U = uncommon; R = rare or accidental; ? = status uncertain.
[2] Species designated as rare or accidental are at the limit of their range.

If caribou are to reproduce successfully, access to high-quality forage is critical in spring and summer. Caribou use moist tussock tundra heavily during calving (Kuropat and Bryant 1980; Jorgenson and Udevitz 1992), when they feed on emerging flowers of the cotton sedge, *Eriophorum vaginatum*. During June-August, the diet broadens to include newly emerged leaves of willows, flowering plants, and sedges in a variety of habitats, especially Moist Sedge-Shrub Meadows and Wet Sedge-Willow Meadows. In spring and summer, caribou prefer easily digestible, nitrogen-rich forage to replace body reserves depleted by winter, pregnancy, and lactation (Klein 1990). Energy demands on cow caribou are greatest during late pregnancy and lactation and are exacerbated by insect harassment (Fancy 1986). Failure to build adequate energy reserves can cause cows to enter winter in poor condition and delay reproduction for a year or more (Reimers 1983; Cameron et al. 1993; Cameron 1994).

Following calving, CAH caribou generally stay within 20 mi of the Beaufort Sea coast through the insect season (Lawhead and Curatolo 1984). Mosquito and oestrid fly (warble fly *Hypoderma tarandi*; nose-bot fly *Cephenemyia trompe*) harassment strongly influences caribou movements between late June and early August (White et al. 1975; Roby 1978). Warm, calm weather conditions promote insect flight activity (Dau 1986), although insect activity is lowest near the coast (Dau 1986) because of lower air temperatures and higher wind speeds (Brown et al. 1975; Walker et al. 1980). Mosquito-harassed caribou form large groups and move generally upwind toward the coast (Lawhead and Curatolo 1984; Dau 1986) until reaching "relief habitat." Because prevailing winds in July are northeasterly (Brown et al. 1975), CAH caribou typically seek mosquito-relief habitat along the coast east of the Colville River Delta, regularly moving as far east as the Kuparuk River delta (Smith et al. 1994). With light westerly breezes during warm weather, however, large groups of CAH caribou may move westward to the Colville River Delta (Smith et al. 1994; Johnson et al. 1996). **Maximum numbers of CAH caribou in the study area during the insect season were approximately 3,300 caribou on the outer Colville River Delta in mid-July 1992 (Smith et al. 1993) and 1996 (Johnson et al. 1997), and 6,400 caribou in the Alpine transportation corridor in mid-July 1996 (Johnson et al. 1997).** Insect-harassed TLH caribou infrequently move onto the delta from the west during periods of prolonged easterly breezes (Smith et al. 1994). When temperatures cool and mosquito activity abates, caribou move away from the coast, usually to the south and west. These conditions also bring CAH caribou from the east into the Alpine transportation corridor and onto the Colville River Delta. Mosquito harassment declines markedly by late July (Lawhead and Curatolo 1984).

By mid-July, oestrid flies drive caribou to seek relief in a variety of unvegetated and elevated sites (such as river bars, mud flats, dunes, pingos, gravel pads, and roads) (Roby 1978; Dau 1986). Relief is often sought in the shade of elevated pipelines, buildings, and even parked vehicles. Fly harassment typically continues into August (Lawhead and Curatolo 1984; Dau 1986), when CAH caribou begin to disperse inland and migrate south off the coastal plain. Although a few caribou breed and winter (October-April) in the project area, most of the CAH moves considerably farther south to the **foothills and mountains of the** Brooks Range (Smith et al. 1994).

In summary, the project area is used most heavily by caribou between late May and late August during the calving and insect seasons. Calving occurs in the transportation corridor from late May to mid-June; very few cows calve on the delta. Relief from insect harassment is sought on the delta during July and August. At least half of the CAH can occur in the project area during summer. Most caribou breed and winter considerably south of the project area.

__Polar Bears__. Polar bears occur throughout the ice-covered seas of the Arctic and are common within 200 mi of the arctic coast of Alaska (Amstrup and DeMaster 1988). Two major populations (stocks) of polar bears have been identified in Alaska: one in the Beaufort Sea and the other in the Chukchi and northern Bering seas; these populations overlap in northwestern Alaska between Point Hope and Point Barrow (USFWS 1995). The range of the Beaufort Sea population, which encompasses the Colville River Delta, extends eastward into Canada between Banks Island and the mainland of the Northwest Territories. This population, which was estimated at 1,579 to 2,165 bears in 1994, has grown at an average annual rate of 2.4% over the last 20 years and now appears to be increasing slightly or stabilizing near carrying capacity (USFWS 1995).

Polar bear distribution is dictated largely by seasonal ice that is inhabited by ringed seals, the primary prey of polar bears (Smith 1980). As seasonal ice forms and spreads southward from the polar pack ice in fall, polar bears move with it, usually appearing along the Beaufort coast in October (Lentfer 1972). Polar bears are typically on land only during the winter denning season. Pregnant females enter dens in October or November, give birth (one to three cubs) in December or January, and emerge in late March or April (Lentfer and Hensel 1980; Amstrup and Gardner 1994). About half of the dens occur on land (Amstrup and Gardner 1994), typically in deep snowdrifts at bluffs along rivers, streams, and lake banks (Amstrup 1995 personal communication); the remainder are on sea ice. Females tend to return each year to the same general area to den (Amstrup and Gardner 1994). Adult males and non-pregnant females are active year-round and do not use dens (except as temporary shelters during poor weather).

Polar bears have historically denned in the Colville River Delta region in low numbers. USFWS computer records (Amstrup 1995 personal communication) list several dens between the Colville River Delta and Oliktok Point (Appendix I-4, Figure 5). Another den was located on Kalubik Creek, just east of the delta, in 1991-92 (Shideler 1992 personal communication in Smith et al. 1993). Nuiqsut hunters (Appendix A in USFWS 1995) described other dens and denning areas in the Colville River Delta region, some of which dated from the 1920s, 1940s, and 1950s: Woods Point; the mouths of the Kupigruak and Nechelik (Nigliq) channels; 15 mi north of Nuiqsut; and the Oliktok Point area. Seaman et al. (1981) showed 12 historic locations of dens, and females with cubs recently out of dens, between the lower Itkillik River and Kalubik Creek, plus five locations in the Beaufort Sea approximately 8 to 20 mi off the Colville River delta. Seaman et al. (1981) classified the Colville River Delta and coastal plain to the east as "preferred onshore/barrier island denning areas," and classified the Kachemach, Miluveach, and Kalubik drainages as "high potential riverine denning areas," based on historical information and USFWS records. Lentfer and Hensel (1980) reported two dens along the east side of the Colville River near the transportation corridor, plus two observations of females with cubs recently out of dens. These records demonstrate that polar bears have historically denned in the Colville River Delta region, although the number denning annually cannot be estimated with confidence. The proportion of bears denning on land in the Beaufort Sea region is increasing, apparently because of population recovery following hunting restrictions in the early 1970s (Stirling and Andriashek 1992; Amstrup and Gardner 1994). Therefore, it is reasonable to conclude that pregnant females will den on land more frequently in the future than in the recent past.

<u>Grizzly Bears</u>. Grizzly bears (also called brown bears) occur throughout northern Alaska from the Brooks Range northward. Population densities are low on the coastal plain. The population using the Prudhoe Bay and Kuparuk River oilfields is increasing. In 1995, ADFG biologists estimated that at least 28 bears inhabited 6,700 mi² between the Colville and Shaviovik rivers, extending inland 50 mi to the White Hills (Shideler and Hechtel 1995a; Shideler 1995 personal communication). The 27 bears captured and marked by ADFG in the oilfields since 1991 have large home ranges (1,000 to 2,000 mi²) and are very mobile, moving up to 30 mi a day (Shideler and Hechtel 1995b). Grizzly bears have been observed more commonly in the transportation corridor and uplands to the south than on the Colville River Delta; at least 14 different bears (most of which had been marked by ADFG) were seen in summer 1995 (Johnson et al. 1996).

Grizzly bears in northern Alaska den from early October to late April or May, and one to three cubs (average of two) are born per litter in December or January (Reynolds 1979; Garner and Reynolds 1986; Shideler and Hechtel 1995a). Males and females remain separate for most of the year, coming together only briefly to court and mate between May and July (Garner et al. 1986). Grizzlies dig dens in pingos, banks of rivers and lakes, dunes, and steep gullies in uplands on the coastal plain (Harding 1976; Shideler and Hechtel 1995b; Shideler 1995 personal communication). Most of the bears studied by ADFG denned within 30 mi of the oilfields, although a few denned 60 to 100 mi inland (Shideler and Hechtel 1995b; Shideler 1995 personal communication). Dens near the project area are clustered in the uplands south (>6 mi) of the transportation corridor, especially in the headwaters of the Miluveach and Kachemach rivers, although single grizzlies denned along the Miluveach River in the eastern transportation corridor during the winters of 1995-96 and 1996–97 (Appendix I-4, Figure 5). No grizzly bear dens were reported on the Colville River Delta until the winter of 1996–97, when a sibling pair of subadult males denned together near the Sakoonang Channel approximately 1 mi south of the proposed in-field facility area, and a female gave birth to cubs in a den on a large island in the East Channel of the Colville River (Johnson et al. 1997; Shideler 1997 personal communication). Thus, grizzly bears may den anywhere in the project area in low densities.

Grizzlies use river drainages on the coastal plain, including the Colville, Kachemach, and Miluveach rivers, as primary travel routes and foraging areas (Shideler and Hechtel 1995a; Johnson et al. 1996, 1997). Riverine habitats contain preferred foods, such as legumes (flowering plants in the pea family) and ground squirrels. In spring and summer, grizzly bears mainly eat plants, but also take ground squirrels, fox pups, caribou, and muskoxen (Quimby 1974; Garner and Reynolds 1986; Garner et al. 1986; Shideler 1995 personal communication). Artificial food sources also are powerful attractants, so human facilities located near rivers are especially likely to attract grizzly bears. Grizzlies in the Prudhoe Bay and Kuparuk oilfields have larger litters, higher growth rates, and greater body sizes (averaging up to 50 to 100 pounds greater) than bears elsewhere on the coastal plain, evidently because of supplemental foods from artificial sources (Shideler and Hechtel 1993). A small to moderate number of grizzlies would encounter the ADP facilities, and that number may increase as the population continues to grow.

__Muskox__. Muskoxen are native to northern Alaska but were extirpated by the late 1800s (Smith 1989). Muskoxen were reintroduced on the Arctic Coastal Plain at Barter Island (in ANWR) in 1969 and at the Kavik River (between Prudhoe Bay and ANWR) in 1970 from Nunivak Island in western Alaska. These reintroductions formed the ANWR population, which grew rapidly and expanded west and east within a decade (Garner and Reynolds 1986). The ANWR population stabilized at 350 to 400 muskoxen after 1986, whereas numbers to the west increased rapidly (Reynolds 1992a, 1995). Stephenson (1993) estimated that 165 muskoxen inhabited the region between the Colville River and ANWR, out of a total population exceeding 550 animals in northeastern Alaska and the northern Yukon. Another population was reestablished near Cape Thompson in northwestern Alaska in 1970 and 1977 and has slowly expanded eastward (Smith 1989).

Muskoxen home ranges are smaller, and activity and movement rates are much lower, during winter than summer. Long-distance movements from winter to summer ranges are common in mid- to late June following river break-up and leafing out of willows along drainages (Reynolds 1992b). Group size typically decreases in summer as the breeding season (rut) approaches; most groups in ANWR ranged from 10 to 30 animals (Reynolds et al. 1986; Reynolds 1992a). The breeding season occurs in August and September, and calves are born between late April and late June with a peak in mid-May (Reynolds et al. 1986). Cows produce single calves at intervals of one to three years.

Muskoxen currently use the ADP area in small numbers during summer, and more are expected to occur there in the future as the population continues to expand. Golden (1990) reported that a small number of muskoxen first overwintered in the Colville River area southeast of Nuiqsut in 1988-89. A few muskoxen (mostly lone bulls) were seen on the Colville River Delta in summer during the 1992-93 and 1995-96 surveys (Smith et al. 1993, 1994; Johnson et al. 1996, 1997), but most muskoxen were seen along the east bank of the Colville River, the lower Itkillik River, and the lower Kachemach River (Appendix I-4, Figure 6). The largest groups (four groups totaling 61 in 1995, seven groups totaling 84 in 1996) have been seen in early June in the uplands east of the Itkillik River, well south of the Alpine project area. Most animals in the Itkillik-Colville region appear to winter east of the Itkillik River (an ADFG survey in April 1997 found approximately 90 muskoxen in that area [Carroll 1997 personal communication]), dispersing into smaller groups during summer. Some of these groups move north along the Itkillik and Kachemach rivers to the Colville River Delta and western transportation corridor. Southward movements and increased group sizes presumably occur during fall and winter, although surveys have not been conducted in those seasons.

Habitat use by muskoxen varies seasonally. In winter, muskoxen select upland habitats near ridges and bluffs with shallow, soft snow cover that permits easy access to food plants (Klein et al. 1993). In spring, muskoxen use Moist Tussock Tundra and Moist Sedge-Shrub Tundra, apparently seeking high-quality flowering sedges (Jingfors 1980; Reynolds et al. 1986). By late spring and summer, muskoxen prefer river terraces, gravel bars, and shrub stands along rivers and tundra streams (Jingfors 1980; Robus 1981); there they eat willow leaves, forbs (especially legumes), and sedges (Robus 1984; O'Brien 1988). Thus, Riverine and Upland Shrub habitats and Moist Sedge-Shrub Meadows on the Colville River Delta and transportation corridor are the most important habitats for muskoxen.

Furbearers. Eight species of furbearing mammals (all small or medium-sized carnivores) occur in the Colville River Delta region (see Table 4.4.2-4). Only the arctic fox is common (see discussion below); the red fox is uncommon; the wolverine and gray wolf are uncommon to rare; and the coyote, lynx, river otter, and mink are rare or accidental because they are at the northern limit of their ranges (Bee and Hall 1956; Manville and Young 1965). Small numbers of red foxes den on the Colville River Delta. Johnson et al. (1997) reported five dens (Figure 4.4.2-10) on sand dunes in Upland Shrub habitat on the delta in 1996; these dens represented 26% of the total fox dens found on the delta, a higher percentage than has been observed elsewhere for this species on the coastal plain of Alaska or Yukon (Burgess et al. 1993b; Smits and Slough 1993). Wolverines have also been observed in low numbers on the Colville River Delta and east to the Kuparuk River (Smith et al. 1993; ABR, Inc. unpublished data), as well as elsewhere on the coastal plain. Wolves have probably never been abundant on the outer coastal plain, and the North Slope population has remained low since federal predator control in the 1950s and early 1960s. In recent years, however, increases in take by Nuiqsut residents and in reports of wolves in northern Alaska indicate the population is increasing (Carroll 1996 personal communication). Since winter 1993-94, several wolf sightings have been reported by workers in the Kuparuk oilfield (Schuyler 1995 personal communication); a single wolf was observed hunting caribou in the ADP transportation corridor in late July 1997 (ABR, Inc. unpublished data). USFWS biologists (North et al. 1984) saw a single coyote on the delta during four summers of bird research in the early 1980s, but no recent sightings of lynx, mink, or river otter have been reported.

Arctic Fox. The arctic fox is the most common predatory mammal on the Colville River Delta and adjacent coastal plain. The arctic fox preys on birds and small mammals and is readily attracted to areas of human activity and artificial food sources (Eberhardt et al. 1982) where its status as a rabies vector raises safety concerns. Population estimates are not available, but the population cycles in response to fluctuating populations of prey species (Follmann and Fay 1981). Small mammals (mainly collared and brown lemmings but also singing and tundra voles and ground squirrels) are the most important prey, supplemented by caribou and marine mammal carcasses and, in summer, by nesting birds and their eggs (Chesemore 1968; Garrott et al. 1983).

Arctic foxes travel long distances in distinct seasonal patterns. Most foxes move toward the coast and onto the sea ice in fall (Chesemore 1975; Follmann and Fay 1981); disperse widely from their summer territories, often scavenging on polar bear kills, in winter (Chesemore 1975; Eberhardt and Hanson 1978); and move back onshore in late winter to early spring to their summer territories, where they mate (March—April) and den. Dens are occupied from late spring until pups disperse in August (Chesemore 1975). Pups (average four to eight but up to 12 per litter) are born between May and early July, seven to eight weeks after adults mate (Chesemore 1975; Follmann and Fay 1981). Besides starvation, predation (mostly by golden eagles and grizzly bears) is a leading cause of mortality (Garrott and Eberhardt 1982; Burgess et al. 1993b). The highest number of arctic foxes in the Colville River Delta and transportation corridor occurs between late winter and fall.

Arctic fox pairs maintain exclusive territories around their dens during summer, and some foxes in the oilfields also use dens for winter shelter (Eberhardt et al. 1983). Home ranges average 8 mi^2 in the Prudhoe Bay oilfield (Eberhardt et al. 1982) but probably are larger outside the oilfields (away from artificial food sources). Because dens generally are stable structures that persist for decades (Macpherson 1969), more dens are available each year than are used; the occupancy rate is higher when food is abundant (Chesemore 1975; Eberhardt et al. 1983). Foxes may use the same den site in successive years. The average density of dens is three to five times higher in developed portions (one per 4 to 5 mi^2) of the oilfields than in undeveloped areas (one per 13 to 28 mi^2) of the coastal plain (including the Colville River Delta and transportation corridor) (Garrott 1980; Eberhardt et al. 1983; Burgess et al. 1993b; Johnson et al. 1997). Clearly, artificial food sources greatly influence den density and occupancy.

Fourteen arctic fox dens were located on the Colville River Delta, 16 in the transportation corridor, and 14 outside of those areas during 1992–93 and 1995–96 surveys (Johnson et al. 1997; see Figure 4.4.2-10). Foxes den on raised landforms with well-drained soil: ridges, dunes, lake and stream shorelines, and pingos (Chesemore 1969; Eberhardt et al. 1983; Burgess et al. 1993b). On both the delta and transportation corridor,

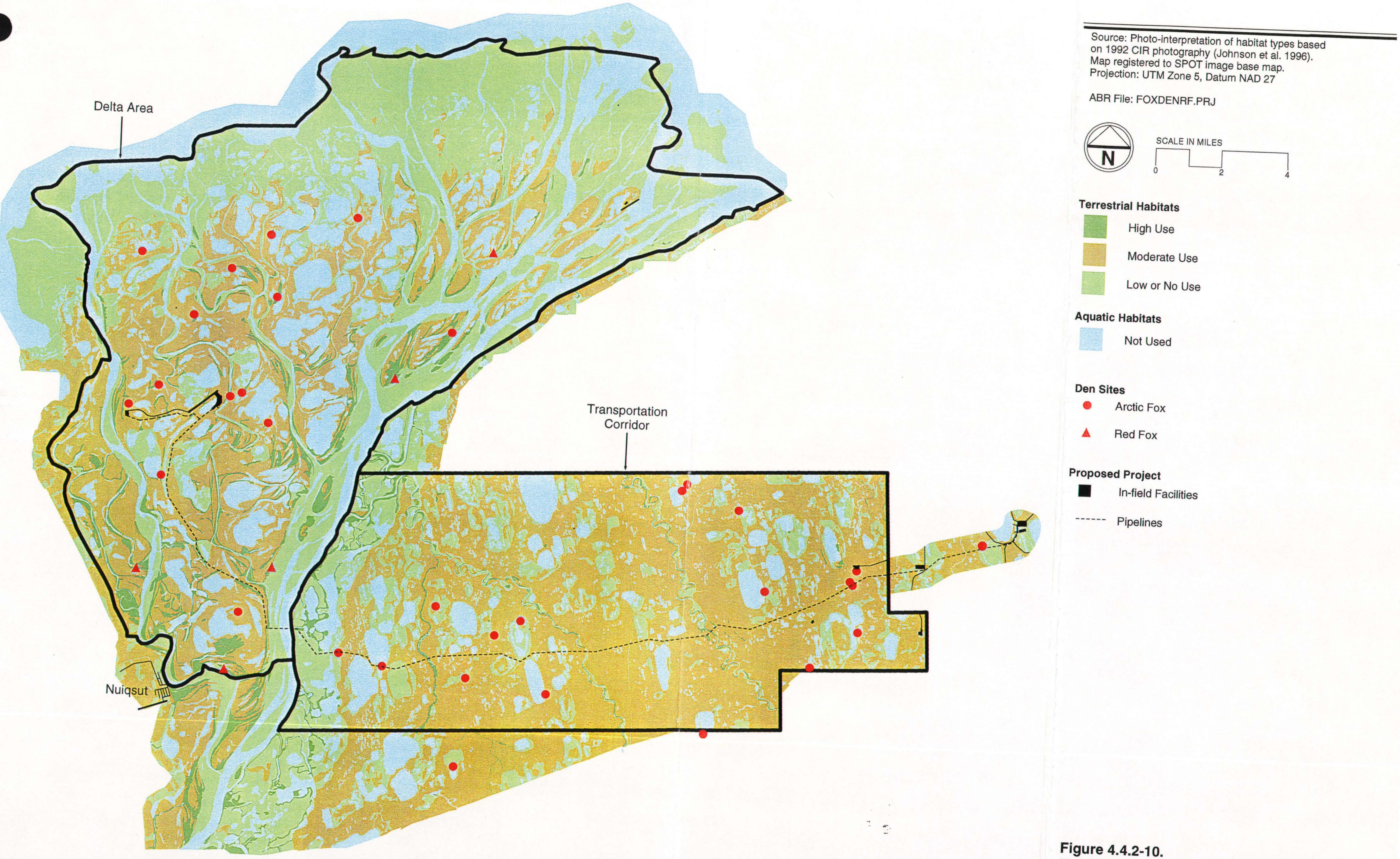


Figure 4.4.2-10.
Fox Denning Habitat

arctic foxes preferred Upland Shrub habitat for denning, followed by Moist Sedge-Shrub Meadow (Johnson et al. 1997). Upland Shrub is relatively scarce in both areas, whereas Moist Sedge-Shrub Meadow is scarce only on the delta. A few dens occurred in other habitats, but all dens were on raised landforms.

Moose. Moose are distributed across the North Slope in low numbers, concentrating in winter along major river drainages. As the largest drainage on the North Slope, the Colville River is the center of regional abundance. Coady (1979) reported that moose were most numerous in late winter in the central Colville drainage ($\geq$ 1.25 moose per mi^2 from the Anaktuvuk River upstream to the Etivluk River), moderately numerous on the lower Colville (0.25 to 1 per mi^2 from the Anaktuvuk River downstream to the head of the delta), and least numerous on the Colville River Delta (<0.25 moose per mi^2). The population in this region recently has declined dramatically (49% from 1991 to 1995), primarily in the central and upper Colville drainage (Carroll 1995; Carroll 1996 personal communication). The causes of this decline are unknown, but adverse weather, increased predation, a deteriorating food supply, and disease are all possible contributing factors.

Field studies on the Colville River Delta confirm that the project area is used by a few moose each year. One to four moose were seen on the delta each year by USFWS biologists during summer bird studies in the early 1980s (Simpson et al. 1982; Renken et al. 1983; Rothe et al. 1983). No moose were seen during the aerial or ground surveys of the delta and transportation corridor conducted by Johnson et al. (1997) in 1992-93 and 1995–96, although ground crews saw two sets of tracks one year. In late July 1997, two moose were seen near the east bank of the Colville River north of the transportation corridor (ABR, Inc. unpublished data). Moose are sighted rarely in the Kuparuk oilfield (ABR, Inc. unpublished data).

Moose prefer the Riverine or Upland Shrub habitat type (see Figure 4.4.2-1) which provides high-quality winter forage in willow and alder shrub thickets (Mould 1977).

Small Mammals. Six rodent species, two weasel species, and two hare species have been recorded in the region of the lower Colville River (see Table 4.4.2-4). Arctic ground squirrels, two lemming species, and three vole species inhabit the region at varying levels of abundance, depending on the species (Pitelka et al. 1955; Garrott et al. 1983; Garner and Reynolds 1986). Short-tailed and least weasels are uncommon (Rausch 1953; Bee and Hall 1956). Snowshoe hares are increasing dramatically in the central Colville drainage (upstream from the mouth of the Anaktuvuk River) (Carroll 1996 personal communication). Although none were observed in the Alpine project area by USFWS in 1981-84 or during ARCO-sponsored studies in 1992-93 and 1995 (Smith et al. 1993, 1994; Johnson et al. 1996), two hares were seen in the delta and transportation corridor in June 1997 (ABR, Inc. unpublished data). The tundra hare historically occurred on the northern coastal plain (Bee and Hall 1956; Manville and Young 1965), but probably no longer occurs in the Colville region because its range has contracted (Klein 1995). While all of these species are ecologically important as plant consumers or predators, the following accounts focus on the most common small mammals (rodents) in the project area.

Arctic Ground Squirrel. The arctic ground squirrel is abundant on the coastal plain of northern Alaska (Bee and Hall 1956). Because ground squirrels live underground, they require unfrozen soils that are deep enough for digging burrows. The most suitable conditions for burrowing are in upland habitats such as sand dunes, ridges, river banks and bluffs, and pingos. On the coastal plain, ground squirrels are most abundant along major river drainages. Average densities at Meade River (west of the Colville River Delta) were three times greater (0.6 vs 0.2 squirrels and 1.4 vs 0.5 burrows per acre) in dune ridges than in river bluffs (Batzli and Sobaski 1980). On the Colville River Delta and transportation corridor, most ground squirrels inhabit Riverine or Upland Shrub habitat (which includes ridges, dunes, and pingos). Also important are bank habitats (classified in the Moist Sedge-Shrub Meadow type), such as those along the river channels and distributaries on the delta, and along the Kachemach and Miluveach rivers in the transportation corridor.

Ground squirrels hibernate from September to May (McLean and Towns 1981; Garner and Reynolds 1986). Mating occurs immediately after hibernation; the young are born in June (three to four weeks after mating), emerge from burrows by July, and begin to disperse by August (Garner and Reynolds 1986). Food eaten includes a variety of plants (>40 species) and animals (other rodents and carrion; Batzli and Sobaski

1980; McLean 1985). Ground squirrels are important prey for golden eagles, foxes, and grizzly bears (Garner and Reynolds 1986).

Lemmings and Voles. Collared and brown lemmings and tundra, singing, and red-backed voles inhabit the project area. Accounts are given below for each of these species, except the red-backed vole, because it is rare in the project area. Red-backed voles almost exclusively occur in the foothills of the Brooks Range (Bee and Hall 1956; Pitelka 1957; Pitelka and Batzli 1993).

Collared lemmings are the most numerous small mammal on the central coastal plain (including the Colville River Delta and transportation corridor) (Feist 1975; Hanson and Eberhardt 1980; Garrott et al. 1983), whereas brown lemmings are uncommon to rare in that region (Feist 1975; Hanson and Eberhardt 1980; Garrott et al. 1983). Collared lemmings prefer drier habitats (tussock tundra and high-center polygons) than do brown lemmings and tundra voles (which prefer wet sedge meadows and polygonized areas). In areas occupied by both lemming species and tundra voles, the collared lemming uses a broader variety of habitats when it is the most abundant species (Pitelka 1957; Batzli and Jung 1980). For example, collared lemmings were more numerous than the other two species in Wet Sedge-Willow Meadows on the Colville River Delta (Garrott 1980). Collared lemmings eat mostly shrubs (willows and *Dryas*) and forbs, whereas brown lemmings and tundra voles eat sedges and grasses (Pitelka 1957; Batzli et al. 1983).

Although the singing and tundra voles are less common than collared lemmings in the project area (Garrott et al. 1983), the singing vole is more common on the Colville River Delta than elsewhere on the northern coastal plain (Garrott et al. 1983; Pitelka and Batzli 1993), presumably because of the access provided by the river corridor connecting the higher inland populations to the delta. The tundra vole may be more abundant in the transportation corridor and uplands east of the Itkillik River than on the delta, given its greater abundance in upland areas farther inland (Bee and Hall 1956; Babcock 1986; Pitelka and Batzli 1993). Habitat use by these two species differs in that singing voles commonly occur in low shrubs on old floodplains, whereas tundra voles use wet meadows (similar to brown lemmings). Food habits of the singing vole are similar to those of the collared lemming (Pitelka and Batzli 1993).

Marine Mammals. The marine waters of the Beaufort Sea, off the Colville River Delta, provide habitat for bowhead and beluga whales; ringed, spotted, and bearded seals; and walruses. Use of these waters is summarized below for each species—except the bowhead whale and walrus. Bowhead whales are discussed in Section 4.4.3 (Threatened and Endangered Species), and walruses and hooded seals are too rare in the region to warrant further discussion.

Beluga Whale. Also called the belukha or white whale, this species is the most numerous whale in northern Alaska and is an important subsistence resource for coastal residents. Most belugas winter (November to March) in the Bering and southern Chukchi seas and migrate northward during spring (March to June), through nearshore leads in the Chukchi Sea, before moving far offshore (between 70°30' and 71°30' N latitude, >70 mi off the central Beaufort coast) in the Beaufort Sea to reach summer areas in the Canadian Beaufort Sea and Amundsen Gulf (Seaman et al. 1981; Frost et al. 1988a; Hazard 1988). Belugas in the Beaufort Sea population molt and calve (averaging one calf in three years per female) in the Mackenzie River estuary in late June and August (Frost et al. 1988a; Hazard 1988). The return route in fall (September-October) is typically offshore from the central Beaufort coast (few belugas occur south of 71° N latitude), although a few animals pass closer to shore (Frost et al. 1988a). The Beaufort Sea population (Beaufort Sea stock) was estimated to be 41,610 whales in 1992 (Small and DeMaster 1995). This population is thought to be stable or increasing. During 1990-94, the combined Alaskan and Canadian subsistence harvest averaged at least 160 belugas (Small and DeMaster 1995).

All but a small number of belugas pass far offshore from the Colville River Delta during the spring and fall migrations. Hazard (1988) reported that belugas were common near shorefast ice in the Colville River Delta region until ice moved offshore in July. Seaman et al. (1981) reported sightings of a few groups ranging up to 100 belugas fairly close to shore near Jones, Pingok, and Thetis islands (north and east of the Colville River Delta) during fall migration, the time when belugas come closest to the delta. In both seasons, the numbers near the delta represent a small proportion of the main migration farther offshore.

Spotted Seal. The spotted seal ranges from the Beaufort Sea to the Sea of Japan and is most numerous in the Bering and Chukchi seas (Quakenbush 1988). No reliable population estimate is available for the species, although the population wintering in the Bering Sea was estimated at 200,000 to 250,000 individuals in the early 1970s (Small and DeMaster 1995). As the seasonal ice cover recedes in summer, spotted seals disperse throughout the open waters of the Bering, Chukchi, and Beaufort seas (Quakenbush 1988). They pup in March or April in Bering Sea wintering areas, mate a month later, and then molt (Seaman et al. 1981; Quakenbush 1988). Spotted seals are uncommon in the Beaufort Sea, occurring only during the open-water season in summer and early fall; they remain near the coast instead of moving offshore to the pack ice (Seaman et al. 1981).

The Colville River Delta is the location of the farthest eastern concentration of spotted seals in the Alaska Beaufort Sea (Seaman et al. 1981); a spotted seal tagged at Kasegaluk Lagoon on the Chukchi coast moved to the Colville River Delta within one summer (Lowry 1996 personal communication). Spotted seals have been seen in the Colville River as far upstream as Ocean Point, and they occur regularly as far up as the mouth of the Itkillik River, often hauling out on sand bars near deep channels (Reed 1956; Seaman et al. 1981). As many as 300 to 400 spotted seals used the Colville River Delta in the 1960s, although that number apparently decreased to 150 to 200 in the 1970s (presumably due to disturbance from boat traffic) after Nuiqsut was established at its present location (Seaman et al. 1981). Since then, the middle and outer delta appear to be used more frequently, particularly between the Tamayayak and East channels (Seaman et al. 1981). **Up to 24 spotted seals were observed in the lower East Channel in August 1996 (Johnson et al. 1997).**

Ringed Seal. The ringed seal is a year-round resident and is the most abundant seal species in the Beaufort Sea (Frost et al. 1988b). Ringed seals winter in shorefast ice (sea ice grounded to land), a habitat not used by other seal species. They maintain breathing holes throughout winter in ice up to 6 ft thick and dig multiple lairs beneath the snow as haulout shelters and nursery lairs (Kelly 1988). The females bear single pups between late March and mid-April; mate in late April or May; and molt in May and June (Frost et al. 1988b; Kelly 1988). They move northward as ice cover recedes, spend summer far offshore (over 100 mi in some years), and return southward as ice advances in fall (Seaman et al. 1981). Like spotted and bearded seals, ringed seals eat mostly fishes and crustaceans (Kelly 1988). The ringed seal is the species most hunted by coastal residents (Frost et al. 1988b; Kelly 1988). The population in Alaska waters has been estimated roughly at 1 to 1.5 million seals (Kelly 1988). Ringed seals are not abundant in the nearshore waters immediately off the Colville River Delta but are more common farther offshore in Harrison Bay, particularly in waters over 10 ft deep (Seaman et al. 1981).

Bearded Seal. The bearded seal occurs throughout the Bering, Chukchi, and Beaufort seas, although it is much less common than the ringed seal. Bearded seals are most abundant in the northern Bering Sea in winter and spring and in the Chukchi Sea during summer and fall (Burns and Frost 1983; Kelly 1988); the species is less common in the Beaufort Sea, where a few overwinter (Burns and Frost 1983). They prefer broken, drifting pack ice, although shorefast ice is also used (Burns and Frost 1983; Kelly 1988). Most of the population migrates northward as the ice recedes between April and June. Bearded seals disperse widely throughout northern Alaska in the open-water season, the time when they move into the Beaufort Sea (Burns and Frost 1983). Bearded seals pup on ice in late April or early May, mate after pups are weaned two to three weeks later, and molt in May and June (Kelly 1988). Recent estimates are not available for the Alaska population, but 250,000–300,000 seals were estimated in the Bering and Chukchi seas in the late 1970s (Small and DeMaster 1995). This species is an important subsistence resource for Alaskan coastal residents. Bearded seals are uncommon near the Colville River Delta because they tend to prefer drifting ice offshore (Seaman et al. 1981).

Wildlife Habitat Use

Birds and mammals use the Colville River Delta and transportation corridor in a variety of ways, many of which have been described in this document for individual species. Although generalizations about broad patterns of habitat use are difficult to make, evaluation of such patterns is necessary to analyze the potential environmental consequences of the ADP. This section categorizes habitat use in three ways to evaluate perspectives of wide interest: use by species for which the Colville River Delta provides regionally important breeding habitats, use by species that are important for subsistence by local residents, and use by multiple species (diversity). A fourth category—use by threatened and endangered species—is discussed in Section 4.4.3.

These four categories were identified and refined through consultation with the USFWS, EPA, USACE, ADFG, and the National Marine Fisheries Service (NMFS). The habitat-use information in the following discussions was derived from quantitative analyses of habitat selection for the Colville River Delta and Alpine transportation corridor by Johnson et al. (1997) and for the Prudhoe Bay oilfield by Troy (1988), as well as from qualitative accounts in existing scientific reports on birds and mammals in northern Alaska (see preceding species accounts and Appendix I-4 for compilations of habitat use information for individual species). For data from the quantitative analyses, the criterion for inclusion in Appendix I-4, Tables 2 through 5 was proportional use by a species that was approximately equal to, or greater than, the proportional availability of the habitat.

Habitats of Regional Importance for Birds. The Colville River Delta has been identified as regionally important for breeding populations of five bird species on the Arctic Coastal Plain: yellow-billed loon (North 1986; Field et al. 1993), tundra swan (Stickney et al. 1994; Johnson et al. 1996), brant (Groves and Conant 1995; USFWS unpublished data), greater white-fronted goose (Simpson and Pogson 1982; Simpson 1983), and bar-tailed godwit (Pitelka 1974; Rothe et al. 1983; Gerhardt et al. 1988). Comparison of breeding densities (birds/mi^2) on the delta with those in other locations on the coastal plain generally corroborates the importance of the Colville River Delta for these species (Appendix I-4, Table 1).

Use of habitats on the Colville River Delta varied among these five species (ranging from 4 to 15 habitat types per species), which is consistent with their different life-history requirements (Figure 4.4.2-11 and Table 4.4.2-5). In spite of these differences, however, one habitat on the Delta—Wet Sedge-Willow Meadow—is used by all five species. Two habitats are used by four species: Aquatic Sedge with Deep Polygons and Deep Open Water with Islands or Polygonized Margins. Nine habitats are used by three species. The four species of waterbirds in this group primarily use aquatic habitats; only tundra swan and greater white-fronted geese use moist or dry (upland) habitats. The bar-tailed godwit (a large shorebird) uses habitats across a wide range of moisture regimes, from wet sedge ponds and meadows to moist and dry shrub habitats (Rothe et al. 1983; Nickles et al. 1987; Gerhardt et al. 1988). Habitats receiving little or no use by these five species include both Shallow Open Water types, basin wetland complexes, barrens, and artificial.

Habitats of Subsistence-Use Species. The primary human use of wildlife species in the project area is subsistence harvest by local residents, primarily from Nuiqsut. Subsistence use of wildlife by Nuiqsut villagers has been documented by Hoffman et al. (1988), Galginaitis (1990), Pedersen (1995), and Brower and Opie (1997). Based on those studies, habitat use was evaluated for 20 bird species (3 geese, 11 ducks, 2 ptarmigan, 3 loons, and tundra swan) and 9 mammal species (caribou, moose, spotted seal, polar and grizzly bears, muskox, arctic and red foxes, and arctic ground squirrel) (Appendix I-4, Tables 2 through 5). (Because this evaluation focuses on habitats within the Colville River Delta and transportation corridor, marine mammal habitats in Harrison Bay are not included; see the discussion of oil spill scenarios under Environmental Consequences).

Subsistence-use bird species occur in all habitats in the project area (Table 4.4.2-6, Figure 4.4.2-12). The habitats used by the greatest number of these bird species on the delta are Aquatic Sedge with Deep Polygons (14 species) and Aquatic Grass Marsh (13 species). In the transportation corridor, Aquatic Sedge Marsh (a type not found on the delta, 11 species) and Aquatic Grass Marsh (10 species) are used by the largest number of subsistence-use birds. An important feature of these aquatic habitats is the presence of emergent vegetation. The habitats receiving the greatest use by subsistence-use birds throughout the project area are Aquatic Sedge with Deep Polygons, Aquatic Grass Marsh, both Deep Open Water types, and the River or Stream type. The area occupied by these five habitat types is greater on the delta (aggregate of 22.6%) than in the corridor (11.9%) (see Table 4.4.2-1).

In contrast to the high use of aquatic habitats by birds, subsistence-use mammals primarily use terrestrial habitats in the project area (Figure 4.4.2-13 and see Table 4.4.2-6). The two habitats used by the greatest number of subsistence mammals (seven to eight species each) are Riverine or Upland Shrub and Moist Sedge-Shrub Meadow; the elements that account for the high use of these habitats by mammals are the presence of shrubs (used for foraging and cover) and

Table 4.4.2-5. **Habitats used by bird species for which the Colville River Delta provides breeding habitats of regional importance[1].**

Habitat Type	Yellow-billed Loon[2]	Tundra Swan[2]	Brant[2]	Greater White-fronted Goose	Bar-tailed Godwit	No. of Species Using Habitat
Open Nearshore Water			●			1
Brackish Water		●	●	●		3
Tapped Lake with Low-water Connection		●		●		2
Tapped Lake with High-water Connection	●	●		●		3
Salt Marsh		●	●	●		3
Tidal Flat			●			1
Salt-killed Tundra		●	●	●		3
Deep Open Water without Islands	●	●		●		3
Deep Open Water with Islands or Polygonized Margins	●	●	●	●		4
Shallow Open Water without Islands		●				1
Shallow Open Water with Islands or Polygonized Margins		●				1
River or Stream			●	●		2
Aquatic Sedge with Deep Polygons	●	●		●	●	4
Aquatic Grass Marsh	●	●	●			3
Young Basin Wetland Complex	--		--	●		1
Old Basin Wetland Complex	--		--			0
Nonpatterned Wet Meadow	●	●		●		3
Wet Sedge-Willow Meadow	●	●	●	●	●	5
Moist Sedge-Shrub Meadow		●		●	●	3
Moist Tussock Tundra						0
Riverine or Upland Shrub		●		●	●	3
Barrens (riverine, eolian, or lacustrine)			●			1
Artificial (water, fill, peat road)						0

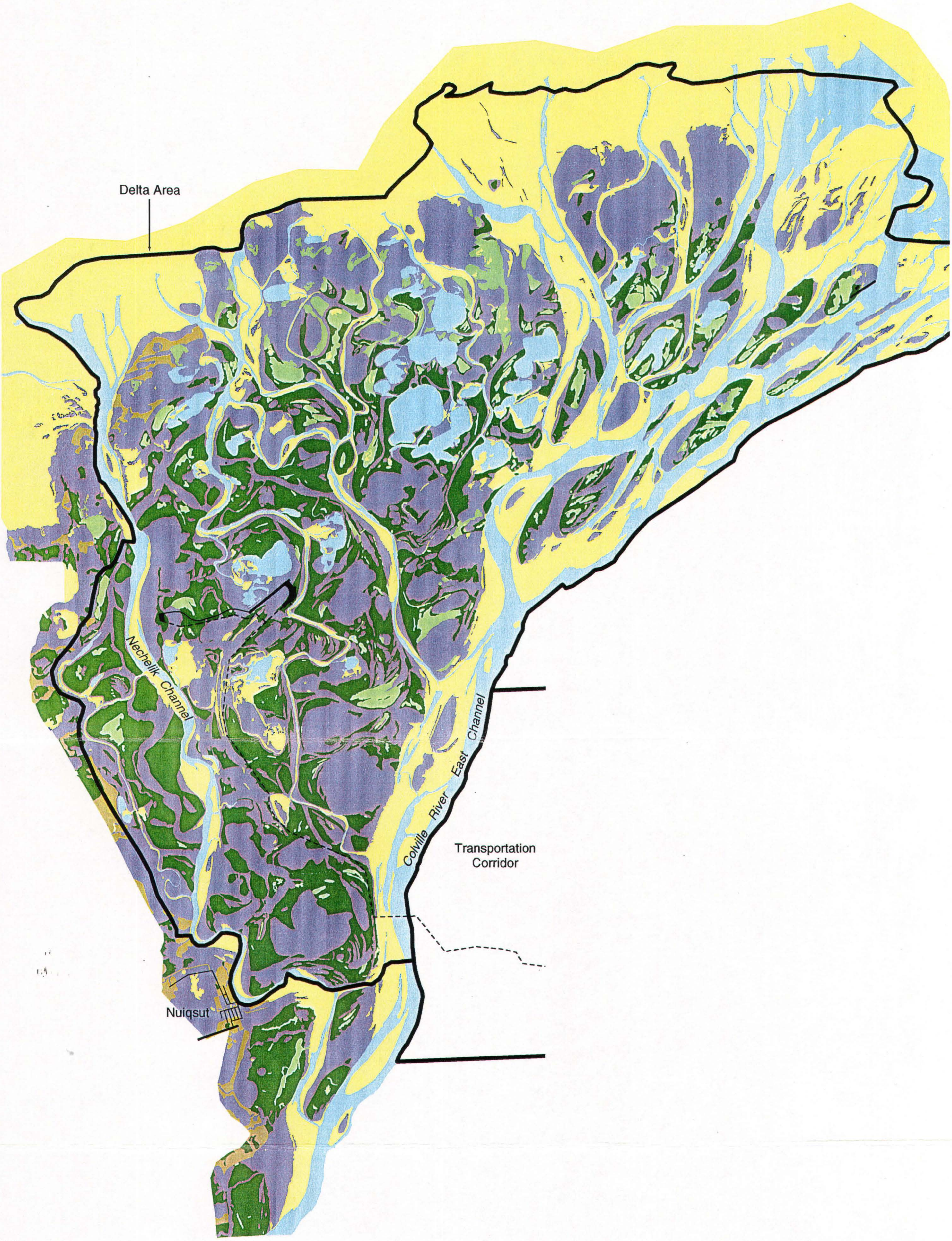
1 Bullets represent use of habitats on the delta only (not the transportation corridor), dashes indicate habitats that were not present in the areas surveyed for those species (Johnson et al. 1997), and blanks signify no indication of habitat use. Information on habitat use was also obtained from Simpson et al. (1982), Rothe et al. (1983), Nickles et al. (1987), Gerhardt et al. (1988), Smith et al. (1993), Meehan (1986a), Andres (1989) and ABR (unpublished data) for the Colville River Delta, and from Bergman et al. (1977) and Derksen et al. (1981) for regional use.

2 Based on statistical analysis of habitat use (Johnson et al. 1997).

Table 4.4.2-6. Summary of habitat use by wildlife on the Colville River Delta and Alpine transportation corridor; specific information is presented in Appendix I-4.

	Colville River Delta					Transportation Corridor			
	Use by Subsistence Species of Birds & Mammals (no. of species using habitat)		Regional Importance (no. of species using habitat)	Diversity of Use by Birds & Mammals (no. of species using habitat)		Use by Subsistence Species of Birds & Mammals (no. of species using habitat)		Diversity of Use by Birds & Mammals (no. of species using habitat)	
Habitat Type	Birds (n=20)	Mammals (n=9)	Birds (n=5)	Birds (n=45)	Mammals (n=13)	Birds (n=20)	Mammals (n=7)	Birds (n=45)	Mammals (n=11)
Open Nearshore Water	3	1	1	4	1	–	–	–	–
Brackish Water	11	0	3	16	0	–	–	–	–
Tapped Lake with Low-water Connection	10	0	2	11	0	–	–	–	–
Tapped Lake with High-water Connection	11	0	3	12	0	6	0	7	0
Salt Marsh	5	1	3	17	1	–	–	–	–
Tidal Flat	3	2	1	17	2	–	–	–	–
Salt-killed Tundra	9	1	3	9	1	–	–	–	–
Deep Open Water without Islands	11	0	3	15	0	9	0	13	0
Deep Open Water with Islands or Polygonized Margins	11	0	4	15	0	8	0	11	0
Shallow Open Water without Islands	6	0	1	7	0	6	0	7	0
Shallow Open Water with Islands or Polygonized Margins	6	0	1	8	0	6	0	9	0
River or Stream	10	1	2	12	1	9	0	11	0
Aquatic Sedge Marsh	–	–	–	–	–	11	0	20	0
Aquatic Sedge with Deep Polygons	14	0	4	25	0	9	0	20	0
Aquatic Grass Marsh	13	0	3	22	0	10	0	19	0
Young Basin Wetland Complex	5	1	1	15	3	9	1	19	3
Old Basin Wetland Complex	2	5	0	8	6	5	6	11	7
Nonpatterned Wet Meadow	9	3	3	15	5	5	1	11	3
Wet Sedge–Willow Meadow	11	4	5	25	7	5	2	18	5
Moist Sedge–Shrub Meadow	7	8	3	25	10	4	7	22	9
Moist Tussock Tundra	2	2	0	6	3	2	3	6	4
Riverine or Upland Shrub	4	8	3	11	12	5	7	12	11
Barrens (riverine, eolian, lacustrine)	4	2	1	19	2	3	1	18	1
Artificial (water, fill, peat road)	1	1	0	6	1	1	1	6	1

Note: Dashes indicate habitats that **do not** occur **in the area referenced.**



Source: Photo-interpretation of habitat types based on 1992 CIR photography (Johnson et al. 1996).
Map registered to SPOT image base map.
Projection: UTM Zone 5, Datum NAD 27

ABR File: REGIMPRF.PRJ

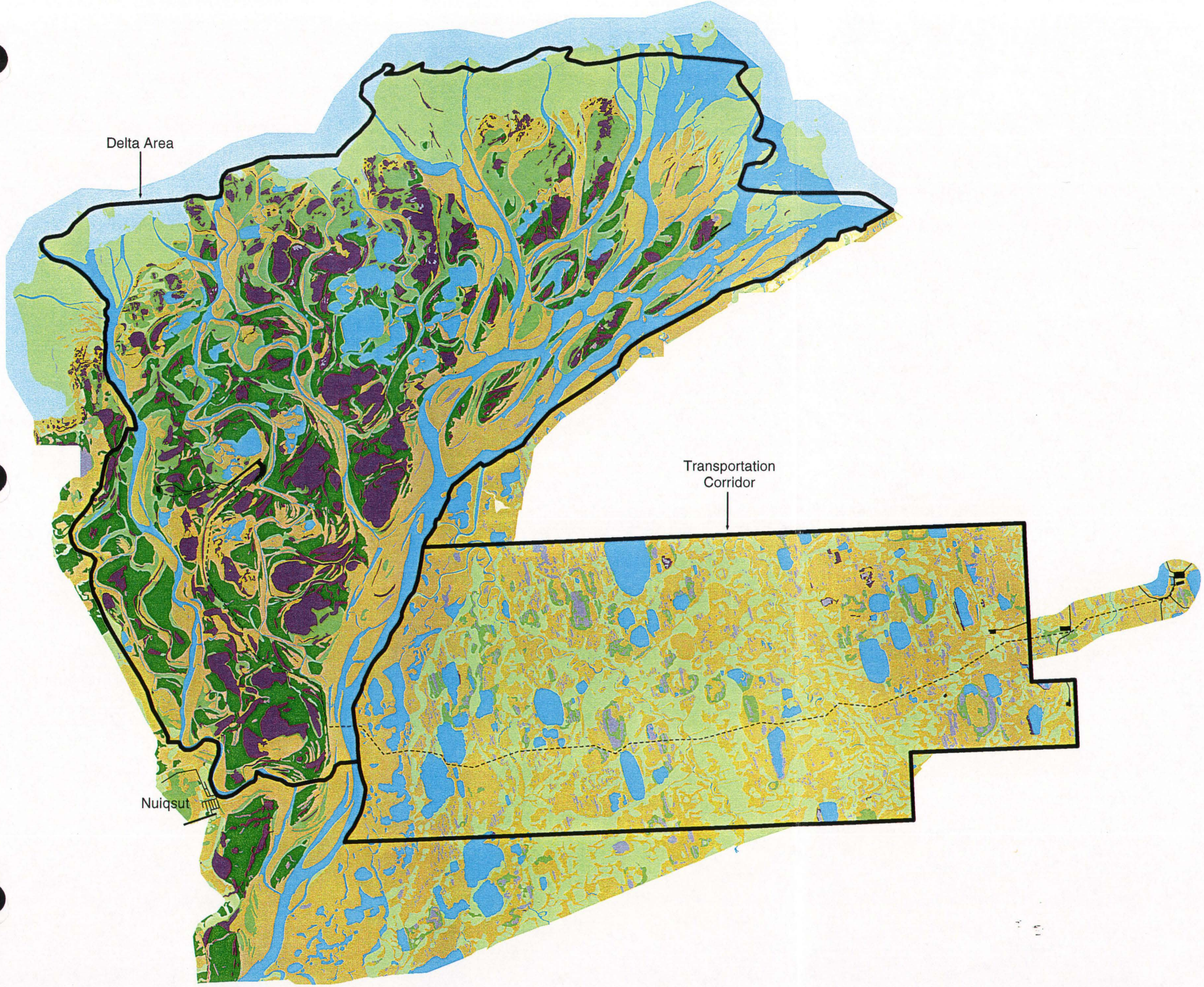
N

SCALE IN MILES
0 2 4

Habitat Use
- Used by 5 Species
- Used by 4 Species
- Used by 3 Species
- Used by 2 Species
- Used by 1 Species
- Use Not Reported

Proposed Project
- In-field Facilities
- Pipelines

Figure 4.4.2-11.
Habitats of Regional Importance for Yellow-Billed Loon, Tundra Swan, Brant, Greater White-Fronted Goose, and Bar-Tailed Godwit



Source: Photo-interpretation of habitat types based on 1992 CIR photography (Johnson et al. 1996).
Map registered to SPOT image base map.
Projection: UTM Zone 5, Datum NAD 27

ABR File: SUBBRDRF.PRJ

N

SCALE IN MILES
0 2 4

Terrestrial Habitats

- Used by 11-14 Species
- Used by 8-10 Species
- Used by 4-7 Species
- Used by 1-3 Species
- Use Not Reported

Aquatic Habitats

- Used by 11-14 Species
- Used by 8-10 Species
- Used by 4-7 Species
- Used by 1-3 Species
- Use Not Reported

Proposed Project

- In-field Facilities
- ------ Pipelines

Figure 4.4.2-12.
Diversity of Habitat Use by 20 Species of Birds Taken for Subsistence

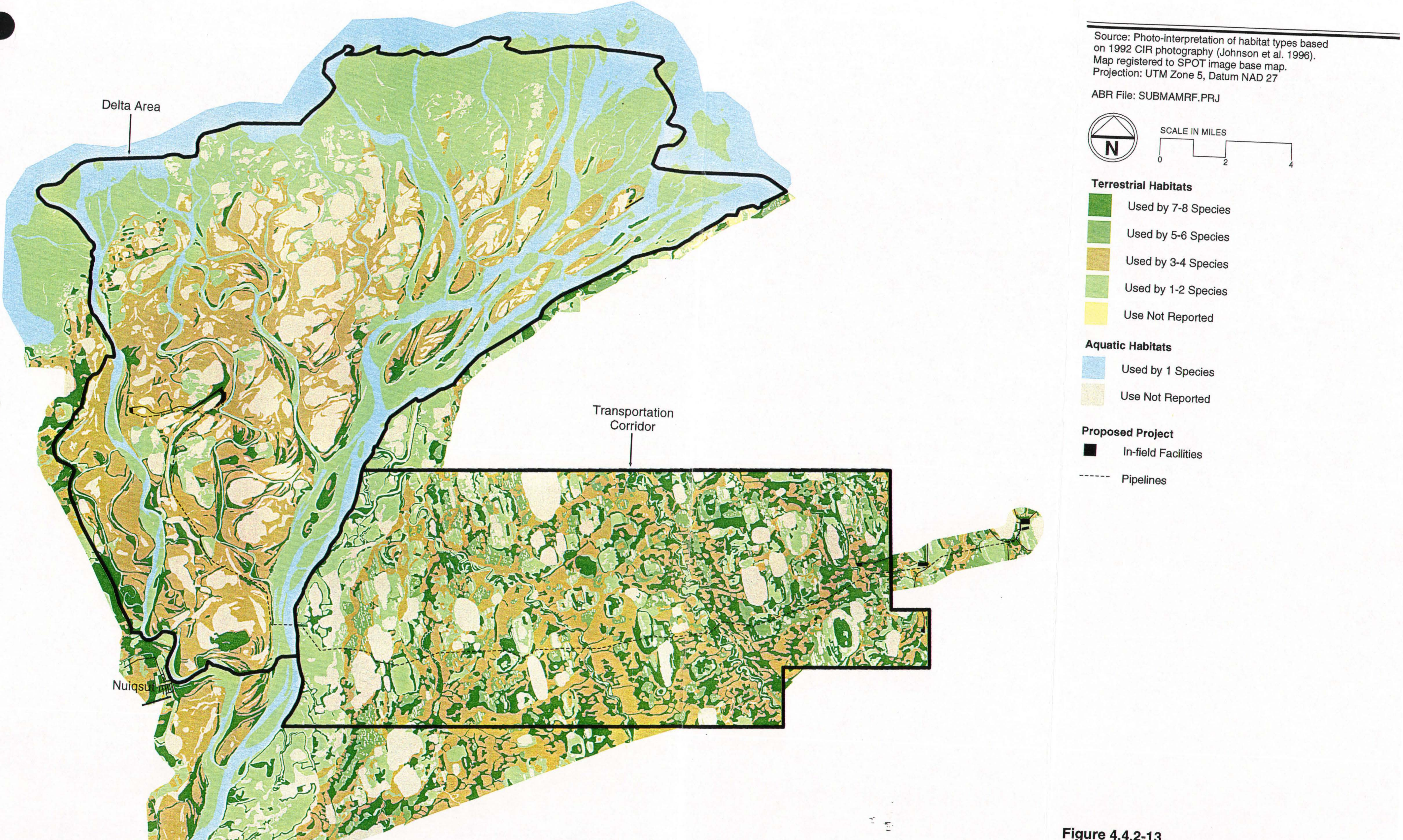


Figure 4.4.2-13.
Diversity of Habitat Use by 9 Species of Mammals Taken for Subsistence

well-drained soils on banks and upland sites (used for denning and burrowing). The Old Basin Wetland Complex is used by six of the subsistence-use mammals in the transportation corridor and five on the delta. Wet Sedge-Willow Meadow is used by four of the subsistence-use mammal species on the delta. Ten of the remaining habitats on the delta and six in the corridor are used by one or two mammal species. Nine habitat types (virtually all of which are aquatic types) in each of the delta and corridor areas are not used appreciably by subsistence mammals. The spotted seal is the only mammal routinely using aquatic habitats, although caribou seek relief from insect harassment on Barrens and Tidal Flats, occasionally wading out into Open Nearshore Water as well. Clearly, however, relatively well-drained habitats in moist and dry upland areas receive the greatest use by the mammal species taken for subsistence.

<u>**Diversity of Habitat Use Among Wildlife Species**</u>. A measure of the relative degree of use of different habitats is the diversity (richness) of bird and mammal species using each type. Habitats supporting numerous species are assumed to be more important to the functioning of ecological communities than are habitats that receive little or no use by wildlife. Habitat use in the delta and transportation corridor was evaluated for 45 bird species and 13 mammal species for which sufficient information was available (Appendix I-4, Tables 2 thruogh 5).

On the Colville River Delta, all habitats are used by birds. Four of the 23 habitats on the delta are used by the largest numbers of bird species (22 to 25 species): Aquatic Sedge with Deep Polygons, Moist Sedge-Shrub Meadow, Aquatic Grass Marsh, and Wet Sedge-Willow Meadow (Figure 4.4.2-14, see Table 4.4.2-6). In terms of species diversity, these four habitat types are the most important nesting habitats in the project area on the delta. Twelve other habitats are used by 11 to 19 species. Several of these habitats are estuarine, located primarily in the outer delta (Brackish Water, Salt Marsh, and Tidal Flat), and used after the breeding season, primarily by shorebirds, for premigratory staging and feeding. Estuarine habitats are also important to waterbirds, particularly brant, which use Salt Marsh and Brackish Water habitats during brood-rearing. Seven habitats, including both types of Shallow Open Water, are used by four to nine species. In general, the habitats on the Colville River Delta support a greater diversity and number of birds than do those in the transportation corridor.

In the transportation corridor, bird species diversity is highest (18 to 22 species) in seven of the 18 habitats that occur there (see Table 4.4.2-6). Species diversity is highest in four types in both the corridor and the delta: Moist Sedge-Shrub Meadow, Aquatic Sedge with Deep Polygons, Wet Sedge-Willow Meadow, and Aquatic Grass Marsh. A fifth type, Aquatic Sedge Marsh, does not occur on the delta. The remaining two habitats hosting the highest diversity were Young Basin Wetland Complex and Barrens. Species diversity was lower in both Deep Open Water types, Riverine or Upland Shrub, Nonpatterned Wet Meadow, Old Basin Wetland Complex, and River or Stream. Moist Tussock Tundra, the most abundant habitat in the transportation corridor, supports the fewest bird species. Thus, on both the delta and in the transportation corridor, aquatic marshes with emergent vegetation and moist and wet sedge meadow habitats support the highest diversity of bird species.

Species diversity in habitats used by mammals is similar on both the Colville River Delta and the transportation corridor (Figure 4.4.2-15, see Table 4.4.2-6). Two habitats receive the greatest use (9 to 12 species) in both areas: Riverine or Upland Shrub and Moist Sedge-Shrub Meadow. Species diversity is lower (five to seven species) in Wet Sedge-Willow Meadow and Old Basin Wetland Complex. Aquatic habitats in the project area receive little use by mammals. Thus, relatively well-drained shrub and meadow habitats, and habitats that are composites of those types (e.g., Old Basin Wetland Complex) support the greatest diversity of use.

4.4.2.2 Environmental Consequences

Over 20 years of experience and research, in the North Slope oilfields and other areas of the Arctic, indicate that the potential impacts of the ADP on wildlife populations and wetlands can be predicted with a high degree of confidence. The magnitude of the impacts from new development projects has generally decreased since North Slope oil development began in the 1970s because the industry and regulatory agencies have developed and implemented increasingly effective mitigation measures. The ADP will benefit from this experience and incorporate the lessons learned over the last two decades.

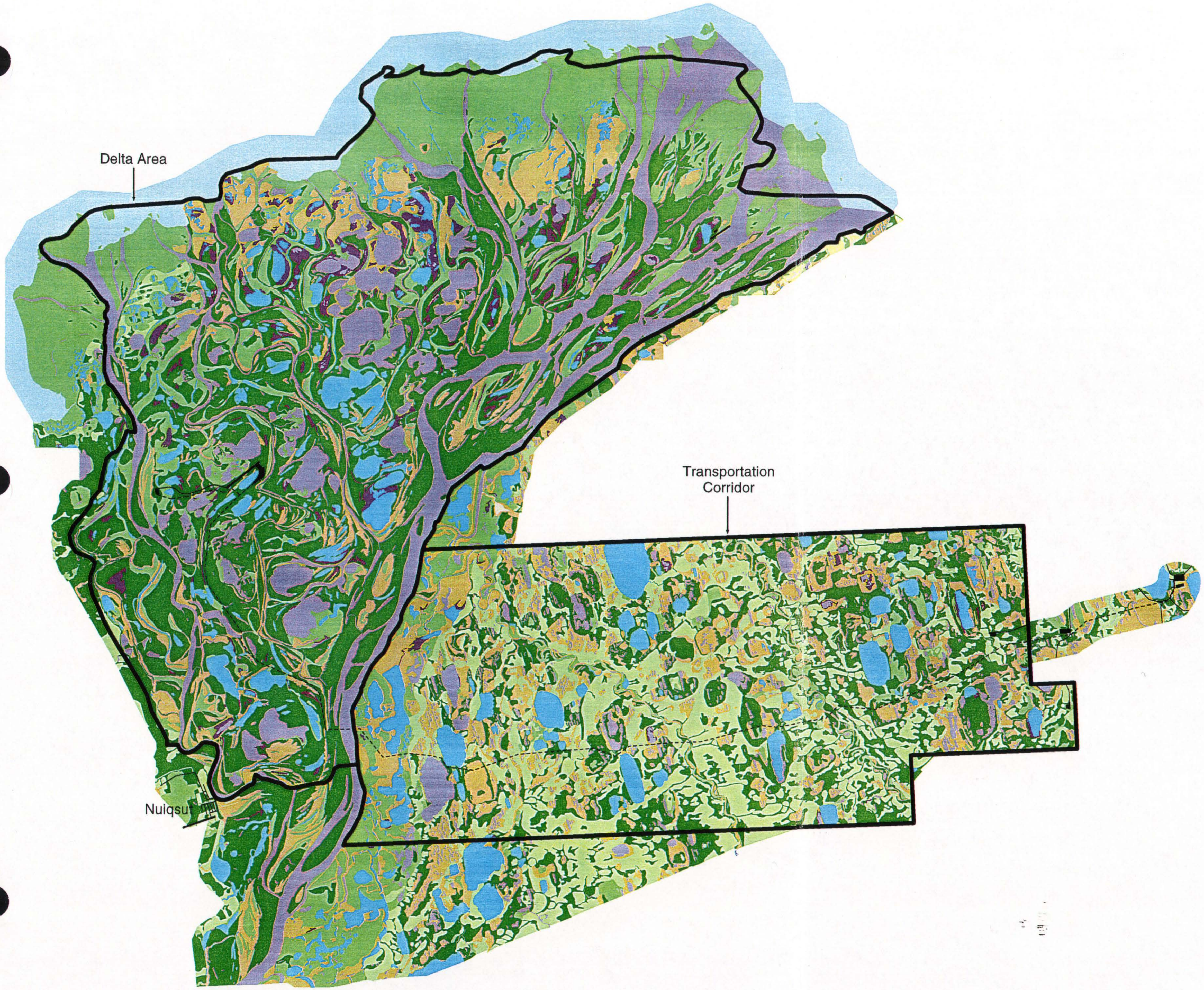


Figure 4.4.2-14. Diversity of Habitat Use by 45 Species of Birds

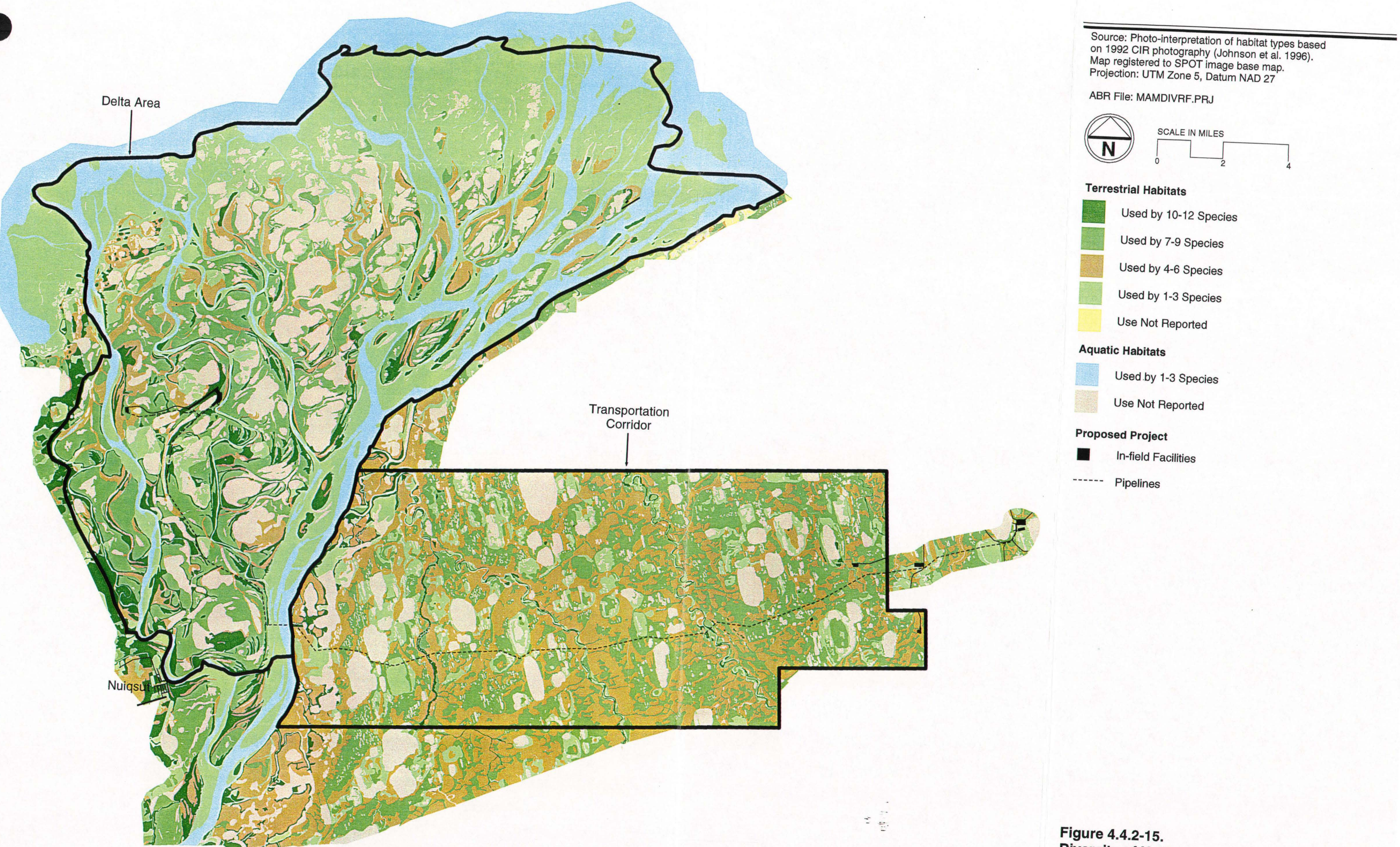


Figure 4.4.2-15.
Diversity of Habitat Use by 13 Species of Mammals

The potential direct and indirect effects on wildlife from construction and operation of the Alpine project can be grouped into the following categories:

1. Long-term habitat loss from gravel extraction and placement for construction of the in-field facilities (two pad complexes, the connecting road, and the airstrip);

2. Temporary habitat modification and loss from soil compaction, disturbance of vegetation, and delayed thaw (1-2 weeks) of snow and ice accumulations following the use of temporary ice roads and ice work pads;

3. Changes in wildlife use of habitats altered by dust fallout, gravel spray from snow removal, persistent snow drifts, impoundments, thermokarst, contaminants, and water withdrawal;

4. Disturbance of wildlife from equipment operation and human activity (drilling, vehicles and heavy equipment, aircraft, processing facility);

5. Attraction of wildlife to project facilities (e.g., herbivores to areas of early snowmelt in spring, caribou to gravel pads and pipelines for insect relief, and predators to artificial food sources);

6. Increased mortality of wildlife from predator populations that have increased because of the availability of foods at the project facilities (possibly resulting in lowered productivity [population suppression]); and

7. Injury and mortality of wildlife from collisions with vehicles or structures and from contact with or ingestion of contaminants.

Impacts of the Proposed Action (Alternative #2)

Permanent Loss of Habitat. Gravel placement for the proposed in-field facilities in the Colville River Delta will cover approximately 97 acres of wildlife habitat, representing a small proportion (<1%) of the available habitats on the entire delta (Table 4.4.2-7). **Approximately 0.4 acre will be covered by gravel for small pads ("cellars") at the HDD crossing transition points on the sales pipeline route.** Gravel fill has a substantial impact on wildlife habitats in the Arctic because the disturbance is long-term and vegetation recovery is difficult (Johnson 1987; Walker et al. 1987; Jorgenson et al. 1991a). Areas covered by gravel are

Table 4.4.2-7. Area (acres) of wildlife habitats affected directly by gravel placement for the proposed in-field facilities for the Alpine Development Project, compared with the total area of those habitats present (available) on the Colville River Delta.

Habitat Type	Area Available on Delta	Area Affected	Percent of Available Area Affected
Deep Open Water without Islands	5,760	0.42	0.01
Shallow Open Water without Islands	568	0.61	0.11
Aquatic Grass Marsh	339	0.02	<0.01
Nonpatterned Wet Meadow	10,358	4.02	0.04
Wet Sedge–Willow Meadow	25,292	51.30	0.20
Moist Sedge–Shrub Meadow	3,301	38.02	1.15
Riverine or Upland Shrub[1]	6,771	2.88	0.04
TOTAL	136,225	97.27[2]	0.07

1 Area affected does not include 4.2 acres of vegetated dunes that would be leveled immediately adjacent to the airstrip to meet federal aircraft safety requirements.
2 Total varies from total shown in Table 2.1.2-1 due to differences in base maps used for detailed engineering layout and delta-wide habitat mapping.

effectively eliminated as productive breeding and foraging habitats for wildlife; this loss is considered permanent unless restoration is completed successfully (see Section 2.10.2, Rehabilitation). In addition to gravel placement, a cumulative area of about 0.1 acre of habitat will be lost from installation of approximately 3,100 VSMs for the sales oil, diesel, seawater, and the in-field gathering pipelines. The amount of habitat disturbed by gravel mine development is not included in these estimates because Nuiqsut Contractors, Inc. hold the permit.

The two wildlife habitats most affected by gravel placement will be Wet Sedge-Willow Meadow (51.3 acres) and Moist Sedge-Shrub Meadow (38.0 acres) (Figure 4.4.2-16 and 4.4.2-17). These two habitat types, which are relatively common on the delta and transportation corridor, (see Table 4.4.2-1) receive high levels of use by waterbirds and shorebirds and moderate to high levels of use by mammals (see Section 4.4.2.1, Wildlife Habitat Use). Approximately 0.2% and 1.2 %, respectively, of the total acreage of these habitat types on the entire Colville River Delta will be covered by gravel (see Table 4.4.2-7). Therefore, the amount of these habitats lost will be small relative to their overall abundance.

Other habitat types affected by the proposed in-field facilities include small areas (0.02 to 4.0 acres) of Aquatic Grass Marsh, Deep Open Water without Islands, Shallow Open Water without Islands, Riverine or Upland Shrub, and Nonpatterned Wet Meadow (see Table 4.4.2-7 and Figure 4.4.2-16). The area affected in each habitat constitutes 0.1% or less of the available area of these habitats on the entire Colville River Delta (see Table 4.4.2-7). Recent studies in the Prudhoe Bay oilfield suggest that most birds (particularly shorebirds) that are displaced from nest sites by placement of gravel fill nest in adjacent undisturbed habitats in subsequent years (Troy and Carpenter 1990). The response of small mammals likely would be similar. Therefore, in view of the relatively small acreage covered by gravel, the small percentage of each habitat type lost, and the apparent ability of most wildlife species to relocate to adjacent undisturbed habitats, the direct effects of gravel placement on wildlife populations will be minor.

<u>Temporary Loss or Disturbance of Habitat</u>. Temporary habitat losses or disturbances will be caused by delayed snowmelt and compaction in the areas underlying the proposed ice road, ice work pads, and snow dumps around facilities. The effects of delayed snowmelt will be confined primarily to the first growing season following use of the structures (unless they are used annually), whereas the effects of compaction may persist longer. Although some damage to habitats results from the use of snow and ice roads, the long-term impacts are considerably less than those associated with gravel roads and pads. In addition to temporary loss related to ice roads and pads, 4.2 acres of vegetated dunes (Riverine or Upland Shrub habitat) will be reduced in thickness immediately adjacent to the airstrip to meet federal aircraft safety requirements. This "scalping" of the dunes would lower its value as wildlife habitat until revegetation could be accomplished, within several growing seasons after airstrip construction.

Temporary loss or disturbance of approximately 367 acres of wildlife habitats will occur in the summer following use of ice roads and work pads; this total comprises 158 acres under the ice work pad for construction of the X14 pipeline, 11 acres under the ice work pads at the HDD entry and exit holes at the East Channel crossing, and 198 acres for the ice road from DS-2M to the in-field facilities (Table 4.4.2-8, Figure 4.4.2-18). The ice pads and associated snow drifts will not melt until after most bird species begin nesting (late May-early June), thereby reducing the availability of nest sites. In addition, compaction of the standing dead vegetation remaining from previous growing seasons will eliminate concealing cover used by ground-nesting birds and small mammals. Temporary losses of habitat are most likely to affect bird species that traditionally use the same nest sites each year, although displaced birds probably will nest in adjacent unaffected habitats.

The greatest compaction will be caused during the first construction year by heavy truck traffic during winter gravel-hauling from the Nuiqsut Constructors, Inc. mine site to the Alpine in-field facilities; approximately 82 acres will be affected under this ice road which will parallel (within ¼ mi to the west) the sales oil pipeline route between the north end of the gravel mine and Alpine Pad 1 (see Figure 2.0-2 and Table 4.4.2-8). The magnitude of these habitat impacts will depend on the volume of ice in the underlying soil (Adam and Hernandez 1977), the vegetation type present (Racine 1977; Walker et al. 1987; Emers et al. 1995), and the duration of use (Buttrick 1973; Adam and Hernandez 1977). Although most research on the effects of winter travel on tundra plant communities has focused on seismic trails rather than snow and ice roads (Felix and Raynolds 1989; Emers et al. 1995; Jorgenson in press), both activities

Source: Photo-interpretation of terrain units based on 1992 CIR photography (Jorgenson et al. 1996).
Map registered to SPOT image base map.
Projection: UTM Zone 5, Datum NAD 27

ABR File: Hab_Infield_rf.apr

N

SCALE IN MILES
0 0.5 1

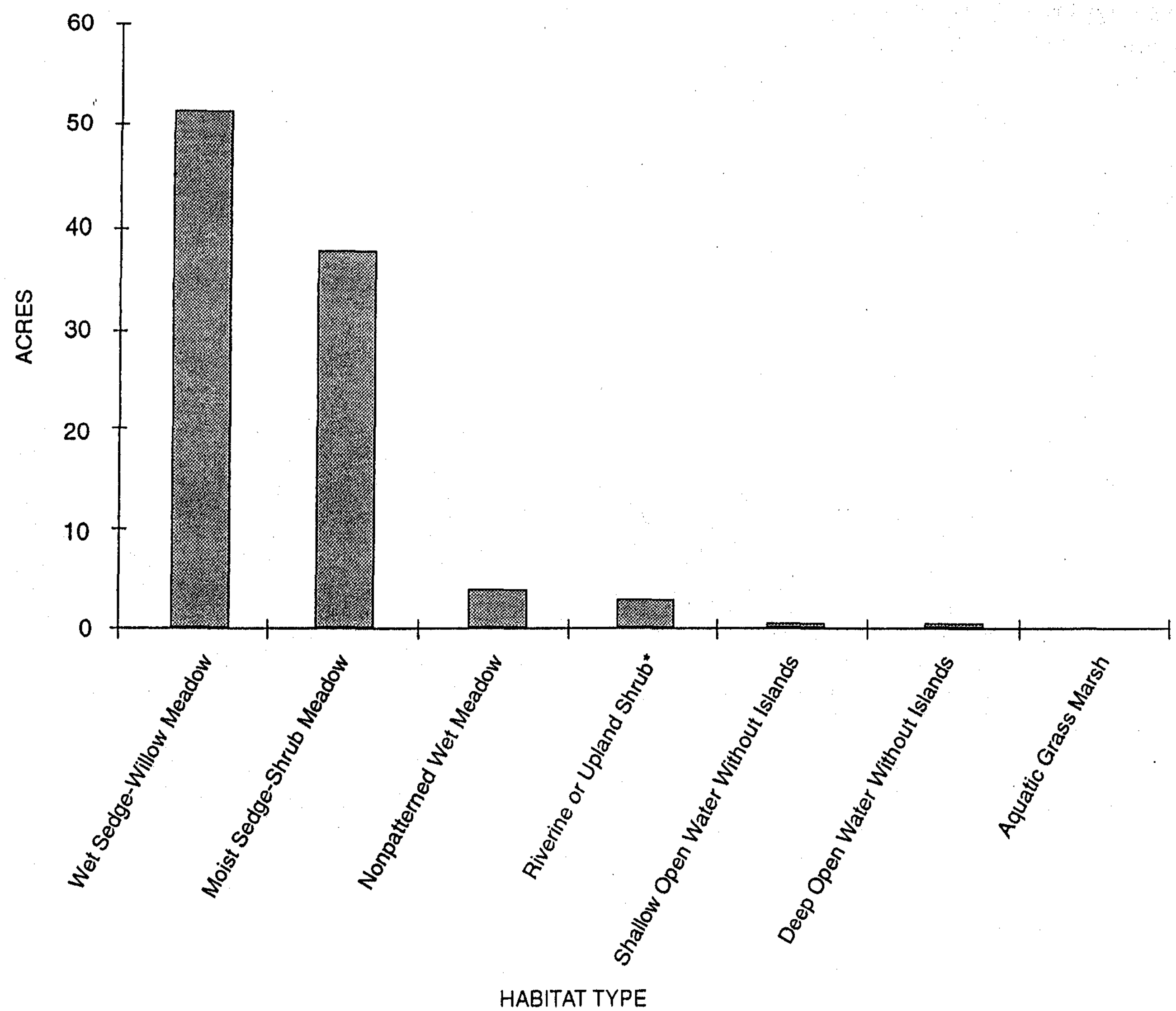
Habitat Types (not all types are present in this view)

- Open Nearshore Water (marine)
- Brackish Water
- Tapped Lake w/ Low-water Connection
- Tapped Lake w/ High-water Connection
- Salt Marsh
- Tidal Flat
- Salt-killed Tundra
- Deep Open Water w/o Islands
- Deep Open Water w/ Islands or Polygonized Margins
- Shallow Open Water w/o Islands
- Shallow Open Water w/ Islands or Polygonized Margins
- River or Stream
- Aquatic Sedge Marsh
- Aquatic Sedge w/ Deep Polygons
- Aquatic Grass Marsh
- Young Basin Wetland Complex
- Old Basin Wetland Complex
- Nonpatterned Wet Meadow
- Wet Sedge-Willow Meadow
- Moist Sedge-Shrub Meadow
- Moist Tussock Tundra
- Riverine or Upland Shrub
- Barrens (riverine, eolian, lacustrine)
- Artificial (water, fill, peat road)

Proposed Project

- In-field Facilities
- Pipelines

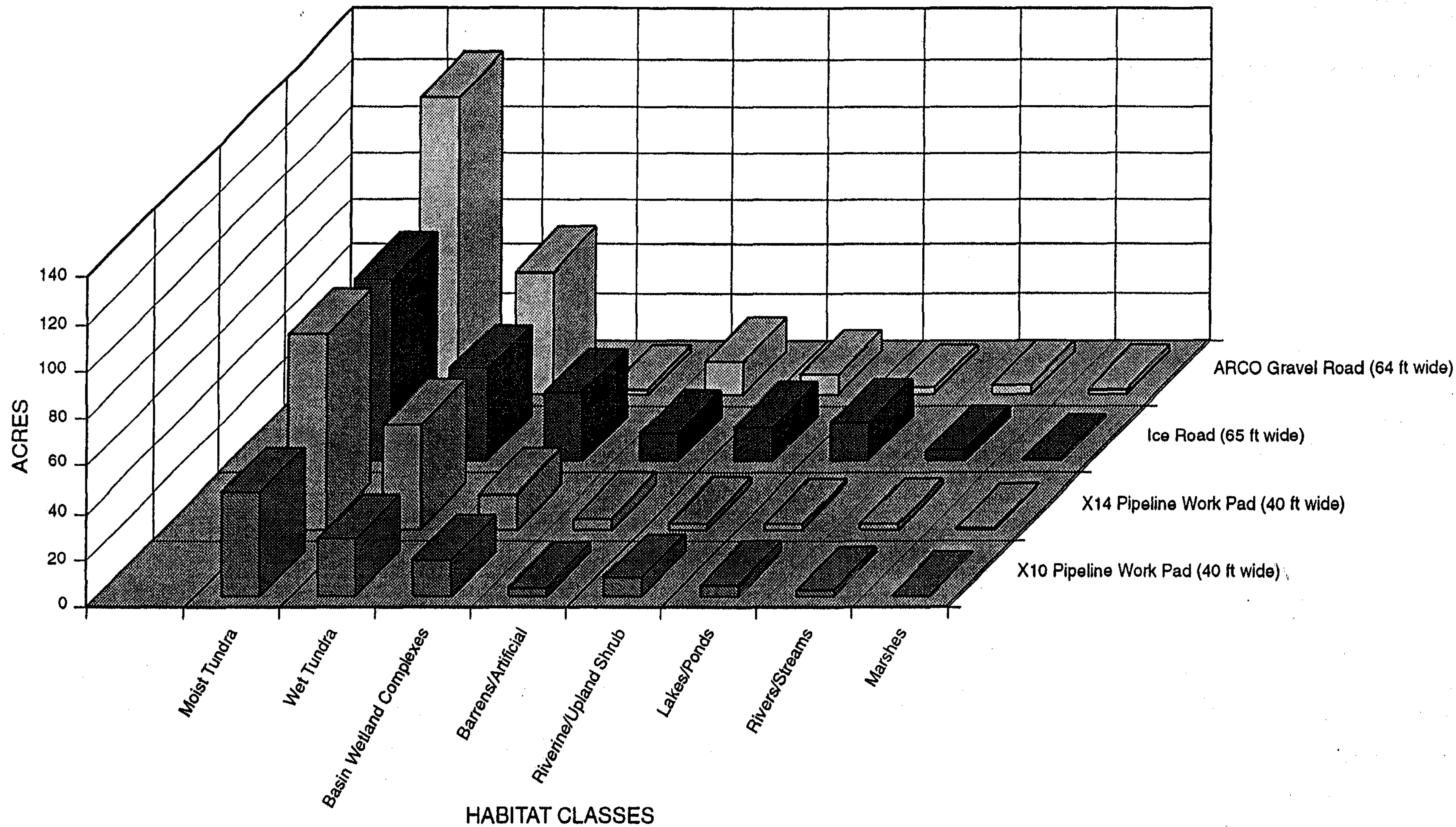
Figure 4.4.2-16. Wildlife Habitats Adjacent to Proposed In-field Facilities



Source: ABR 1997

Figure 4.4.2-17.
Habitat Types Affected by Gravel Placement for In-field Facilities (including the airstrip)
Alpine Development Project

* Does not include 4.2 acres of vegetated dunes that would be leveled immediately adjacent to the airstrip to meet federal aircraft safety requirements.



Source: ABR 1997

Figure 4.4.2-18.
Habitat Classes Affected by Pipeline Alternatives (construction ice pads), the Proposed Ice Road, and the ARCO Gravel Road Alternative, Alpine Development Project

Table 4.4.2-8. **Habitats (acres) affected by ARCO pipeline route alternatives, ARCO gravel road alternative, and proposed ice road to Alpine Development Project facilities on the Colville River Delta, Alaska*.**

Habitat Type	X14 Pipeline (proposed)		X10 Pipeline			Gravel Road	Ice Road
	8 ft[1]	40 ft[2]	8 ft[1]	40 ft[2]	0.5 mi[3]	65 ft[3]	65 ft[4]
Tapped Lake with Low-water Connection	0	0	0.02	0.12	47.57	0	0
Tapped Lake with High-water Connection	0.03	0.20	0	0	71.98	0.39	0.00
Salt Marsh	0.31	1.57	0.33	1.62	140.47	1.07	2.37
Deep Open Water without Islands	0.04	0.19	0.15	0.83	982.40	0.87	6.47
Deep Open Water with Islands or Polygonized Margins	<0.01	0.12	0.12	0.67	113.88	1.09	1.09
Shallow Open Water without Islands	0.27	1.38	0.36	1.94	368.57	0	8.59
Shallow Open Water with Islands or Polygonized Margins	0.10	0.46	0.19	0.92	180.14	0.54	0.34
River or Stream	0.44	2.19	0.42	2.05	411.88	3.98	4.64
Aquatic Sedge Marsh	0	0	0	0	18.35	0	0
Aquatic Sedge with Deep Polygons	0.05	0.28	0	<0.01	52.12	0.86	0.78
Aquatic Grass Marsh	0.02	0.08	0	0	34.57	1.21	0.15
Young Basin Wetland Complex	0.73	4.11	1.06	5.46	687.71	0	8.84
Old Basin Wetland Complex	2.11	10.68	1.92	10.36	1,084.26	2.49	20.40
Nonpatterned Wet Meadow	2.87	13.82	0.95	4.89	812.26	17.39	13.42
Wet Sedge-Willow Meadow	5.91	30.64	4.00	19.42	1,622.29	34.74	26.11
Moist Sedge-Shrub Meadow	9.58	46.47	4.02	20.74	2,650.01	54.66	39.76
Moist Tussock Tundra	7.48	37.08	4.59	23.11	2,775.91	72.74	38.19
Riverine or Upland Shrub	0.93	3.07	1.47	7.84	982.26	8.64	14.98
Barrens (riverine, eolian, or lacustrine)	0.71	3.64	0.69	3.50	691.37	13.66	11.60
Artificial (water, fill, peat road)	0.13	1.19	0.01	0.07	16.42	0.76	0.12
Total Acreage	**31.70**	**158.17**	**20.31**	**103.55**	**13,744.43**	**215.10**	**197.87**

* This table does not include 4 habitat types (Open Nearshore Marine Water, Brackish Water, Tidal Flats, and Salt-killed Tundra) because they occur north of the project area.

1 Buffer along pipeline route (8 ft wide), representing potential reduction of bird nesting directly under pipeline and VSMs.

2 Buffer along pipeline route (40 ft on south side of alignment) for pipeline construction ice road and work pad, representing area of temporary habitat loss.

3 Buffer along 28-mi-long permanent gravel road (road width = 64 ft) included by ARCOas an alternative for field access.

4 Buffer along ice road proposed for project construction and operational access (road width = 65 ft).

can produce the following impacts (Adam and Hernandez 1977; Johnson and Collins 1980): torn and crushed sedge tussocks, broken and abraded willows, and mortality of crushed mosses and lichens (Walker et al. 1987). Some individual plants may be killed or small areas damaged, but if the tundra organic mat is not torn, recovery usually occurs within a few years. Removal of plant cover (ripped or scraped) or disruption of the soil surface can cause long-term damage or mortality to plants. The effects **will** persist longer if the same route is used each year for the ice road.

The effects of compaction and vegetation disruption by ice roads and work pads **will** be greater in dry and moist habitats than in wet habitats. The habitats most affected **will** be Moist Tussock Tundra, Riverine or Upland Shrub, and Moist Sedge-Shrub Meadow (Felix and Raynolds 1989; Emers et al. 1995). Shrub habitats are important for small mammals such as collared lemmings and voles and for large mammals such as moose and muskoxen; changes in plant species composition in these habitats could cause localized degradation of habitat quality for these mammals, similar to the winter road effects on small mammals reported by Douglass (1977). Because a relatively small amount of the total habitat in the delta and transportation corridor **will** be affected, populations are not likely to decline as a result of temporary habitat loss.

<u>Altered Patterns of Habitat Use</u>. Wildlife use of habitats adjacent to the in-field facility road and pads **will** be affected by habitat alteration from dust fallout, gravel spray, persistent snow drifts, impoundments, thermokarst, contaminants, and water withdrawal. The magnitude of these impacts depends on habitat type, volume of ground ice, and hydrologic regime (Brown and Grave 1979; Walker et al. 1987) and season, but the area affected **will** be small relative to the size of the entire delta.

The effects of dust fallout **will** be most pronounced within 35 ft of the source, constituting about 34 acres of habitat at the ADP in-field facility; the magnitude of dust effects **will** depend on traffic intensity, distance from the source, **and substrate acidity** (Everett 1980; Walker and Everett 1987; **Auerbach et al. 1997**). The primary effects of dust fallout within this zone of influence **could** include advanced snowmelt (up to two weeks early) because of increased albedo, increased depth of seasonal thaw (to 20 inches in ice-rich polygons), thermokarst, increased soil pH, reduced photosynthetic capability of plants, **lower nutrient levels**, decreases in acidophilous mosses (particularly *Sphagnum*) and some lichens (*Cladina* and *Peltigera*) and increases in other mosses, decreases in some prostrate shrubs (*Dryas* and *Ledum*), and barren patches of ground (Spatt 1978; Everett 1980; Spatt and Miller 1981; Werbe 1980; Klinger et al. 1983; Walker et al. 1985; Walker and Everett 1987; **Auerbach et al. 1997**). Cotton sedges, such as *Eriophorum* spp., are more tolerant of dust exposure, perhaps because they occur in wetter areas and appear to be adapted to disturbed areas (Everett 1980). The plants most affected by dust are generally not preferred forage for wildlife. Dust fallout **will probably** be greatest during project construction but considerably less during project operation; also, fallout **will** extend further off the ends of the airstrip than along the drill-site road.

Advanced snowmelt from dust fallout has **both positive** and negative effects on wildlife. Advanced snowmelt often impounds runoff and causes early "green-up" of plant species (e.g., *Eriophorum vaginatum*) (Makihara 1983; Walker and Everett 1987). Open water and early plant growth attract waterfowl, ptarmigan, and caribou (Walker and Everett 1987; Lawhead and Cameron 1988; Murphy and Anderson 1993). Although these animals gain early access to nutritious forage, their exposure to traffic-related disturbance and risk of vehicle strikes also increases. In the Lisburne Development Area **of the Prudhoe Bay oilfield**, the snow-free areas near roads supported large numbers of foraging geese and swans during pre-nesting, although birds moved away from roads to rest and sleep (Murphy and Anderson 1993). Troy (1986, 1988) noted that dust benefited shorebirds within 150-300 ft of roads when traffic was relatively light because it melted snow and made habitats available earlier for nesting. At higher traffic levels, however, disturbance offset these benefits, as reflected in lower shorebird nesting densities (Troy 1988). In the in-field facility, early snowmelt from dust will attract some wildlife species in spring. This effect **will probably** be most pronounced during construction, when traffic rates **(and therefore dust fallout) will** be highest. The lower projected traffic rates of traffic during operation, combined with dust control measures during both construction and operations, should reduce dust fallout to a low level.

Thermokarst has both positive and negative effects on wildlife habitats. Although there are long-lasting visual and hydrologic effects (Lawson 1986), other ecological changes may benefit plant productivity and wildlife use (Truett and Kertell 1992). Physical and thermal changes may enhance organic matter decomposition, nutrient release, primary production, and nutrient concentrations in plant tissue (Challinor and Gersper 1975; Chapin and Shaver 1981; Ebersole and Webber 1983; Emers et al. 1995). Thermokarst may increase habitat diversity, species richness, and plant growth on thin gravel fill (Jorgenson and Joyce 1994). While some arctic herbivores selectively graze plants of higher nutritional value (McKendrick 1981), the effects of tundra disturbance on secondary production are uncertain (Truett and Kertell 1992). In one study of habitat use, severely disturbed tundra associated with a peat road had higher use (in relation to availability) than most other undisturbed habitats in Prudhoe Bay (Murphy and Anderson 1993). Overall, however, data are insufficient to assess the net effect of thermokarst on wildlife populations (Truett and Kertell 1992). **It is expected that** thermokarst impacts **will** be small at the in-field facility because of the relatively small amount of habitat affected relative to the entire delta.

Water impounded by gravel roads and pads both displaces and attracts birds, depending on the species (Troy 1986; Kertell and Howard 1992; Kertell 1993, 1994). Impoundments can be temporary, disappearing by mid-June, or they can persist through summer. Temporary impoundments preclude nesting (Walker et al. 1987) but also attract some birds. Troy (1986) found that some shorebirds and Lapland longspurs avoided a 330-ft-wide zone along the West Road in Prudhoe Bay, whereas other shorebirds and snow buntings (this species nests in pipeline supports) preferred it (habitat use exceeded availability). These changes were attributed to temporary impoundments adjacent to the road, early availability of some habitats because of the "dust shadow" produced by traffic, and reduced habitat availability from persistent snowbanks created by snow removal and drifting (Troy 1986). **An important objective in designing the ADP was minimization of impacts on water flow, so as not to significantly alter wetland habitats used by waterbirds on the delta. In view of the detailed cross-drainage plan developed for this project (see Appendix Q), permanent impoundments will be unlikely to occur adjacent to the in-field facilities. If any long-term impoundments form following initial gravel placement, they will be removed by installing additional drainage structures in the second year of construction. Temporary impoundments probably will occur for brief periods (probably a week or less) during spring runoff, potentially affecting (both positively and negatively) shorebirds and waterfowl. For more details on the projected impact of the Alpine in-field facilities on drainage patterns, refer to the Appendix Q , Hydrology and Drainage Proposal.**

Water withdrawal from lakes could potentially alter wetland community structure by changing the hydrologic regime; however, restrictions will be placed by the state of Alaska on the proportion of water **volume** the Alpine project **will** be permitted to withdraw from each water-source lake. The large single-season volume of water required for HDD boring at the X14 river crossing for the sales pipeline **will** not have adverse impacts, as long as the affected waterbodies receive adequate recharge following this withdrawal. **The** lake (L9313) **immediately adjacent to Alpine Pad 1 and the airstrip, which will** be a source of fresh water (for oil-well drilling, potable water, and firefighting), supports few nesting waterbirds. Because the level of the lake **will** not be substantially lowered and emergent plant communities along the lake margin are not well-developed, negative effects on wetland habitats at lake L9313 **will** be negligible.

__Behavioral Disturbance by Project Activities__. Equipment noise, vehicles, human pedestrians, aircraft operations, and other activities associated with construction and operation of the project **will** disturb some wildlife near the in-field facilities. Drilling and construction activities on the pads **will** cause some disturbance to wildlife **nearby,** primarily during summer. Since most construction activities **will** occur in winter when the smallest numbers of birds and mammals are in the delta, wildlife disturbance **will** be **lowest** in that season.

Disturbance effects of construction and operations on birds in the existing oilfields are well-documented (WCC 1985; Hampton and Joyce 1985; Troy 1986, 1988; Anderson 1992; Anderson et al. 1992; Burgess and Rose 1993; Murphy and Anderson 1993). Vehicles are the most ubiquitous source of oilfield disturbance, but are less disturbing than humans on foot or natural predators (foxes or gulls). In general, the level of disturbance tends to increase as traffic rate and the number of large, noisy vehicles (and those with unusual profiles such as boom cranes) increases. The effects of traffic vary during the breeding season; in the Lisburne Development Area, brood-rearing was the most sensitive period, although the strongest reactions were observed during pre-nesting, when birds were close to roads (Murphy and Anderson 1993). Most disturbance occurs close to facilities; for example, most reactions from geese and swans occurred within 500-700 ft of roads and pads in the Lisburne area (Murphy and Anderson 1993). Approximately 10% of all vehicle passes elicited reactions from geese and swans (Murphy and Anderson 1993; ABR, Inc. unpublished data). Birds reacting to vehicles primarily displayed brief alert (head-up) behavior, with a small proportion of birds walking, running, or (rarely) flying (Murphy and Anderson 1993). Based on these findings, a small percentage of birds will likely show short-term alterations in their behavior and minor nesting avoidance from project-related disturbance within 700 ft (229 acres) of Alpine Pads 1 and 2 and within 500 ft (319 acres) of the gravel road. Six nests of 2 species of birds were found in this area in 1995, and 13 nests of 6 species were found in 1996 (Table 4.4.2-9). Disturbance will be highest during construction and will decrease considerably during project operation. These potential levels of disturbance during construction and development drilling and operation will not likely reduce the populations of wildlife using the project area.

The development and operation of the airstrip will disturb wildlife because of high noise levels and the visual stimulus of low-flying aircraft. Birds can be sensitive to noise disturbance during any life history stage. However, during nesting, waterbirds are restricted to one site for 2 to 4 weeks, and disturbance during this period can lead to nest failure. Most waterfowl and loons tend to nest after June 1 and all but a few species hatch by July 15. Following nesting, waterbirds typically move from nest sites to other locations and different habitats, and generally are capable of moving away from disturbance sources (e.g., an airstrip) if necessary. Noise disturbance will be highest during takeoffs by large aircraft (Boeing 737-200 jets and "Hercules" turboprop cargo aircraft), particularly during project construction. Based on U.S. Air Force data (OMEGA 10.8 noise model; Mohlman 1996 personal communication), the area affected by the highest noise levels during takeoff by a Boeing 737-200 can be approximated by a zone extending to 6,300 ft around the runway (totaling 5,090 acres), within which noise levels could reach or exceed 85 decibels (A-scale weighting) as the engines reach maximum power. Forty-six nests of ten species of birds were found in this zone in 1995 and 69 nests of 12 species of birds were found in 1996 (see Table 4.4.2-9). Noise levels during landings will be substantially lower than during takeoffs, although the aircraft will be at low altitudes longer on approach to the airstrip.

The low number of projected landings and takeoffs by large planes during project operation will reduce the frequency of disturbance, although the noise levels per takeoff will not change. Landings and takeoffs by the ARCO Twin Otter (or similar aircraft) will occur most frequently, but this aircraft is substantially smaller and less noisy than the other aircraft. Approaches from and departures to the northeast will overfly lakes used consistently for nesting and brood-rearing by yellow-billed loons and other waterbirds. The long distance (10 to 12 mi) from the airstrip to the large colonies of brant nesting at the mouth of the East Channel will minimize disturbance to those birds. The effects of large fixed-wing aircraft have not been studied in the Arctic; rather, most studies of aircraft disturbance have focused on low-flying helicopters (LGL 1974; Barry and Spencer 1976; Simpson et al. 1980; Derksen et al. 1992). Some waterbirds show startle responses to landings and take-offs by Boeing 737s near the Prudhoe Bay and Kuparuk airports, but responses are of short duration and the birds using the area appear to have habituated to the disturbance (ABR, Inc. unpublished data). In the Lisburne Development Area, birds were less habituated to infrequent disturbances than to constant (steady-state) disturbances (Murphy and Anderson 1993). Therefore, habituation could be less likely to aircraft operations at the Alpine airstrip than at the Prudhoe and Kuparuk airstrips, where landings and takeoffs by jets occur daily. In response to concern about aircraft noise levels, ARCO will restrict the frequency of flights by large aircraft at the Alpine airstrip during the nesting season to reduce disturbance on the central delta (see Section 2.9, Airstrip Construction and Operation, and Section 4.4.2.3, Project Scheduling, for use restrictions).

Table 4.4.2-9. Number of nests of selected bird species found within noise buffer zones[1] surrounding the airstrip and in-field facilities for the Alpine Development Unit, Colville River Delta, Alaska.

Species, by Year[2]	Number of Nests	
	Proposed Airstrip	In-field (Pads and Road) Facilities
Yellow-billed Loon		
1992	0	0
1993	1	0
1995	1	0
1996	3	0
Pacific Loon		
1992	0	0
1993	7	0
1995	2	0
1996	14	0
Red-throated Loon		
1992	0	0
1993	0	0
1995	3	0
1996	2	0
Tundra Swan		
1992	2	0
1993	2	0
1995	9	1
1996	6	1
Brant		
1995	10	0
1996	3	1
Greater White-fronted Goose		
1995	15	4
1996	29	6
Green-winged Teal		
1995	0	0
1996	1	0
Northern Pintail		
1995	0	0
1996	2	0
Oldsquaw		
1995	3	0
1996	6	3
Arctic Tern		
1995	1	0
1996	0	0
Glaucous Gull		
1995	1	0
1996	0	0

Table 4.4.2-9. **Number of nests of selected bird species found within noise buffer zones[1] surrounding the airstrip and in-field facilities for the Alpine Development Unit, Colville River Delta, Alaska (continued).**

Species, by Year[2]		Number of Nests: Proposed Airstrip	Number of Nests: In-field (Pads and Road) Facilities
Sabine's Gull			
1995		1	0
1996		1	0
Parasitic Jaeger			
1995		0	0
1996		1	0
Long-tailed Jaeger			
1995		0	0
1996		1	1
Total Nests	**1995**	**46**	**5**
	1996	**69**	**13**

[1] Buffer zones extend 6,300 ft from airstrip, 700 ft from pads, and 500 ft from roads (see text). Survey effort and area covered varied somewhat among years.

[2] Sources: Smith et al. (1993, 1994) for 1992 and 1993; Johnson et al. (1996, 1997) for 1995 and 1996.

Disturbance by traffic, structures, and human activities has several effects on caribou behavior and movements. During and immediately after the calving season, female caribou with calves (up to four weeks old) tend to avoid areas within at least 1,500-3,300 ft of active pads and roads (Johnson and Lawhead 1989) and perhaps as far as 1-2 mi (Dau and Cameron 1986; Lawhead 1988; Cameron et al. 1992). During the insect season, however, harassment by insects overwhelms this avoidance response by cows with calves, and caribou of all ages and both sexes regularly approach and cross pipeline-road corridors while moving to and from insect-relief habitat located near the coast. In that season, the greatest impact is reduced crossing success of caribou groups attempting to cross pipelines adjacent to within 300 ft of roads where traffic rates reach or exceed 15 vehicles per hour (Curatolo and Murphy 1986; Cronin et al. 1994). Deflected movements and delays of up to several hours are common under these circumstances (Johnson and Lawhead 1989; Lawhead et al. 1993). This impact will be likely for caribou groups encountering the ADP in-field road during the construction phase, but will diminish to low levels during project operation as traffic rates decline. In addition, the pipeline and road will be separated where possible between 400 ft and 1,000 ft in the western and central portions of the in-field facility, to facilitate caribou crossings. The transition points of the sales oil, diesel, and seawater pipelines, between above- and below-ground mode at the X14 river crossing, will be set back far enough from the riverbanks to permit movement of caribou groups following the banks.

In cooperation with ADFG and the USFWS, ARCO has evaluated different caribou mitigation measures in North Slope oilfields since the late 1970s. Proper pipeline height has been one of the primary research components of this effort. After testing different caribou mitigation measures, the USFWS, ADFG, NSB, and AOGA formed a Caribou Steering Committee and commissioned a study of the effectiveness of mitigation measures, with recommendations for designs that provided for free (unimpeded) passage of caribou through areas of oilfield infrastructure. The Caribou Steering Committee reviewed the literature and historical records and issued a report of findings in July 1994 (Cronin et al. 1994). The committee concluded that pipelines elevated to 5 ft above the ground surface do not hinder caribou movements as long as a road with a high traffic rate is not located nearby, confirming the conclusions reached by Curatolo and Murphy (1986). The minimum elevation of the ADP pipeline will be 5 ft above the tundra (at each VSM), but the actual height will be greater due to variation in the ground surface. For example, in areas such as streams and the floodplain on the east side of the Colville River, the pipe will be 10 to 12 ft above the tundra. Therefore, the proposed pipeline should not interfere with caribou movements across the pipeline route. Drifting snow along a pipeline elevated to a minimum of 5 ft without adjacent gravel road is not judged to present any impediment to migrating caribou, because snow generally does not drift to any appreciable height along a pipeline without an adjacent gravel road. To further mitigate potential impediments to caribou movements along the pipeline route, ARCO will place sections of pipeline, elevated higher than 5 ft above tundra grade, at crossing locations known or judged likely to receive high levels of use by caribou. Pipeline elevations will be 15 to 25 ft for distances of 80 to 100 ft at the nine vertical expansion loops (e.g., on the banks of the Colville, Kachemach and Miluveach rivers and in several other locations; see Figure 2.0-2). A special section of higher-than-normal elevated pipeline (to 7 to 8 ft aboveground) will be located between two large lakes east of the Colville River to facilitate caribou movement across the narrow isthmus between those lakes, and other locations at the ends of large lakes in the transportation corridor are being evaluated for placement of higher-than-normal pipe as detailed engineering design work proceeds.

Besides caribou, other large mammals, such as muskoxen and bears, could be disturbed by equipment and aircraft operations at the in-field facility. Little is known about muskoxen responses to oilfield facilities and activities, but the species is sensitive to disturbance by aircraft and snowmobiles (Miller and Gunn 1979; Clough et al. 1987). Small numbers of muskoxen will encounter the sales pipeline, primarily along the Kachemach and Miluveach river drainages in the transportation corridor. Disturbance could displace bears from their dens (Reynolds et al. 1986; Clough et al. 1987; Amstrup 1993), risking mortality of cubs; the potential for disturbance will be highest during construction. Bears have abandoned dens because of disturbance (Clough et al. 1987), although Amstrup (1993) concluded that many bears exposed to human activities were not affected in ways that reduced production of young. The low frequency of bear denning in the project area will greatly diminish this risk.

<u>**Indirect Loss of Habitat Through Displacement**</u>. Habitats experiencing increased noise levels adjacent to processing facilities could become less attractive to wildlife. High noise levels could cause a long-term reduction of wildlife use in the immediate areas of constant disturbance. Early studies of noise effects on birds in the Arctic found that simulated compressor noise did not affect nesting Lapland longspurs (Gollop et al. 1974), but it decreased habitat use by fall staging snow geese (Gollop and Davis 1974). More recently, increased noise at the Central Compressor Plant in the Prudhoe Bay oilfield caused some waterbird species (spectacled eiders, pre-nesting Canada geese, brood-rearing tundra swans) to shift their distribution (averaging 1,600-2,000 ft) away from habitats close to the compressor plant, although most waterfowl species (including nesting Canada geese, brant, greater white-fronted geese, loons, ducks) habituated to the noise levels (Anderson et al. 1992). Wildlife near a new processing facility (CPF-3) in the Kuparuk oilfield showed variable responses to disturbance (Hampton and Joyce 1985). Although nesting by waterfowl was significantly lower within 0.5 mi of the facility, a brant nesting colony located approximately 0.5 mi away has not been affected adversely by the constant noise emanating from the facility; the nesting colony has been used continuously since facility operation began (Stickney et al. 1994; Anderson et al. 1995, 1996). These studies suggest that some wildlife would be displaced from the immediate area (within 0.5 mi) surrounding the ADP in-field facility, with the size of the displacement area depending on the species and the nature of the noise generated by the facilities. The displacement area would likely be lower around the two drill site pads, which would have smaller and quieter equipment (after construction and development drilling are completed) than the processing facility. Most wildlife using the area will be likely to habituate to the constant operational noises.

<u>**Attraction of Wildlife to Facilities**</u>. Glaucous gulls and common ravens are attracted to garbage and food handouts at human settlements and camps. Although adequate historical records are lacking, biologists generally agree that the populations of these two species have increased because of the availability of these foods from the North Slope oilfield operations. Ravens and some raptors nest on buildings (particularly ravens on processing facilities) and other structures in the existing oilfields, including elevated pipelines (Ritchie 1991; ABR, Inc. unpublished data); therefore, it is probable that a pair of ravens will nest on the ADP processing facility. Raptors, gulls, ravens, ptarmigan, songbirds, and shorebirds all perch on elevated pipelines, and snow buntings nest in VSM supports and buildings. The presence of new facilities will be likely to increase populations of predatory birds and snow buntings in the project area. Increases in predator populations largely will be mitigated through proper

garbage handling and disposal at the Alpine in-field facility (see Section 4.4.2.3, **Other Mitigative Measures**).

Foxes and bears also are attracted to areas of human activity; they readily feed on garbage and handouts (Eberhardt et al. 1982; Follmann 1989; Follmann and Hechtel 1990; Shideler and Hechtel 1993; Truett 1993). Their presence near human activity creates the potential for animals to be struck by vehicles, to ingest toxic substances, to infect humans with rabies, or to harm humans through aggressive behavior. Foxes and, to a lesser extent, bears, also use human structures (gravel berms and empty pipes) for denning (Burgess et al. 1993; Shideler 1994 personal communication). Caribou are often attracted to elevated gravel pads and shaded areas under pipelines and buildings for relief from oestrid fly harassment (mid-July to mid-August) (Roby 1978; Johnson and Lawhead 1989). Thus, the ADP project facilities will attract some foxes throughout the year, grizzly bears in summer and fall, caribou during the summer insect season, and possibly polar bears in late fall and late winter.

Increased Predation. Increased predator populations around oilfield developments may increase predation on prey populations (Martin 1997). This impact is inferred from the higher number of foxes, increased density of fox dens (Eberhardt et al. 1982; Burgess et al. 1993), and higher numbers of bears (Shideler and Hechtel 1995b), gulls, and ravens in the North Slope oilfields. Gulls and ravens prey on bird eggs and young, foxes prey on birds and small mammals, and bears prey on caribou, muskoxen, ground squirrels, and bird nests. The ADP will be a relatively small development, and its overall effect on predator populations should be minimized by strict management of garbage sources and enforcement of oil company policies that prohibit feeding of wild animals. Food waste will be removed from the delta (see Section 4.4.2.3, Other Mitigative Measures) and policies against feeding animals will be strictly enforced. Even with effective enforcement of these policies, some attraction of predators is likely and mortality of prey populations may increase slightly, but it is unlikely that these effects will cause measurable population declines of prey species.

Mortality and Injury. Strikes by vehicles (trucks and aircraft) and collisions with structures pose some risk to wildlife at the project in-field facility. Risks of vehicle strikes will be greatest during summer when large numbers of birds and mammals move onto the delta. Although vehicle-caused mortality is poorly documented for the Kuparuk and Prudhoe Bay oilfields, the number of animals injured or killed by vehicles is generally very low. The risk of vehicles striking caribou will be greatest during July and August, when caribou are attracted to pipelines, roads, and pads to seek relief from fly harassment; at such times, caribou often are less cautious around vehicles than at other times of the year. The likelihood of injury and mortality of wildlife will be minimized by the relatively small road system in the project area, the relatively low level of daily traffic during project operation and the application of speed limits. The greatest risk of vehicle strikes will occur during construction and development drilling, when traffic rates will be highest. However, construction will occur mostly during winter when few wildlife populations are present in the area.

Impacts of Alternatives #3 - #8

In-field Facilities.

ARCO Alternatives to the Proposed Project Layout. The impacts on wildlife from the in-field facility options considered during project planning differed in several ways from the proposed project. Each in-field alternative would have resulted in the loss of approximately 97 acres of habitat to gravel placement and affected similar numbers of nesting birds in behavioral disturbance zones. The road alignment near Alpine Pad 2 in several alternatives passed directly through Aquatic Sedge with Deep Polygon habitat at the southeast corner of lake L9321, a nesting area used by brant and other waterbirds. Therefore, the road was re-routed to the south of that high-value habitat. Different options for the airstrip alignment at the in-field facility would have resulted in a flight path farther south or west with a more east-west orientation than the proposed project alternative. Although those alignments would have caused less behavioral disturbance to wildlife (such as loons and spotted seals) on the outer delta, local disturbance of the nesting areas at lake L9321 and other low-lying wet sedge habitats in the western portion of the facility area would have been greater, potentially increasing direct impacts on waterbirds and indirect impacts from drainage alteration. Similarly, locating the processing facility between Alpine Pad 2 and Alpine Pad 1 would likely have had greater effects on wildlife than the proposed action, because that option did not consolidate the facility pads to limit habitat impacts.

and behavioral disturbance as much as the proposed project.

ASRC, ASRC/Kuukpik, Kuukpik (Western Initiative) Alternatives (**#6-8**). The in-field facility for these alternatives would be smaller than those for the proposed project, because the airstrip and field camp would be in Nuiqsut. Elimination of the airstrip from the delta would reduce the in-field facility footprint from about 97 acres to about 59 acres and shift a major source of disturbance to the south. These changes would be offset by additional gravel placement (and traffic) required for the 9-mi access road between Nuiqsut and the in-field facility. The Kuukpik Western Initiative alternative (#8) would also shift some habitat loss out of the central delta by moving the processing facility west of the Nechelik (Nigliq) Channel. These modifications would reduce the ADP in-field facility footprint to about 30 acres. However, this alternative would require construction of an 9.3 mi permanent gravel road to access the processing pad from Nuiqsut and construction of a 1.5-mi permanent gravel road to connect with Alpine Pad 2; this construction would cover 88 acres of wildlife habitat. This road would also require a major bridge crossing of the Nechelik (Nigliq) Channel and another side channel crossing. Vehicles using this road could adversely impact wildlife because of noise, dust generation, and collisions.

Pipeline Route/Crossing Location and Field Access.

Crossing X10 Pipeline (#3). This alternative pipeline route would extend 27.9 mi from KRU CPF-2 to the proposed in-field facility, about 5 mi less than the proposed X14 route. Ice roads and ice pads required for construction of this alternative route would temporarily disturb about 104 acres of wildlife habitat beneath these structures, not including the habitat adjacent to the existing KRU gathering pipelines extending from DS-2M to CPF-2 (see Table 4.4.2-8). As with the proposed route, the principal habitat classes affected would be wet and moist tundra (see Figure 4.4.2-18). Because of the longer river crossing, the amount of area disturbed by the ice pads required for assembling the HDD pipeline strings would be approximately twice that required for the X14 route.

With regard to the potential effects of alternative pipeline routes on caribou movements, all transportation corridor alternatives would result in a similar degree of caribou-pipeline interactions as the proposed route. Because the primary directions of movement during calving, insect season, and fall migration through the transportation corridor are north and south, the frequency of encounters would be similar whether the pipeline alignment was a few miles north or a few miles south of the proposed X14 route. Caribou impacts would increase significantly along any pipeline alternative if a gravel road were constructed along the route.

Crossing X14 Pipeline with Permanent Road (**#4, 5**). Approximately 215 acres of habitat would be lost to gravel placement for this 28 mi permanent road from the Kuparuk oilfield (DS-2M) to the ADP in-field facility (see Table 4.4.2-8). Most of the area lost would occur in moist tundra (primarily the Moist Tussock Tundra and Moist Sedge-Shrub Meadow types) and wet tundra (primarily the Wet Sedge-Willow Meadow type) (see Figure 4.4.2-18). Disturbance of wildlife species (except for small mammals and possibly denning bears) from road construction would be minimized by constructing the road in winter. Other impacts from road construction and operation (habitat alteration, influence on caribou movements) would be similar to those discussed previously for the in-field road, although the magnitude of those impacts would increase because of the far greater length of the road to the Kuparuk oilfield. The alternative of burying the pipeline in the roadbed (#5) would eliminate the small habitat loss from VSMs, but would increase gravel requirements because the road bed would be wider and thicker. Vehicle traffic would disturb and likely displace cow caribou and their newborn calves within 1-2 mi of the road during and immediately (within 3 weeks) after the calving season.

ASRC Pipeline (**#6**). The effects of the 22.8-mi (not including 6.6 mi from DS-2M to CPF-2) cross-country pipeline from Kuparuk DS-2M to Nuiqsut would be similar to the X14 and X10 pipelines (#2, #3), resulting in the temporary disturbance of approximately 111 acres of wildlife habitat from ice-road and ice pads. However, this alternative also includes a 9-mi gravel road with buried pipeline from Nuiqsut to the in-field facility. This road would cover at least 70 additional acres of wildlife habitat. Building a wider road to accommodate burying the pipeline would increase the acreage of habitat loss. Most of the habitats affected by the road west of the Nechelik (Nigliq) Channel would be moist tundra types that tend to be used less by waterbirds, although mammal use would be greater, than in the central delta.. The wildlife impacts discussed above relative to gravel roads and vehicle traffic would occur. During project operation, traffic levels on this road would likely be higher than on the in-field access road, because personnel would be transported from Nuiqsut daily, and some amount of local traffic not directly associated with the project is probable (at least to the Nechelik [Nigliq] Channel).

ASRC/Kuukpik Pipeline with Permanent Road (#7). The access road from Nuiqsut to the in-field facility, and the resulting impacts on wildlife, would be identical to the ASRC alternative. The addition of the permanent access road and buried pipeline from the Kuparuk oilfield to Nuiqsut would substantially increase wildlife impacts. Including the proposed BIA road from Nuiqsut to the Colville River, this route would traverse 29.4 mi from Kuparuk DS-2M to Nuiqsut, causing the loss of at least 208 acres of wildlife habitat (at minimum, increasing if roadbed width were increased for pipeline burial) due to gravel placement. Impacts on wildlife would be greater than along the ARCO road alternative because of the increased length of this road alternative (including the 9-mi road north from Nuiqsut to Alpine) and the connection across the Colville River (on a vehicle-passable bridge) to Nuiqsut. Because this most southerly route traverses more of the Moist Tussock Meadow habitat preferred by caribou during calving, traffic would displace a larger number of caribou than the ARCO road alternatives. The effects on wildlife, from permanent bridges or an ice bridge/summer ferry, would be similar to those discussed below under "River Crossing Method."

Kuukpik (Western Initiative) Pipeline with Permanent Road (#8). Impacts of the gravel road and buried pipeline from the Kuparuk oilfield to Nuiqsut would be identical to those discussed for the ASRC/Kuukpik alternative. However, the 11.6 mi of road reaching north from Nuiqsut to the relocated processing facility and then to Alpine Pad 2 would cover more habitat (at least 88 acres). The location of this road in drier habitats west of the delta would cause less impact on waterbird habitat but more impact on mammal habitats.

__Access__. A major feature common to all three Native proposals (#6 - #8) is using the Nuiqsut airstrip for access to the oilfield, rather than construction of a new airstrip on the delta. Using the existing Nuiqsut airstrip would reduce habitat loss from gravel placement on the central delta by about 32 acres and would diminish the impacts of aircraft operations on the central and outer delta. Although some of these impacts would be shifted to wildlife and their habitats adjacent to the Nuiqsut airstrip, the increased air traffic there would have less overall impact than the new airstrip. Jet operations at Nuiqsut would increase noise levels in the immediate vicinity, but the incremental effect on wildlife would be minimal, given the existing level of disturbance near the village and the likelihood that animals using this area have habituated to human disturbance. However, the benefits of using the Nuiqsut airstrip would be significantly offset by the need to construct a 9- to 11.6-mi permanent gravel road with bridges to the in-field facility. Other types of access have been addressed in the preceding paragraphs.

__River Crossing Method__.

Cable Bridge Span (#3). This option would pose a major collision hazard to birds flying along the East Channel of the Colville River, particularly in low-visibility conditions (fog, rain, snow). Although the bridge pilings probably would be visible in most cases, the relatively high cable support system would be less visible to flying birds. Towers with cable support wires and powerlines are responsible for bird mortality from collisions under poor weather conditions (Avery et al. 1980), and birds collide with powerlines in the Prudhoe Bay area (Anderson and Murphy 1987; ABR, Inc. unpublished data). Waterbirds (e.g., loons, ducks) flying low over the river channel during poor weather would be most susceptible to colliding with the cable bridge.

Buried Using Conventional Trenching (#4, #5). This option would disturb more habitat than the proposed HDD option because of excavation of the river bank and channel. Winter construction would have minimal disturbance impacts on wildlife but would require using several large ice pads for staging equipment and storing dredge material; the effects of ice pads were discussed in previous sections.

Vehicular Pile-Supported Bridge (#7, #8). These options (ASRC/Kuukpik and Western initiatives) would pose some collision risks for birds, although the risks would be lower than for a cable bridge (#3). The impacts would be lower because of the shorter cable supports needed to suspend the pipeline under the bridge and the shorter cable length of cable.

Ice Bridge/Ferry **(#7-8)**. The ice bridge/summer ferry option would affect wildlife to a minor degree by disturbing habitat for building docks and disturbing some wildlife using the river channel or adjacent banks during ferry operation.

4.4.2.3 Mitigation Measures for the Proposed Action (Alternative #2)

The mitigation measures to reduce the impacts of the ADP project on wildlife can be grouped into four categories:

1. Siting of project facilities to avoid and minimize impacts to important habitats;
2. Minimizing the in-field facility footprint to reduce loss of habitat from gravel placement and associated secondary impacts;
3. Scheduling construction activities to minimize habitat impacts and disturbance of wildlife; and
4. Reducing disturbance to wildlife during construction and operation, particularly traffic and noise disturbance, by restricting traffic volumes and speed, as well as other measures.

Although Section 2.9 Mitigation Measures provides detailed mitigation for the entire Alpine Development, the following sections describe specific wildlife mitigation measures planned for the ADP.

Siting of Project Facilities

Prior to finalizing the proposed facility locations, ARCO met with USFWS, EPA, COE, and ADFG (on several occasions) to discuss and design the appropriate criteria for evaluation of wildlife habitat use. With this agency guidance, four habitat use (value) categories were developed (as described in Section 4.4.2.1, Wildlife Habitat Use, and Section 4.4.3.1, Spectacled Eider):

- Regionally important habitats for selected birds (yellow-billed loon, tundra swan, brant, greater-white fronted goose, and bar-tailed godwit);
- Diversity of habitat use among subsistence-use species (20 birds and 9 mammal species);
- Diversity of habitat use among wildlife species (45 birds and 13 mammal species); and
- Habitat use by threatened species (spectacled eider), focusing on three periods of the annual breeding cycle (pre-nesting, nesting, and brood-rearing).

These four categories were used to formalize environmental input for final facility siting. Various options for location of gravel in-field facilities were evaluated by a team of resource specialists. Habitat use by wildlife was a primary criterion used in evaluating these options. Several alternative locations were compared in locating in-field facilities on the delta for the proposed project, for the transportation pipeline routing, and for the route of the alternative access road from the KRU (Figure 4.4.2-19). The in-field facility layout and transportation pipeline route were adjusted to avoid or minimize loss of important wildlife habitats (e.g., lakes and other aquatic habitats supporting nesting waterbirds).

The two drill pads and road were sited to avoid direct encroachment on, and loss of, existing swan and brant nests (birds for which the delta provides habitats of regional importance). In particular, the road was re-routed to avoid nesting areas used by brant and other waterbirds, and, within the constraints placed by adjacent lakes, the pads and connecting road were sited to provide appropriate buffer distances from those next locations. In addition, following public input, the Alpine Pad 2 was moved northward, away from the abundant and diverse bird activity that occurs throughout the summer season at Nanuk Lake (subsistence activity, habitat of regional importance, and diversity of habitat use).

The preferred alternative for field access, which substitutes a year-round airstrip and winter ice road for a permanent gravel access road to the delta, will itself be a major mitigative measure that substantially minimizes gravel placement and long-term loss of wildlife habitat. The ice roads and pads will have some short-term impacts on wildlife habitats; however, these will be lessened by locating these structures in wet habitats, thereby avoiding drier bluffs and upland sites where vegetation is more susceptible to damage from compaction and crushing. In addition, ice roads will be routed through low-use nesting habitats for birds, and the routes will be varied each winter (provided sufficient water is available in lakes along the route) to avoid repeated disturbance (and possibly long-term damage) to underlying tundra vegetation.

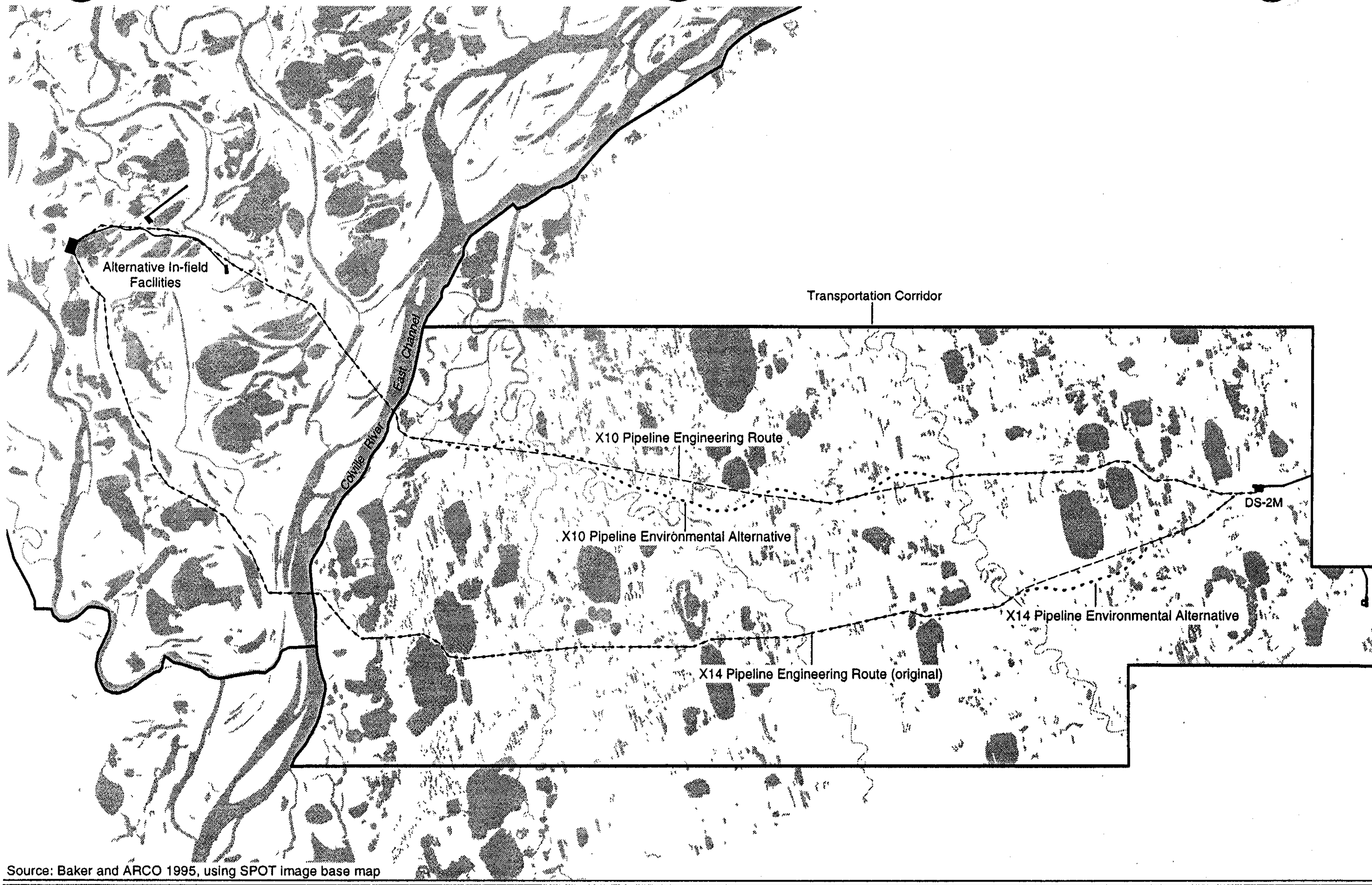


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**Figure 4.4.2-19.
Pipeline Route Alternatives
Identified During Mitigation Planning**

The pipeline route was modified in several locations to reduce habitat disturbance and (fish and) wildlife impacts. Modifications were made in the alignment to route around drained-lake basins (high diversity of habitat use), swan and brant nesting areas (regionally important species), and habitats used by spectacled eiders during multiple seasons (threatened species). The pipeline was routed on higher ground when possible to minimize flooding concerns and disturbance to habitats and animals from oil spills. In scoping meetings, initial agency opinion expressed minimal concern for potential habitat impact from elevated pipe only (without road). Hence, several modifications were made in the alignment, as referenced above. Pipeline length and cost also were evaluated when considering alternative re-routes.

The decision to site the airstrip in its proposed location includes an assessment of impacts on wildlife habitats. The airstrip occupies a habitat type (Moist Sedge-Shrub Meadow) that, while abundant (25%, co-dominant) on coastal plain tundra in the transportation corridor, occupies only about 2.4% of the delta area. Frequent flooding, saturated soils, and extensive ground ice restrict the disturbance of this habitat type on the delta. Siting the airstrip in the proposed location is considered to be optimal because it avoids and minimizes impacts to other, less common wetland habitats that support higher levels of use by wildlife. For this reason, it was desirable to locate the airstrip away from Aquatic Sedge with Deep Polygons, Aquatic Grass Marsh, Salt Marsh, and Wet Sedge-Shrub Meadow habitats in the central and western portions of the proposed in-field facility. Moist Sedge-Shrub Meadow is of high importance to mammals and high or moderate importance to a number of birds (see Table 4.4.2-6), but it is either less important or more common than the other aquatic and wet meadow habitats mentioned above. In view of its regional abundance on the central Arctic Coastal Plain, siting the airstrip largely in this habitat type would result in a lower level of wildlife impact than if the structure were located in lower, wetter areas in the western portion of the in-field facility. The 38 acres of this habitat affected by gravel placement for the proposed in-field facility is 1.2% of the total area of this habitat type available on the Colville River Delta (3,301 acres). Other important criteria were considered as well in siting the airstrip, including consolidation of facilities in the eastern portion of the in-field facility area (e.g., away from the Nechelik [Nigliq] Channel, which receives high levels of human use for subsistence); location of the airstrip on higher, better-drained ground less likely to be affected by major flood events and to pose cross-drainage challenges; and minimization of aircraft disturbance to waterbird nesting and staging areas located in and near the western portion of the in-field facility area. Clustering the airstrip with the processing facility and Alpine Pad 1 places all project activity centers and noise generation sources within a half-mile radius, thereby minimizing direct and indirect disturbance of wildlife (as compared with spreading these facilities up to 3 mi apart). The proposed location also moves the air traffic away from concentrations of bird activity in high-use habitats near and at Nanuk Lake, the brant nesting colony north of Nanuk Lake, and nesting swans north of Nanuk Lake.

Size of Project Facilities and Gravel Footprints

In conjunction with locating project facilities to reduce impacts on wildlife and habitats, the size of the ADP in-field facility and its gravel footprint will be minimized to reduce loss of wildlife habitats. Current drilling technology (directional drilling, close wellhead spacing, zero discharge waste management) uses smaller pads than those used in older oilfields. Thus, the small pad footprints of the in-field facility will reduce the volume of gravel required and the corresponding loss of wildlife habitat. The gravel fill will be designed to minimize interference with water flow or habitat in the delta (see Section 2.1.2). Moreover, ARCO will restore and rehabilitate areas of gravel fill upon abandonment of the ADP. Locating the airstrip immediately adjacent to the in-field access road will reduce habitat loss. For the proposed pipeline route, some of the mitigative measures include using temporary ice work-pads (instead of a gravel work-pad) during pipeline construction and using HDD technology to cross the Colville River, thus eliminating the placement of structures required for bridge alternatives.

Project Scheduling

The proposed project will minimize the impacts of behavioral disturbance by scheduling most heavy construction during winter when most wildlife species either are absent or are present in low numbers. Using temporary ice roads and work pads in winter during the operation of the oilfield also will lower wildlife disturbance. Furthermore, restricting operations by large aircraft during the summer breeding season (see Section 2.9, Mitigation Measures - Airstrip Construction and Operation) will reduce the impacts from a new airstrip in the central delta. Following consultation with resource agencies, it was judged that activity at the airstrip will likely be the primary disturbance to nesting birds, with less disturbance associated with other project facilities. Thus, with concurrence from those agencies, ARCO concluded it was most appropriate to focus mitigation for birds on aircraft activity during the nesting season. Noise associated with aircraft will be mitigated by imposing aircraft restrictions during the nesting period (1 June-15 July). The restriction on aircraft operation from 1 June to 15 July primarily alleviates disturbance to nesting birds (see Section 2.10.3).

Other Mitigative Measures

Additional measures used to reduce project impacts on wildlife include elevated pipeline to allow free passage by caribou and other large mammals, implementing strict waste management measures to forestall increases in predator populations, minimizing traffic volume, restricting vehicle speed on the in-field facility road, and using noise suppression devices on equipment during drilling and production. Two mitigative measures that have proven useful in the Kuparuk oilfield, to promote free passage of caribou are incorporated into the pipeline design for the ADP. First, pipelines (both in-field and sales) will be elevated ≥5 ft aboveground to accommodate caribou passage under the pipeline, with four sections of higher-than-normal pipe built at crossing locations expected to receive high use (including the vertical expansion loops, which are up to 25 ft high, at the Colville, Miluveach, and Kachemach river crossings). Second, the in-field gathering pipelines will be separated from the road by 400 to 1,000 ft, where possible, to decrease the possibility of restricting caribou movements during construction and development drilling, when traffic rates will be highest.

During project operations, traffic volume and speed on the in-field facility road will be restricted to reduce wildlife disturbance, particularly during summer. These restrictions will have the added benefit of decreasing dust fallout and potential collisions with wildlife. An additional mitigative measure will be to conduct surveys for bear dens along pipeline and road alignments before construction each winter to locate and avoid any dens in the transportation corridor and on the delta.

Mitigation measures, which would be used in conjunction with optimal siting and sizing of facilities, include restricting field access and traffic in the project area so as to reduce dust fallout and disturbance of wildlife. Using ice roads for winter access will avoid impacts on wildlife habitat (primarily habitat loss) associated with a gravel road.

Prevention and control of contaminants will be an integral part of the project development. ARCO will implement design features and training programs to avoid chronic spills. ARCO also will implement inspection and maintenance programs, state-of-the-art leak detection measures, and appropriate spill response plans to avoid, detect, and respond to spills (see Table 2.9.0-1 and Section 2.7). The most current spill prevention technology will be employed, and containment and cleanup of oil spills will be in the operational plans. Some of the mitigation measures incorporated into the project will include using proper prevention measures, monitoring and detection for leaks and spills along pipelines and at well sites, and implementing standard waste handling and fluid transfer procedures. Important measures for controlling an oil spill will include preventing oil from reaching river channels, limiting the spread of oil into wildlife habitats by using containment booms, and using containment structures made of ice dams (in winter) or sandbags (vs. gravel). If vehicles are used for cleanup on the tundra, low-pressure tires will be used in summer to minimize damage to tundra vegetation and wildlife habitats. Low-impact cleanup techniques will be used where possible and, when necessary, techniques will be used that maximize oil recovery while minimizing additional damage (e.g., surface flushing) from cleanup efforts. To minimize damage to wildlife habitats from a seawater spill, the pipeline route will, where practicable, avoid habitats sensitive to seawater contamination, including Riverine or Upland Shrub, Moist Sedge-Shrub Meadow, and Moist Tussock Tundra. Complete avoidance of these habitats will not be practicable because of the high relative abundance of these types in the transportation corridor.

ARCO has researched historical problems caused by inefficient handling of waste and is committed to preventing increases in predator populations from access to food waste in the project area. For two reasons, predator problems similar to those at PBU and KRU are not likely to develop at Alpine. First, all camp waste will be managed and controlled by ARCO, and not subcontracted to a third party for secondary handling on the delta. In response to concerns about air-quality impacts, however, ARCO's original proposal to incinerate organic waste may be changed to require shipment of putrescible organic waste to Kuparuk or Prudhoe for disposal. Waste containers used for the ADP will be state-of-the-art containers that cannot be entered by predators and scavengers. Second, the small population of workers on-site (about 50 during operation) will use a single-camp facility in which food will be served in only one location. Because these conditions are significantly different from those at PBU and KRU, they will allow control of this issue. Moreover, existing state and oil company prohibitions on feeding wildlife will be strictly enforced. Kuparuk and Prudhoe oilfields require all employees to receive environmental awareness and training courses that specifically discuss wildlife avoidance measures (food handling when outside facilities, speed limits for vehicles, strict prohibitions on feeding wildlife, and avoiding approaching wildlife to take photographs, e.g. polar bears). The worker awareness training program will reduce interactions with wildlife and reduce adverse impacts on wildlife from traffic hazards. In addition, ARCO is pursuing other options for waste disposal. The principal possibility being examined in a pilot program at Prudhoe Bay is composting. If the Prudhoe pilot program proves successful and can be practically adapted to Alpine, ARCO will use this waste disposal technique in place of backhauling or incinerating organic waste to KRU.

Eventually, after oil deposits on the Colville have been exhausted, the oilfield will be closed out and the gravel placed on the tundra for roads and pads would be removed or rehabilitated. Rehabilitation of these gravel roads and pads will benefit from techniques being developed in the Kuparuk and Prudhoe Bay oilfields. Although thick gravel fill can be difficult to revegetate because it has low moisture and nutrients, techniques for rehabilitating gravel fill have been developed, including adding organic matter and sludge, using nitrogen-fixing legumes, contouring to alter snow capture and water balance, and removing gravel to promote tundra restoration (Jorgenson and Joyce 1994). The most appropriate techniques are revegetating gravel in place with a diverse mixture of native cultivars (grasses and legumes) and removing gravel in selected areas to facilitate revegetation. Section 2.10.2, Rehabilitation of Lands Affected by the Alpine Development, presents a detailed rehabilitation plan.

In addition to rehabilitation of gravel pads and roads, the alignment of ice roads will be varied annually to allow vegetation to recover from the stress of a shortened growing season (from delayed melt) and compaction.

4.4.3 Threatened and Endangered Species and Species of Special Concern

The project area extending into Harrison Bay is seasonally occupied by one endangered species, two threatened species, and two species of concern (formerly candidate species) under the Endangered Species Act (ESA). Each species is discussed below.

4.4.3.1 Affected Environment

Bowhead Whale

The bowhead whale is the only endangered species that occurs in the central Beaufort Sea. Bowheads winter (November-March) in the Bering Sea, migrate northward (April-June) in leads in the sea ice off the coasts of the Chukchi and Beaufort seas, summer (July-September) in Amundsen Gulf and the Canadian Beaufort Sea, and return to the Bering Sea during fall (September-November) (Moore and Reeves 1993). The Canadian Beaufort Sea and Amundsen Gulf are the primary bowhead feeding grounds, although some feeding also occurs in the Alaska Beaufort Sea during fall migration (Lowry 1993). Bowheads mate between January and October (Koski et al. 1993), and females produce a single calf, usually between April and June (Koski et al. 1993). Bowheads are hunted by Alaskan Eskimos during spring and fall migration; harvests averaged 42 whales (including those struck and lost) per year between 1989 and 1993 (Small and DeMaster 1995). The western Arctic population was estimated at 8,000 whales in 1993 and is believed to be increasing slowly (Small and DeMaster 1995).

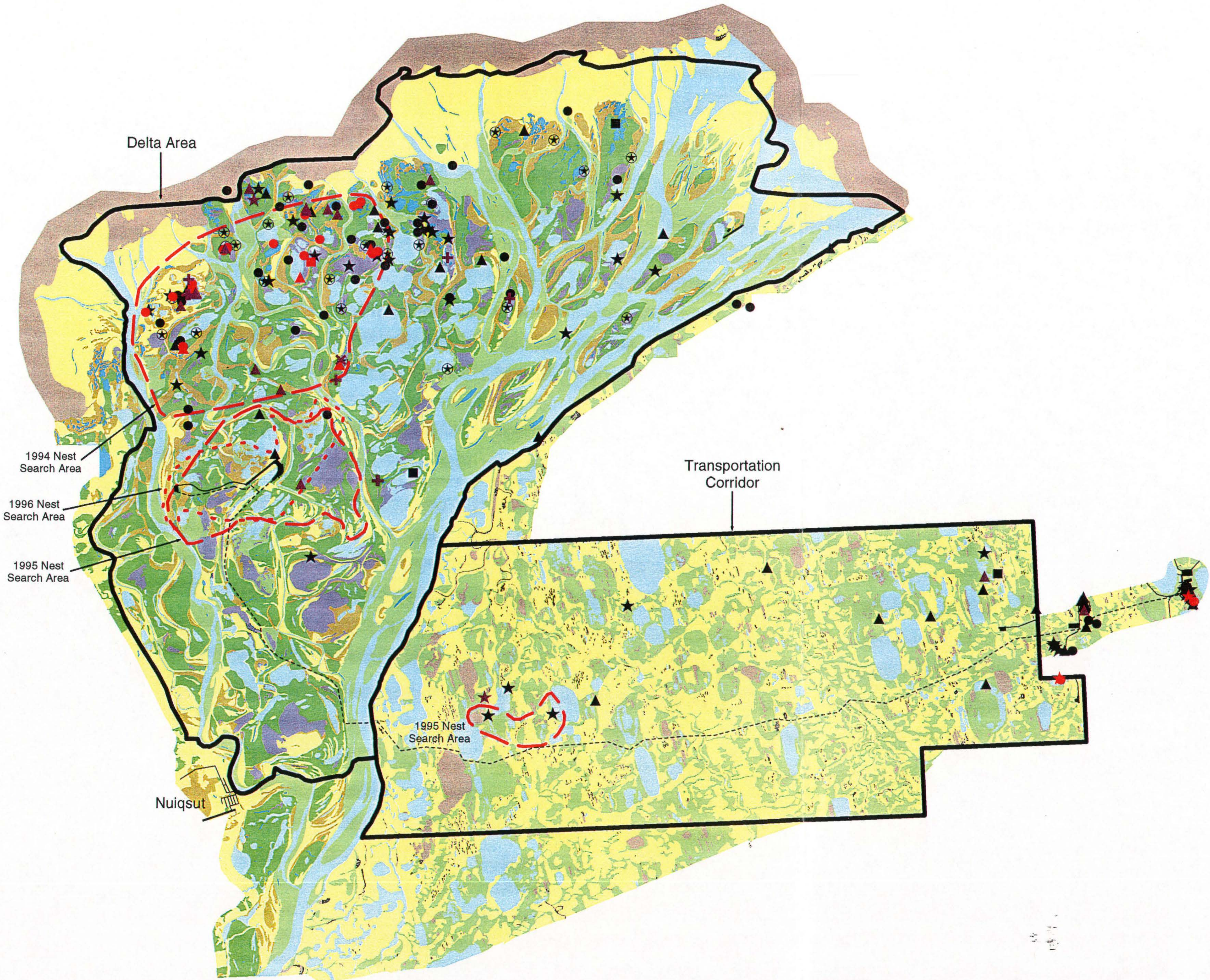
Bowheads pass far offshore from the Colville River Delta during the spring migration. Because of the location of leads, most of the whales passing Point Barrow in spring continue east between 71° and 72° N latitude, which places them over 30 mi offshore from the Colville River Delta (Moore and Reeves 1993; Figure 9.3). Bowheads come closer to shore in the fall because sea ice does not constrain their movements. Most bowheads pass along the northern Alaska coast from mid-September to early October (Moore and Reeves 1993; Figure 9.6), ranging from the coast at Barter Island and Point Barrow to 100 mi offshore, generally remaining in waters deeper than 60 ft (Seaman et al. 1981). Sightings are rare near shore in Harrison Bay and along the barrier islands east of the Colville River Delta (Seaman et al. 1981; Moore and Reeves 1993).

Spectacled Eider

The spectacled eider, a threatened bird species, has declined by more than 96% from historical levels (50,000) on the Yukon-Kuskokwim Delta, western Alaska (Stehn et al. 1993). Historical records of spectacled eider abundance on the Arctic Coastal Plain are unavailable, but the USFWS has estimated the current population to be at least 7,000 to 9,000 breeding pairs (Balogh and Larned 1994). Data for the nesting population in the Prudhoe Bay area suggest that it declined by as much as 80% between 1981 and 1992 (Warnock and Troy 1992; TERA 1993). Recent estimates suggest that the Arctic Coastal Plain supports the main breeding population of spectacled eiders in Alaska (USFWS 1994). Spectacled eiders also nest on the Yukon-Kuskokwim Delta, possibly on the Seward Peninsula, and in arctic Russia.

Spectacled eiders are distributed throughout the project area during pre-nesting from late May to mid-June, but have a more restricted distribution (primarily on the outer delta) during the remainder of the breeding season (Figure 4.4.3-1). Spectacled eiders arrive on the Colville River Delta and in the transportation corridor in late May (Johnson 1995; Johnson et al. 1996, 1997). On the delta, pre-nesting eiders prefer Brackish Water, Salt Marsh, and Salt-Killed Tundra, mostly within 10 mi of the coast, as well as Shallow Open Water with Islands and Polygonized Margins, and Aquatic Sedge Marsh with Deep Polygons (Johnson et al. 1997). Spectacled eiders also use several other habitats on the delta, although they are usually found only in low numbers (Table 4.4.3-1). In the transportation corridor, where spectacled eiders are four to six times less abundant during pre-nesting (Table 4.4.3-2), they prefer two habitats: Young Basin Wetland Complexes and Deep Open Water without Islands (Johnson et al. 1997). Observations during the pre-nesting period suggest that habitats containing open water are important to spectacled eiders.

Studies show that spectacled eiders nest on the northern delta, primarily on the delta front between the Nechelik (Nigliq) and Tamayayak channels, but apparently not in the transportation corridor (see Figure 4.4.3-1) (Johnson et al. 1996, 1997). Nesting begins in mid-June and eggs start hatching in mid-July; males



Source: Photo-interpretation of habitat types based on 1992 CIR photography (Johnson et al. 1996). Map registered to SPOT image base map.
Projection: UTM Zone 5, Datum NAD 27

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SCALE IN MILES 0 2 4

Terrestrial Habitats
- Used in 3 Periods
- Used in 2 Periods
- Used in 1 Period
- Use Not Observed

Aquatic Habitats
- Used in 3 Periods
- Used in 2 Periods
- Used in 1 Period
- Use Not Observed

Pre-nesting by Year
- 1996
- 1995
- 1994
- 1993
- 1992

Nests by Year
- 1995
- 1994
- 1993
- 1992

Brood-rearing by Year
- 1995
- 1993
- 1984
- 1983

Proposed Project
- In-field Facilities
- Pipelines

Figure 4.4.3-1. Spectacled Eider Habitat Use During the Pre-Nesting, Nesting, and Brood-Rearing Periods

Table 4.4.3-1. **Summary of habitat use by spectacled eiders during three periods (pre-nesting, nesting, and brood-rearing) of the breeding cycle on the Colville River Delta and ADP transportation corridor (data from Johnson et al. 1997); dashes indicate habitats that were not present.**

	Colville River Delta				Transportation Corridor			
	No. of Periods Habitat Used	No. of Pre-nesting Groups (Individuals)	No. of Nests (n=25)	No. of Brood Groups (n=11)	No. of Periods Habitat Used	No. of Pre-nesting Groups (Individuals)	No. of Nests (n=0)	No. of Brood Groups (n=1)
Open Nearshore Water		0			--	--	--	--
Brackish Water	3	7(22)	5	3	--	--	--	--
Tapped Lake with Low-water Connection	1	4(12)			--	--	--	--
Tapped Lake with High-water Connection	2	5(8)	1			0		
Salt Marsh	2	7(13)	1		--	--	--	--
Tidal Flat	0	0			--	--	--	--
Salt-killed Tundra	3	8(15)	3	4	--	--	--	--
Deep Open Water without Islands	1	2(3)			1	2(4)		
Deep Open Water with Islands or Polygonized Margins	1	1(2)				0		
Shallow Open Water without Islands	3	1(2)	1	1		0		
Shallow Open Water with Islands or Polygonized Margins	1	2(2)				0		1
River or Stream	1	1(4)				0		
Aquatic Sedge Marsh	--	--	--	--		0		
Aquatic Sedge with Deep Polygons	2	16(30)	7			0		
Aquatic Grass Marsh	2	1(1)		1		0		
Young Basin Wetland Complex		0			1	2(3)		
Old Basin Wetland Complex		0				0		
Nonpatterned Wet Meadow	2	5(12)	5		1	1(2)		
Wet Sedge-Willow Meadow	3	8(23)	2	2		0		
Moist Sedge-Shrub Meadow		0			1	1(2)		
Moist Tussock Tundra		0				0		
Riverine or Upland Shrub		0				0		
Barrens (riverine, eolian, or lacustrine)		1(2)				0		
Artificial (water, fill, peat road)		0				0		
TOTAL		69(151)	25	11		6(11)	0	1

Table 4.4.3-2. **Numbers and densities (birds/mi²) of spectacled eiders during pre-nesting and brood-rearing on the Colville River Delta and transportation corridor.**

Area	Year	Pre-nesting No. (/mi²)	Brood-rearing Adults No. (/mi²)	Brood-rearing Young No. (/mi²)
Colville River Delta				
	1993[1]	31 (0.34)	--	--
	1994	79 (0.43)	--	--
	1995	61 (0.29)	1 (<0.01)	5 (0.02)
	1996	41 (0.21)	--	--
Transportation Corridor				
	1993[1]	8 (0.15)	--	--
	1995	9 (0.07)	1 (0.01)	1 (0.01)
	1996	0 (0)	--	--

Sources: Colville River Delta - 1993 (Smith et al. 1994), 1994 (Johnson 1995), 1995 (Johnson et al. 1996), 1996 (Johnson et al. 1997). Tansportation corridor - 1993 (Anderson and Cooper 1994), 1995 (Johnson et al. 1996), 1996 (Johnson et al. 1997).

1 Aerial survey coverage in 1993 was at only 50%, therefore, densities are calculated only for the area searched (92 mi² on the Colville River Delta and 52 mi² in the transportation corridor).

disperse from the area by late June (Warnock and Troy 1992; Anderson and Cooper 1994). In recent studies, 25 nests were found in eight habitat types on the Colville River Delta including: seven in Aquatic Sedge with Deep Polygons, five in Brackish Water, and five in Nonpatterned Wet Meadow (Johnson et al. 1996). East of the transportation corridor, spectacled eiders in the Kupavuk oilfield nested primarily in Nonpatterned Wet Meadows within wetland complexes containing emergent grasses (*Arctophila fulva*) and sedges (*Carex* spp.) (Anderson and Cooper 1994; Anderson et al. 1995, 1996). Spectacled eiders in the Prudhoe Bay oilfield nested principally in Nonpatterned Wet Meadows (Warnock and Troy 1992). Observations show that spectacled eiders nest in a variety of habitats in the region, particularly coastal habitats in the delta.

During brood-rearing, which extends from mid-July to when the young fledge in early September (TERA 1995), spectacled eiders use a variety of aquatic habitats in the project area. Only a few broods (one in 1995, ten in 1993) were observed on the Colville River Delta, which precluded detailed analysis of habitat use. Most broods (64% of 11 broods) used two coastal habitats, Salt-Killed Tundra (four broods) and Brackish Water (three broods), and the remaining were in Wet Sedge-Willow Meadows (two broods), Shallow Open Water without Islands (one brood), and Aquatic Grass Marsh (one brood). The only brood found in the transportation corridor was in Shallow Open Waters with Islands or Polygonized Margins. Brood-rearing in the Kuparuk, Milne Point, and Prudhoe Bay oilfields primarily occurs in waterbodies with margins of emergent grasses and sedges, basin wetland complexes, and occasionally deep open lakes (Warnock and Troy 1992; Troy 1994; Anderson and Cooper 1994; TERA 1995). These results demonstrate that brood-rearing (and nesting) habitat is strongly associated with aquatic habitats, particularly coastally influenced habitats in the delta. Eiders depart the Arctic Coastal Plain by mid-September, when freeze-up begins.

In summary, spectacled eiders have been observed using 15 of 23 habitat types on the Colville River Delta and 5 of 18 habitat types in the transportation corridor (see Table 4.4.3-1). On the delta, Brackish Water, Salt-Killed Tundra, Shallow Open Water with Islands, and Wet Sedge-Willow Meadow were particularly important to eiders. These habitats were the only types where eiders were observed during all three periods (pre-nesting, nesting, and brood-rearing) of the breeding cycle (see Figure 4.4.3-1). Of the five habitat types used during two periods, relatively high numbers of observations were in Aquatic Sedge with Deep Polygons. Six habitats were used by eiders during only one of the three periods, and all of those were used exclusively during pre-nesting. In the transportation corridor, none of the five habitat types used by eiders was occupied during more than one period of the breeding cycle. These same habitat types were used by eiders in the delta, except for Young Basin Wetland Complex. Eiders were not observed in four habitat types found in both the delta and transportation corridor, suggesting that these types are not used by eiders during the breeding cycle. The results of the habitat analysis indicate that habitat use is most diverse during the pre-nesting period and least diverse during the brood-rearing period. In addition, most nesting and brood-rearing occur on the delta, generally within 5 mi of the coast, and 3 to 4 mi north of the proposed Alpine development.

Steller's Eider

As originally was proposed in July 1994, the Steller's eider was listed as a threatened species on June 11, 1997 (62 F.R. 31748). Historically, Steller's eiders nested throughout much of western and northern coastal Alaska and in arctic Russia (Kertell 1991; Quakenbush and Cochrane 1993) but currently they nest only on the Yukon-Kuskokwim Delta (one pair in 1994), the Arctic Coastal Plain, and arctic Russia (Kertell 1991; Quakenbush and Cochrane 1993; Flint 1995 personal communication).

Nesting densities on the Arctic Coastal Plain are highest near Barrow, but the breeding range probably extends from about Point Lay to the vicinity of the Colville River Delta (Day et al. 1995; Quakenbush et al. 1995). Nonbreeders and post-breeding birds use the nearshore zone of the northeastern Chukchi Sea and large lakes around Barrow for molting and summering, and a few occasionally occur as far east as the Canadian border. Steller's eiders periodically occur on and near the Colville River Delta but have not been seen in the transportation corridor; for example, a small flock (three males, two females) was on the central delta on June 10, 1995 (Bart 1995 personal communication) and a male was seen about 10 mi northwest of Nuiqsut in early June 1997 (Larned 1997 personal communication). No Steller's eider nests or broods have been found in the project area. The preferred habitats of Steller's eiders near Barrow are waterbodies with *Arctophila fulva*, pendant grass (Aquatic Grass Marsh). Aquatic Grass Marshes are uncommon on the Colville River Delta (339 acres), and are even less common (169 acres) in the transportation corridor. Thus, although the project area may be visited by small numbers of Steller's eiders each year, there is no evidence to suggest that they nest there.

Arctic Peregrine Falcon

The arctic peregrine falcon was removed from the threatened list by the USFWS on October 5, 1994 (59 F.R. 50796), but the species is now being monitored for five years as a species of concern. Peregrines generally are infrequent visitors to the coastal plain (Pitelka 1974; Johnson and Herter 1989) but regularly breed inland (Cade 1960; Pitelka 1974). The densest concentration of breeding peregrines occurs along rivers in the northern foothills of the Brooks Range, especially the central Colville River and its tributaries (Cade 1960; White and Cade 1971).

No nesting has been recorded, either on the Colville River Delta or in the transportation corridor, but peregrines regularly use the delta between late April and mid-September. The northernmost nest recorded on the Colville River was on bluffs near Ocean Point, approximately 10 mi south of Nuiqsut (Swem 1995 personal communication). Peregrine use of the delta includes occasional hunting forays during summer by adults, movements of young birds after leaving the nest, and fall aggregations during migration (Johnson and Herter 1989). Peregrines banded as nestlings on the upper Colville River have been recovered on the delta (Swem 1995 personal communication).

Drummond Bluebell

The Drummond bluebell (*Mertensia drummondii*) is a species of concern (formerly Category 2 candidate). This small (5- to 6-inch-tall) vascular plant has been found in areas of moderately active sand dunes on the Meade River at Atqasuk and the Kogosukruk River near Umiat (Murray and Lipkin 1987). Exposed sand dunes from the Colville River westward (Pic Dunes, Fish Creek dunes, and point bars on the Itkillik and Meade rivers) have been surveyed for this species, and, although suitable habitat was present, no populations were found (Murray and Lipkin 1987). No specimens of this plant were found during a ground search of suitable habitat in the proposed facility area in August 1996 (ABR, Inc. unpublished data).

4.4.3.2 Environmental Consequences

No protected species of mammals are present in the terrestrial portion of the project area, and bowhead whales (listed as endangered) pass far offshore in Harrison Bay.

Potential direct effects of the proposed ADP on threatened birds would be restricted primarily to the spectacled eider, because Steller's eiders are rarely seen on the delta, and peregrine falcons occur only sporadically and do not nest in the area. Most spectacled eiders nest within 5 mi of the coast (3-4 mi north of the proposed in-field facilities) and, although one pair of spectacled eiders was seen near the proposed in-field facility location during pre-nesting in 1995, no nests or broods were found there in 1995 or 1996 (Johnson et al. 1996; ABR, Inc. unpublished data). In the transportation corridor, spectacled eiders have been seen during pre-nesting in widely scattered locations, two of which were within 1 mi of the proposed pipeline routes, and one brood was found in 1995 in the western corridor, approximately 4 mi north of the proposed pipeline route (Johnson et al. 1996). Spectacled eiders use habitats between DS-2M and CPF-2 during pre-nesting, nesting, and brood-rearing (see Figure 4.4.3-1), as indicated by repeated surveys (Anderson and Cooper 1994; Anderson et al. 1995, 1996).

Direct effects on spectacled eiders could include potential long-term loss of habitat suitable for pre-nesting, nesting, brood-rearing, and fall staging (see below). Other direct effects could include behavioral disturbance of eiders (near roads, pads, and airstrips) by noise, humans on foot, and vehicles; these types of potential effects on wildlife were discussed in detail in Section 4.4.2.2. In addition to the potential direct effects of the proposed project, potential indirect effects include altered habitat use patterns from disturbance and increased mortality or nest failure from increased predator populations. The relative magnitude of the direct and indirect effects in the in-field facility area would be minimal for spectacled eiders because the birds rarely occur in that area.

As part of the consultation process required under the ESA, the USACE has informally consulted with USFWS regarding the spectacled eider (USFWS letter to the Corps date June 6, 1997). USFWS has concluded that neither a Biological Assessment nor further consultation is necessary at this time because no adverse impacts to protected species are anticipated by USFWS.

Impacts of the Proposed Action (Alternative #2)

Habitat Loss. Five of the seven habitats directly affected by gravel placement for the in-field facility are used by spectacled eiders elsewhere on the Colville River Delta (see Table 4.4.2-7 and Figure 4.4.3-1). Nevertheless, the magnitude of habitat loss from gravel placement and temporary loss in the nesting season, following use of ice roads and pads, would be low because spectacled eiders are rare in the immediate vicinity of the in-field facility and pipeline route (Johnson et al. 1997). In addition, the loss of habitats from gravel placement for the in-field facility is minor compared to the amount of these habitats available on the entire delta (see Table 4.4.2-7).

Disturbance and Indirect Impacts on Habitat Use. If spectacled eiders use available habitat within the facilities area in future years, one potential indirect effect is a shift in habitat use away from disturbance from oilfield operations (noise, vehicle traffic, human pedestrians), including operation of the ADP airstrip. As was discussed in Section 4.4.2.2, this effect may occur within 500-700 ft of roads or pads. The addition of new compressors at the Central Compressor Plant as part of the Gas Handling Expansion (GHX-1) program in Prudhoe Bay and the subsequent increase in noise levels resulted in a noticeable shift by spectacled eiders away from the noise source during the nesting season (Anderson et al. 1992). Long-term alteration of habitat from the effects of dust, impoundments, snow drifts, thermokarst, and other vegetative changes near gravel roads and pads could potentially affect habitat use by spectacled eiders. In the Kuparuk oilfield, spectacled eiders appear to be attracted to snow-free areas near roads during pre-nesting because of the early availability of open water (Anderson and Cooper 1994; Anderson et al. 1995, 1996). Use of such areas increases the exposure of spectacled eiders to disturbance from vehicles and noise. Locations of eider nests in the Kuparuk oilfield indicate that eiders select nest sites farther from roads than the sites used by the pre-nesting pairs, suggesting that nesting females are more sensitive to disturbance (Anderson et al. 1996). However, the likelihood of any direct or indirect impact from the ADP will be greatly reduced by their low use of the proposed in-field facility location.

Mortality and Injury. A direct effect on spectacled eiders is the increased risk of mortality and/or injury to eiders from collisions with vehicles or project facilities, fouling by oil, and ingestion of other contaminants. The risk of such mortality and injury is very low, however, due to the rarity of spectacled eiders in the in-field facility area.

Increased Predation. Artificial food sources at the project could increase predator populations and thereby cause detrimental effects to spectacled eiders, particularly those nesting on the delta. This risk is decreased because the primary nesting areas are located away from the in-field facility, prohibitions on wildlife feeding will be strictly enforced, and organic waste will be shipped to the Kuparuk and Prudhoe Bay oil fields, or composted.

Impacts of Alternatives #3 - #8

Because the general impacts on birds, from the various project alternatives were discussed in detail in Section 4.4.2.2, the following discussion focuses only on alternatives that may have impacts on threatened and endangered species.

In-field Facilities.

ASRC, ASRC/Kuukpik, and Kuukpik (Western Initiative) Alternatives (#6 - #8). Shifting the camp facility to Nuiqsut would reduce disturbance and limit potential garbage sources on the Colville River Delta, thus reducing the potential for increased predator populations adversely affecting nesting spectacled eiders. Use of the Nuiqsut airstrip also would decrease disturbance to eiders by removing aircraft operations from the delta and relocating them several miles farther south from primary nesting areas on the outer delta. However, habitat loss from constructing the 8-10 mi of gravel road associated with these alternatives would offset the above reduction in impacts.

Pipeline Route/Crossing Location and Field Access. In general, the pipeline routes (and associated roads) would have limited effect on spectacled eiders because most of these facilities would be constructed primarily in the transportation corridor, which receives little use by spectacled eiders (Johnson et al. 1996). However, the 8-mi road from Nuiqsut to Alpine (#6), through the delta area, would cause preferred habitat loss.

River Crossing Methods.

Cable Bridge Span (#3). This option could pose a collision hazard for spectacled eiders flying along the East Channel of the Colville River, particularly in low-visibility conditions (fog, rain, snow). Johnson et al. (1996) noted heavy use of this channel by king eiders during pre-nesting, and it is likely that some spectacled eiders also use the river before moving to nesting areas. Although pre-nesting groups are not common in the vicinity of the bridge, small numbers of eiders using the transportation corridor and those migrating farther east may pass through this area, particularly during spring.

Vehicular Pile-Supported Bridge (#7, #8). This option (ASRC/Kuukpik and Western Initiative) also would pose many of the same collision problems for spectacled eiders as the cable bridge span, but collisions would be less likely because of design differences (see discussion in Section 4.4.2.2).

4.4.3.3 Mitigation Measures for the Proposed Action (Alternative #2)

The mitigation measures discussed previously for birds generally apply to spectacled eiders as well. Mitigation to reduce habitat loss and disturbance for other species should benefit spectacled eiders. No major construction activities are planned to occur in the transportation corridor during the pre-nesting or nesting seasons, which typically concludes in mid-July. The ADP project will, however, involve some construction activities at the in-field facilities during the May 20–August 1 time period, which the USFWS has identified as the period of concern for spectacled eiders. During the first summer season in the construction phase, ARCO plans to compact gravel. During the second summer season, ARCO plans site preparation for module installation. As described earlier (Section 4.4.3.1), surveys of the Colville River Delta indicate that spectacled eiders occur rarely in the proposed in-field facility area. No nests or broods were observed within that area in 1995, 1996, and 1997 (Johnson et al. 1996, 1997; ABR, Inc. unpublished data). Regardless of this low level of recent use, however, pre-nesting and nesting surveys for spectacled eiders near the in-field facility area will be conducted during construction and the first year of operations, as one component of ARCO's monitoring study of the effects of aircraft operations on birds. ARCO will follow a USFWS-approved nest survey protocol and will consult with USFWS if any nests of spectacled (or Steller's) eiders are observed within 650 ft of project facilities at which construction activities or gravel-compaction are conducted. If surveys record the presence of any confirmed or probable eider nests near the ADP facilities, activities occurring off the gravel pads, such as surveying and litter clean-up (by "stick-pickers") will be prohibited within 650 ft of the nests while they are occupied.

Chapter 4.5

4.5 HUMAN USE RESOURCES

4.5.1 Communities of the Colville River Region

4.5.1.1 Affected Environment

The Kuukpikmiut (Inupiat Eskimos)

Historical Background. The mid-Beaufort region of Alaska's North Slope, which includes the Colville River Delta area, has been occupied and used by hunter gatherers for at least 11,000 years. Evidence also shows the delta served as a meeting and trading ground for Native groups. Such occasions established and maintained social relations between peoples who, for most of each year, lived widely dispersed over this vast territory in migratory subsistence bands and families.

Toward the end of the 19th century, contacts between Europeans and the mid-Beaufort dwelling Inupiat were first documented. The most noted visitor was the explorer Vilhjalmur Stefansson who, between 1905 and 1914, studied their language, described their social groupings, and surveyed their subsistence and trading practices (Stefansson 1913, 1914a,b).

Stefansson believed the Kuukpikmiut ("people of the [lower] Kuukpik River") to be part of a larger, widely dispersed collection of Inupiat hunting groups. Stefansson and subsequent ethnographers labeled this larger group the Nunamiut. The Kuukpikmiut were those Nunamiut families and bands who resided in the lower Colville River region and along the coastal areas adjoining it (Stefansson 1914a,b; Jenness 1957; Gubser 1965). One reason for establishing permanent residence appears to have been that the Kuukpikmiut specialized in the harvest of marine mammals that could only occur at the coast.

The settlement pattern described here probably distorts the social, economic, and human ecological dynamics that have characterized the last century of Kuukpikmiut history. The early ethnographers made their observations during a time of great social change (Hoffman et al. 1988).

Commercial bowhead whaling, which began in earnest in the Beaufort Sea in the 1880s (Bockstoce 1986) and continued to 1910, was the prime impetus for change. Hunting bands were attracted to the coastal whaling stations with their trading posts and employment opportunities. The European whaling crews' demands for fresh meat opened the greatest opportunity for Inupiat hunters. These demands were supplied from the caribou herds of the North Slope. The introduction of firearms increased the efficiency of the hunt and, by the turn of the century, caribou numbers had declined dramatically.

One consequence of this decline was that the migratory hunting bands increasingly resided near the coastal whaling posts, particularly around what is now Barrow. The contact was expressed in many ways. The introduction of new diseases from which the Inupiat had little natural immunity took a substantial toll of lives. Alcohol produced equally dramatic and damaging consequences. Intermarriage between white male commercial whalers and traders and Inupiat women created new social bonds expressed through expanding family networks. Missionary efforts introduced both Christianity and the English language.

These decisive changes were felt over little more than a single generation (1890-1910). After 1910, the baleen and whale oil markets collapsed and commercial whaling abruptly ended. It was replaced by the Euro-American economic demand for Arctic furs. Instead of concentrating people around coastal stations, the commercial production of furs and pelts required hunters and trappers to disperse widely over the landscape.

Throughout the 1920s and 1930s, hunting and trapping became an economic mainstay for the Kuukpikmiut. However, the fur trade could not sustain a significant permanent occupation of their traditional lands and after the collapse of fur prices in the mid-1930s, the government trustees who bore responsibility for the welfare of northern Alaska Natives applied pressure to move the widely scattered families to places having schools and rudimentary health services. By the 1940s, most Kuukpikmiut families moved to Barrow or other villages. A few families did not leave the area.

Those who did move to Barrow never forgot that their true home lay within the region that government action and economic distress forced them to leave. Although it required lengthy travel, there also continued to be a pattern of subsistence use even by those who resided in Barrow. Seasonal hunting, trapping, and fishing forays were made. Even bowhead whaling was undertaken by the well-known captain, Taaqpak (Carnahan 1979).

Nevertheless, from World War II through the late 1960s, the Kuukpikmiut lands lay beyond the range of the intensive subsistence use known during preceding generations.

Beginning around 1950, three new elements shaped the present day socioeconomic character of the lower Colville River Delta region. First, the construction of distant early warning sites (DEW Line) by the U.S. government along the coast provided new employment opportunities for Inupiat men. Second, the oil exploration program initiated by the U.S. Navy on the Naval Petroleum Reserve-Alaska (NPR-A) lands to the west of the lower Colville River was expanding toward the delta region. Various Inupiat individuals with knowledge of and claims to the area worked on the cat trains and exploratory drilling operations. Third, a non-Inupiat family, the Helmericks, established permanent residence in the Colville River Delta and began a commercial fishery and guiding service.

The first two of these three new elements provided direct and sustained contact with the Kuukpikmiut lands despite many of its residents having moved elsewhere. So, after the discovery and development of the Prudhoe Bay and neighboring oil reservoirs, families and individuals who possessed clear and provable claims to the occupation and use of Colville area lands claimed their lands.

Two major land settlement acts forced the need for action. The Alaska Statehood Act gave the new state, chartered in 1959, the opportunity to select immense tracts of territory from Alaska's federal territorial holdings. Among those selections were most of the Colville River Delta as well as what proved to be the oil-productive lands of Prudhoe Bay and Kuparuk. The federal government owned the NPR-A lands which were located westward from the Colville to Barrow. These massive government holdings, federal and state, were coterminous with the traditional subsistence use territories of the mid-Beaufort region Inupiat.

Under the Alaska Native Claims Settlement Act (ANCSA) (passed in late 1971), Native groups that could demonstrate historical occupation and use of specific lands—normally focused on the presence of a village or settlement within them—could have portions of those lands conveyed to them through the mechanism of a village corporation. It was incumbent on the Kuukpikmiut to demonstrate traditional occupation and use, and to create a village corporation as the required institution to receive and manage the promised land grant benefits.

In March 1973, 212 initial enrollees established the Kuukpik (Native) Corporation. Its purpose was to seek land grants in the Colville River Delta region to which it was entitled under the appropriate provisions of ANCSA. Since most resided in Barrow, they had to physically reoccupy the area. In April 1973, 27 families numbering some 145 individuals established a tent village which housed the group through the winter of 1973-74. With the assistance of the ASRC, housing construction commenced in spring 1974, and the first set of dwellings was occupied by fall freeze-up. Shortly thereafter, a school building, Kuukpik Corporation office, and a store were completed (Hoffman et al. 1988). Local government institutions were developed and the Kuukpik Corporation began the process of selecting its land entitlements.

Cultural Resources of the Colville River Delta and Surrounding Areas. Cultural resources include archaeological sites, historic places, place names, traditional land use sites, and cultural information. These resources include actual physical remains or ethnographic memories of places and activities.

The cultural history of the region is the subject of ongoing studies. The archaeological record has been severely damaged by natural erosion and is incomplete, but the existing information allows archaeologists and anthropologists to develop some generalities about past human adaptations. Table 4.5.1-1 lists some of the existing finds.

Cultural Resources: Place Names, Historic Sites, and Archaeological Sites. Place names have become of increasing cultural resource interest. These names, normally Iñupiaq, refer to locations where important events or activities, frequently subsistence use, took place. Most have no physical remains. Others may include known archaeological features, such as sod house ruins or tent circles. The names reflect an "ethnohistoric present" or a living memory of the past. This component of oral tradition may extend back three to four generations or even beyond.

Since the early 1970s, the NSB Commission on History, Language, and Culture has been recording

Table 4.5.1-1. Selected North Slope archaeological finds.

Tradition	Date	Finds	Selected Sites
Historic Inupiat	A.D. 1837	Stone, metal, organic artifacts; historic, ethnographic, and informant accounts	Historic Coastal and Mountain Eskimo sites
Late Prehistoric	A.D. 1400	Many lithic, wood, bone artifacts, house ruins	Pingok Island, Thetis Island
Arctic Small Tool	2000 B.C.	Small lithic microtools, cores, blades	Putuligayuk River, Central Creek Pingo
Northern Archaic	4000 B.C.	Notched points, microblades, bone tools	Putuligayuk River, Kuparuk Pingo
Paleoarctic (?)	7000 B.C.	Microcore, microtools, bifaces	Putuligayuk River
Paleoindian (?)	9000 B.C.	Lanceolate points, bifaces	Mesa, Putu

place names and compiling a traditional land use inventory (TLUI) through the existing oral traditions as told by Elders within Inupiat society. Twenty-two names have been recorded on a list of place names for the Colville River Delta for places of importance (Hoffman et al. 1988) (Figure 4.5.1-1).

1. ***Uyagagaviit*** ("rocky place").
2. ***Niglivik*** ("white-fronted goose place") is a tributary stream.
3. ***Nanuq*** ("polar bear").
4. ***Nigliq*** ("white-fronted goose"), also called Woods ***Inaat*** ("Woods Camp"). This place relates also to ***Nechelik,*** which has been reported as meaning "new deep channel," but may actually be a variation of the word ***nigliq,*** meaning "white-fronted goose" in Iñupiaq. This place is west of the Nechelik (Nigliq) Channel and is an archaeological site (49-HAR-169) dating to the late prehistoric as well as a presently used subsistence place.
5. ***Kayuqtusilik*** ("red fox") where an old trading post was located.
6. ***Aki*** ("big fish hook used for burbot") where a hidden camp along a creek was located.
7. ***Puviqsuq*** ("swelling up; hills or pingos").
8. ***Tirragruaq***, place name for an old sandbar.
9. ***Itqilippaa*** ("mouth of the Indian River"), referring to the ***Itqiliq*** (Indian) River.
10. ***Aanayyuk*** ("a man who died there"), this is the same as archaeological site 49-HAR-162, a historical house site, also called ***Aanayyuk***.
11. ***Pisiktagvik*** ("place of bows and arrows").
12. **Nuiqsut Site #1**, this is the same as the Historic period archaeological site 49-HAR-159, ***Nuiqsapiaq***.
13. **Helmericks**, also known as Colville Village.
14. ***Putu*** ("a deep hole that is now dry")
15. **Texaco Well**, operated 1984-85.
16. ***Milugiak*** ("long-nosed sucker") or ***Milugiaqvik*** ("place where we take the long-nosed sucker fish") is located at the mouth of the Miluveach River where it empties into the eastern Colville River. Also the same derivation for the river name.
17. ***Anachlik***, the name of the island in the Colville River. One of the Woods camps was located there.
18. **Elaktoveach Channel**, actually ***Ilaaqtugviit*** ("the place of the wide stream in the middle"). This term probably refers to ***Illaqtuq***, a fishing method of setting fishing nets under winter river ice through a series of small holes in the ice.
19. **Kupigruak Channel** ("big old river") from ***Kuukpigruaq*** or ***Kuukpiq***, the Inupiat name for the Colville River.
20. **Pikonik Mound**, actually ***piquniq*** ("a high place or lookout place") from which the term pingo is derived. It usually refers to a large and gradually rising pingo, rather than a sharp hill.
21. **Kachemach River**, a name for the river of "wide high bluffs" also perhaps named after ***Qakimak*** ("a seal on top of the ice").
22. **Kalubik Creek**, actually ***Quluviq*** ("place of tears"). The Historic period archaeological site 49-HAR-015, ***Qulvi*** ("tears") is located at the mouth of this stream.

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SCALE IN MILES

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Proposed Project

■ In-field Facilities

----- Pipelines

Figure 4.5.1-1.
Local Place Names and Cultural Sites, Colville River Delta and Vicinity

Paleontological Resources. No paleontological remains are yet reported for the Colville River Delta. There are no rock outcrops, but the massive outwash delta likely contains dispersed fossils. Underlying gravel in the adjacent areas (Kuparuk and Prudhoe) has occasionally produced the remains of Pleistocene fauna. Although some fossils, including extinct mammoth (*Mammuthus* spp.) and bison (*Bison priscus*) have been found in other North Slope production areas, the depths have been relatively deep and associated with outwash plains sediments recovered in gravel mine sites or excavated reserve pits. Such fossils cannot be determined to exist in an area unless uncovered during the borrow operations.

Socio-Cultural Systems. Inupiat socio-cultural systems are the institutions and arrangements that bind together people of a common background, language, and kin relationships. Nuiqsut socio-cultural systems also derive from the dynamic features that have accompanied the joining together of people in a single location. In an earlier age, social arrangements had been governed by peoples' wide dispersal over a vast landscape in small, family-based groupings. In the more recent past, the situation was characterized by residence in village communities, such as Barrow, which lay some distance from the traditional Colville River Delta homeland territories.

Kinship and family ties remain the social glue that binds together individuals and small groups. These ties are expressed differently from the ways characteristic of the traditional migratory hunting band. Not all members of a family accompanied those who formed part of the resettlement group. Many remained in Barrow or located in other villages or towns distant from Nuiqsut. Beyond that, the long Kuukpikmiut residence of many members away from their traditional region had resulted in alliances based on intermarriage outside the immediate group. Thus, in the contemporary setting even core members of an extended family do not always reside in the same physical location. However, air transportation between Nuiqsut, the other North Slope communities, and the rest of Alaska has maintained strong family ties despite separation by significant distance.

The migratory family-based band was also the principal economic, or work, unit of traditional Kuukpikmiut society. It focused on subsistence harvest, domestic consumption, and sharing of wild resources. Relations between families were based upon mutual assistance and sharing and, in one case, whaling, upon inter-family cooperation in the hunting effort. All lands and waters where the animals and fish might be harvested were held in common and were not, with the exception of respect for the rights of an individual family's traditionally used fishing camps, regarded as owned by either individuals or families.

Establishing a relatively large number of families in a single location demanded some major transformations in the traditional pattern. Owing to the construction of housing on individual lots, households increasingly became residential units for nuclear rather than extended families (Harcharek 1994). This did not preclude the mechanisms of cooperative work and sharing that lay at the heart of the old socio-cultural system, but it did fundamentally change how individual family members interacted with each other. Increasingly, wage-earning employment was equal to the economic importance of subsistence hunting, fishing, and gathering pursuits. The product is something which many analysts of change in rural Alaska have termed a "mixed economy" (Kruse et al. 1983), where cash incomes are essential to support not only new housing and other services available in a residential village setting but to underwrite the costs of subsistence as well. When mechanized transport (snowmachines and motor-powered boats) replaced dog teams and skin boats by the 1960s, the resulting hunting and fishing efficiencies also carried the costs of acquiring and maintaining them. These costs require money. Consequently, the older division of labor where adult males produced family incomes from subsistence hunting, while women attended to domestic and child-rearing needs of the family, has been importantly altered. Both men and women now work for wages (Harcharek 1994).

Another major element that sustains the Kuukpikmiut socio-cultural system is the widespread use of the mother tongue, Iñupiaq. While most of the community is both fluent and literate in English, Iñupiaq is spoken as a first language in one-quarter of the households of Nuiqsut, and Iñupiaq and English are both spoken in an additional 50% of the households. Among those individuals who speak Iñupiaq as a first language (183 of 418 individuals based on the 1994 census), 153 are also literate in the language (Harcharek 1994). These rates of Iñupiaq proficiency and use are the highest among the eight village communities in the NSB.

Public business and group socialization (city council, school advisory board, village corporation meetings, church services, etc.) are conducted by using a mix of English and Iñupiaq. Where consensual decision-making is sought—particularly in matters involving relations between non-Iñupiaq speakers and Native residents—Iñupiaq use typically dominates.

It is hard to over-estimate the importance that Iñupiaq language holds in the contemporary Kuukpikmiut socio-cultural system. But in making such an assertion, two or three qualifications must be recognized. First, Iñupiaq is not only the language of elders. Nuiqsut has a very young population (median age 18 years). Those people 60 years or older living in the community, as of the 1994 census, were represented by only 29 individuals or 7% of the population. And yet Iñupiaq, or a mixture of Iñupiaq and English, is spoken in three-quarters of the households. Second, Iñupiaq use persists despite the fact that most residents of school age and above have received formal schooling almost exclusively in English. Bi-lingual instruction is in the school curriculum, but Iñupiaq usage within the family setting appears to account for its prevalence. Third, even if the level of proficiency and use of Iñupiaq is relatively low, especially among the youth, it still provides strong reinforcement to Inupiat cultural and social values within the community. Thus, far from appearing as the relic of an earlier traditional and now dramatically changed Inupiat culture, Iñupiaq usage has an instrumental role in the effective functioning of the contemporary socio-cultural system.

But of all the elements upon which the socio-cultural system is based, subsistence activities, and the values attached to them, are central. A motivation for the physical resettlement of the Kuukpikmiut in the lower Colville River Delta region was to have direct and immediate access to the rich terrestrial, fish, and marine mammal resources (Nuiqsut Heritage 1979; Galginaitis 1990). Despite the major changes in permanent residence locale, hunting and fishing technologies, transportation, and participation in the wage labor market, the "subsistence lifestyle" is central in the scheme of Kuukpikmiut cultural values. For many, it dictates the calendar of annual events: spring waterfowl hunting, summer and fall fishing, late summer moose hunting, fall whaling, winter trapping, favored times for caribou hunting throughout the year, and so forth (a discussion of the subsistence cycle is in Section 4.5.4.1). While the Kuukpikmiut subsistence harvest makes a major contribution to household food supplies (and for many constitutes the preferred diet), its importance obviously transcends dietary needs and preferences. It demonstrates an important link between people and their lands and waters. It is the basis for sharing through both cooperative activities and distribution of the fruits of the harvest. It also provides the occasions for feasts and communal celebrations.

Family and kinship ties, with special emphasis on respect for elders; a shared common language; and the keen desire for a subsistence lifestyle are bedrock characteristics of the Kuukpikmiut socio-cultural system. These are extended and reinforced through institutions that have become a major part of contemporary social interaction and cultural expression. The Presbyterian Church, which took root among the Inupiat of the North Slope dating at the turn of the century, plays a significant role in the religious and social life of today's Colville River Delta residents. The village church provides the sacramental setting for those life cycle events of baptism, marriage, and death. Assembly of God missionary efforts have provided, for some, another avenue to attend to these same crucial matters.

The school, which is attended by nearly one-half of the population, is the most obvious formal institution for social interaction. While most of the faculty consists of non-Inupiat, credentialed teachers who reside in the village only during the academic year, the school itself is a common venue for nearly all Nuiqsut residents. Its activities are informed by a School Advisory Board made up of local residents. Its service personnel and teachers' aides are community residents, both men and women. It is used for community recreational activities (within which basketball holds a prominent position), music and dance performances, and feasts. The school lunch program serves students and regularly provides meals for the elders.

The school curriculum only modestly reinforces the central values of Iñupiaq language preservation and subsistence lifestyle. It does not contravene those values as had been the case in earlier government and mission school programs where Native language use was forcefully suppressed and traditional activities discouraged in favor of the push to assimilate the Inupiat to Western-style values in an English-only language framework. The use of Iñupiaq is encouraged by the provision of regular classes taught by bi-lingual aides. Furthermore, schedules are adjusted to accommodate hunting and fishing for school employees and, by extension, their older children.

Other institutions important in perpetuating Kuukpikmiut social and cultural values are the Nuiqsut Whaling Captains' Association (for greater detail see Section 4.5.4.1) and its associated wives' organization; the Mothers' Club; and the traditional dance performance group. Voluntary associations common to many small towns, such as service clubs, are not present in Nuiqsut.

Five years after the Kuukpikmiut resettlement at the present Nuiqsut townsite, the residents were assisted in preparing a document that reasserted their interests in preserving and solidifying their cultural values. This resulted directly from the enormous changes caused by the development of the North Slope oilfields, the ANCSA, chartering of the Native corporations, the establishment of the NSB, and the creation of a local city government. That document, prepared in 1979 for the Village of Nuiqsut by the NSB Planning Commission and the Commission on History and Culture, is entitled *nuiqsut paisanich* (*Nuiqsut Heritage: a cultural plan*). The plan focuses on protection of the natural environment and its subsistence resources and, thereby, the subsistence lifestyle itself. Formal resolutions passed by the Nuiqsut City Council in June 1995, and accepted by the NSB Planning Commission, decreed that *nuiqsut paisanich* shall continue to provide the basic framework governing ongoing development of modern Kuukpikmiut institutions.

Contemporary Village of Nuiqsut. Nuiqsut has grown from an original population of 128 in 1973 to 418 as of 1994. That growth has largely resulted from a high birth rate and, to a lesser degree, immigration. The median age of the total population, male and female, is 18 years as contrasted to 25 years for the NSB. Approximately one-half of Nuiqsut's current residents are of school age or younger. The resident population is 90% Inupiat.

Accompanying this population increase (a 226% growth rate between 1973 and 1994) has been an equal pace of village infrastructural development. Public facilities and services in Nuiqsut have grown quickly. Within a decade of its founding, Nuiqsut had an airport and a full, all-weather road and street grid. Electrification and treated water were provided to each dwelling and public building. A health clinic, fire station, public safety building, and community center/city hall were completed by the mid-1980s. By the late 1980s there was a major warm storage/vehicle and equipment servicing facility. A local telephone network with long distance capability and a cable television distribution system are available to all households. There is a plan to upgrade the sewage disposal system by constructing individual wastewater treatment units for each dwelling. The school and public utilities buildings are already connected to such a system.

The bonding authority of the NSB funded the infrastructure development program. The revenues to underwrite the bonds are based upon property taxes primarily levied on the neighboring oilfield and oilfield service industry installations at Prudhoe Bay, Kuparuk, and Deadhorse. A significant portion of these revenues was directed to a capital improvements program (CIP) launched by the NSB in the late 1970s. State grants also contributed to various projects. Thus, the regional government provides for and maintains the public facilities and services described above, including the school. The telecommunications systems are managed by the respective owner cooperatives and companies.

During the CIP and subsequent programs, perhaps one of the most important changes in the resident Kuukpikmiut community was caused by expanded employment opportunities. During the construction phases, wage-earning opportunities were made available on the various projects. Following construction, a large number of local jobs fell within the operation and maintenance scope. By 1993, 60 of the 96 locally available jobs (63%), including teacher employment at the school, were provided by the NSB (Harcharek 1994).

Most other essential community services are handled by the for-profit village Kuukpik Corporation. It is responsible for the acquisition, storage, sales, and distribution of heating fuel, motor gas, and diesel. Kuukpik also operates the main retail store (groceries, dry goods, hardware), although private owners have occasionally run successful small retail operations. However, Kuukpik's role is much greater than that suggested by the operation of these local retail services, and this role is discussed in Section 4.5.3.1.

In one respect Nuiqsut is unique among all rural Arctic Alaska villages. For up to five months of the year (mid-December through April in most years), it is "road-connected" to the Alaska highway system. In virtually all other villages, including Barrow, the only fully usable transportation systems are air or, in the case of coastal communities, barge during the brief open-water season. From Nuiqsut, however, it is possible to drive to the oilfield road system in Kuparuk and thence to the Dalton Highway (the Haul Road from Deadhorse to the Yukon River) and Fairbanks. Nuiqsut lies near the main channel of the Colville River. When the river freezes to acceptable thickness, usually 2 plus ft by mid-December, one may drive to the oilfield road network. By late February heavy loads (bulk fuel, construction materials, etc.) can be transported directly to the village. Given the high cost of air freighting these same items, Nuiqsut has the advantage of potentially lower transport costs for bulk goods. In most years, the NSB has maintained the connecting spur road from the village.

In summary, the contemporary village of Nuiqsut has evolved into a modern town with adequate standard housing, superior public facilities and services, better-than-average air and surface transportation connections during at least portions of each year, and local employment opportunities based on the operation and maintenance of its public infrastructure.

The central reason why contemporary Nuiqsut was established was to provide a base within and access to the traditional Kuukpikmiut hunting and fishing territories where a subsistence lifestyle could be preserved. However, this new town required appropriate institutions for governance, land management, and economic viability beyond that which subsistence harvest alone could supply. These matters are addressed in the appropriate sections, below.

Colville Village (Helmericks Family)

Harmon (Bud) Helmericks and his wife, Connie, traveled to Arctic Alaska in the mid-1940s. They wrote of their adventures in two popular books, Our Alaskan Winter (Helmericks and Helmericks 1949) and Our Summer With the Eskimos (Helmericks and Helmericks 1948). They returned regularly to the Colville River Delta area to hunt and fish. In cooperation with the George Woods' family, locally resident Kuukpikmiut, they began a commercial fishery at the mouth of the Nechelik (Nigliq) Channel of the river (Hoffman et al. 1988).

Bud Helmericks remarried in the early 1950s. He and his wife, Martha, and her son established a camp on Anachlik Island along the main channel of the river near the delta front. This became known as Colville Village. They continued operating the commercial fishery while providing guiding services, remote camp provisioning, material and fuel hauling, and airplane chartering (Helmericks 1969). Bud and Martha Helmericks had two sons, and have maintained the family presence in Colville Village. All are involved with the family businesses.

In the mid-1980s, the Helmericks acquired title ownership to the land where Colville Village is sited. They are the only non-Kuukpikmiut private landholders in the delta region.

Kuparuk, Milne Point, Prudhoe, Deadhorse Oilfield Complex

The 1967 discovery of the Prudhoe Bay oil and gas reservoir dramatically changed the human use landscape of the mid-Beaufort region. Where previously open tundra and a scattering of Inupiat seasonal hunting and fishing camps existed, now production facilities and pipelines, camps and oilfield service company installations, docks to receive summer barge traffic, a large main and satellite airports, and an industrial highway linking this remote region to Fairbanks were all constructed by 1973. The TAPS was built between 1973 and 1977 to the port of Valdez, 800 mi to the south. For many North Slope residents, this burst of construction activity offered new and highly remunerated employment opportunities. However, it did not provide many Inupiat either a permanent residential locale or long-term employment prospects.

Deadhorse, the dedicated industrial service area, and the Prudhoe Bay oilfield installations provided camp housing for workers whose permanent residences were elsewhere in Alaska or "Outside." At the peak of the facility construction period as many as 6,500 workers resided in the Prudhoe/Deadhorse complex. The current population has been reduced as the oilfield has matured and its production has declined.

By the early 1980s, the areal extent of petroleum operations increased by more than half as the Kuparuk River and Milne Point Units were developed to the west of the Prudhoe complex. KRU's network of roads, pipelines, drill pad(s), and production facilities extended to within 33 mi of Nuiqsut.

The affected human environment of the North Slope oilfields consists primarily of a workplace whose workers reside in permanent homes located away from the North Slope and whose civic attachments and web of social relations (other than those of membership in a workforce) are elsewhere.

4.5.1.2 Environmental Consequences

<u>**Impacts of Proposed Action (Alternative #2)**</u>

It is unlikely that the proposed development would significantly impact the following areas: the residential composition of the village of Nuiqsut; social cohesion and the socio-cultural systems of the Kuukpikmiut; the social arrangements of non-Inupiat local residents; and the resident workforce of the oilfield and service areas. Under the proposed action, during both the construction and operations phases, workers and facility operators—except for employees who reside in Nuiqsut during their time off—would stay at worksite locations or in established oilfield camps in the Kuparuk/Prudhoe area. The project would place no additional demands on local and community services such as schools, roads, housing, medical assistance, social services, public safety (fire and police protection, search and rescue), public facilities, and utilities. Social interactions between project personnel and members of the local community would consist primarily of workforce contacts and communication/ coordination of on-site operations.

Important archaeological, historical, and cultural resources are situated near the proposed development area. Five identified cultural resource sites are along the Nechelik (Nigliq) Channel near the proposed production facilities and the pipeline route. These are: Nigliq/Woods-inaat, Nanuk, Niglivik, Uyagagviit, and Putu (Hoffman et al. 1988). Only the Nanuk location is within the immediate area of planned development facilities. There are a number of other traditional use sites—primarily fish camps—in the same area. Beyond their present use as subsistence sites, they all have cultural and historical significance for the contemporary Kuukpikmiut. The identification of all cultural resource and traditional use sites—and their protection from illegal artifact removal or surface damage from project associated construction activities and operations—are of great importance (Lobdell 1996).

<u>**Impacts of Alternatives #3 - #8**</u>

The socioeconomic and cultural impacts of three of the six alternatives would be similar to those described for the proposed action. However, significant added impacts would result from the construction of all-weather roads linking Nuiqsut to the Kuparuk oilfield network (#4, 5, 7, and #8). Surface access is presently available from late November through April via ice roads constructed annually either between the village and Oliktok Point or by connection to the ice road built by the operator between the 2-M Pad in Kuparuk and the ADP. All-weather access, as contrasted to seasonal access, would have the effect of reducing travel costs outside the delta during those periods when air transport is the main option. It would also lower the cost of transporting goods into the community, especially bulk goods such as fuel and construction materials. Any all-weather road that linked Nuiqsut to (and across in the bridge and ferry alternatives) the Colville River main channel would also make access to some subsistence use areas easier. On the other hand, it is possible that an all-weather road link between KRU and Nuiqsut could adversely impact the local subsistence lifestyle by introducing increased competition for resources from non-resident hunters.

The most important impacts on the socioeconomic and cultural systems of the resident community of Nuiqsut arise from the Kuukpik and ASRC proposed alternatives that propose use of the existing airstrip as the major logistical staging area and personnel transfer point for the project (#6 - #8). These alternatives would require the movement of non-local members of the workforce on a regular basis through the village and their transport to the ADP area via road from the village. While this would place an increased demand on local services, it would also presumably result in increased local revenues from providing services levying usage fees and/or taxes. Under the proposed Native alternatives (#6 - #8), which would also place a residential camp within the village, major impacts would obviously be experienced by community residents. This would involve social interactions between non-local project personnel and the majority Inupiat population. Non-local workers would likely not have their families permanently located in the village and thus a common source of socioeconomic and cultural impact on local communities would not be a feature: that is, the need for schools and health and social services associated with families.

None of the alternatives would cause impacts on known archaeological, historical, cultural resource or traditional use sites. Undiscovered sites, should any be encountered in the course of construction and operations, would be subject to the same physical avoidance and protection measures as in the case of the preferred alternative (Lobdell 1996).

4.5.1.3 Mitigation Measures for the Proposed Action (Alternative #2)

All known archaeological, historical, cultural resource, and traditional use sites (e.g., fish camps) within the planned area of operations have been surveyed (Lobdell 1996). These locations will be physically avoided. All protective laws and regulations that prohibit cultural artifact removal or site disturbance will be strictly enforced. If archaeological or historical remains are inadvertently discovered during construction, work in the immediate vicinity would cease, the State Historical Preservation Office, the NSB Commission on History and Culture, and the City of Nuiqsut would be notified, and a professional archaeologist consulted. Depending on the significance of the discovery and the degree of disturbance anticipated from construction, the archaeologist will determine measures necessary to protect the cultural resource.

To maintain a complete and thorough knowledge of the cultural resource base of the area, the operator proposes to work closely with a Subsistence Oversight Panel in the planning, siting, construction, and operation of its development project.

A cultural awareness training program will be administered to all project employees. Beyond merely describing the traditional and Native uses of the Colville River Delta region, this program will address possible cross-cultural misunderstandings between non-Inupiat employees and the local Inupiat residents. The training will likely use the Inupiat cultural awareness program developed and offered by the NSB and ASRC.

See Section 2.9, Mitigation Measures - Nuiqsut, for other detailed mitigation.

4.5.2 <u>Government Institutions</u>

4.5.2.1 Affected Environment

<u>**The Village of Nuiqsut**</u>

<u>**City Government**</u>. Nuiqsut, which is incorporated as a second-class city, is governed through an elected city council of seven members who elect the mayor and vice-mayor from among their number. The duties of the council are to oversee elections, manage city-owned lands and property, sponsor recreational and social programs, pass ordinances relating to local option matters (e.g., animal control, curfews, etc.), operate the cable television service, and provide a forum for discussing community-wide public issues. This last function is of considerable importance in Nuiqsut. Many of the village's residents are not shareholders in the Kuukpik Corporation, although most are Inupiat. Since Kuukpik is the principal landowner (including residential properties) and, therefore, a major player in de facto local government affairs, the city government serves as the only local governing institution that addresses the concerns and interests of the non-shareholder residents. The city government is also the main point of contact with state and federal agencies and with other organizations or parties that hold public hearings or meetings.

Thus, while many governmental functions in Nuiqsut are carried out by the NSB and, in the case of land management, by the village Native corporation, the municipal government acts as the lead in dealings with other governmental agencies and private interests such as the oil and gas industry.

<u>**Native Village of Nuiqsut**</u>. All NSB villages have established Native councils that are linked to each other through such organizations as the Inupiat Community of the Arctic Slope (ICAS). They operate various Native welfare and social programs through the Arctic Slope Native Association (ASNA) using grant money received from the BIA. The Native village of

Nuiqsut serves mainly to connect its Inupiat residents to those organizations, such as the ICAS and ASNA, which are exclusively concerned with Native issues.

The North Slope Borough

The NSB was created in 1973 as one of the principal institutions of regional government for Arctic Alaska. The NSB directly provides most of the public services for its eight villages (schools, public safety, health and social services, utilities and public works) and also performs many functions commonly assigned to local jurisdictions, such as planning and zoning.

The NSB is presided over by an elected Assembly. At various times, a Nuiqsut resident has been elected to an Assembly seat. More commonly, however, Nuiqsut provides members for key NSB boards and commissions, such as the Planning Commission and the District School Board. Through this forum, the village's local interests and concerns are represented at the regional level. An NSB Coordinator is a village resident, and it is his or her job to ensure programs and services directed and managed by borough departments headquartered in Barrow are carried out in the village.

The NSB has primary taxing authority and supplies the funding for municipal services and programs in each village from tax and bond revenues. This limits the degree of autonomy that Nuiqsut can exercise in many areas of local government.

State and Federal Agencies

Land. Prior to the passage of the ANCSA in 1971 and the establishment of the NSB shortly thereafter, the federal role in local governance was paramount. For Alaska Natives, the BIA bore responsibility for services now supplied by the NSB (schools, public safety, health care, housing assistance) and the regional and village Native corporations. The BIA is also the chartering authority for village and tribal councils. Nuiqsut's adoption of a city government, based on Alaska statute rather than a federally sanctioned tribal council to oversee its affairs, reduced the prime reason for direct federal involvement. When coupled to the new roles that Kuukpik and ASRC played in land acquisition and management, the BIA's direct involvement in local affairs fundamentally ended. The BIA continues to provide support in some areas such as the award of financial grants for special projects, funding for various activities of the ASNA, and trusteeship responsibilities for the Native Allotment (private land grant and ownership) program.

Kuukpik Corporation's ANCSA land selections lay both within the Colville River Delta proper and on lands designated as NPR-A. The agency responsible for managing the NPR-A federal estate is the BLM. As of 1996, most of Kuukpik's land entitlement had been conveyed and patented. The ownership is to the surface only. Ownership of the sub-surface, or mineral, estate on Kuukpik lands is vested in the regional corporation, ASRC or the ASRC/state of Alaska jointly owned sub-surface. Much of what has not yet been fully conveyed to Kuukpik lies within NPR-A. The state of Alaska is also an important land owner in the delta. State land interests are overseen by the ADNR.

Fish and Game. The main federal and state agencies regulating subsistence harvests include: the USFWS, for migratory waterfowl and polar bears; the NMFS, for whales and seals; and the ADFG, for caribou, moose, and fish—including those caught in both the subsistence and commercial fisheries.

From 1990 to date, the federal government has replaced the state of Alaska as the administrator of the subsistence priority on federal public lands. That management authority has been extended to certain navigable waters, selected-but-not-conveyed lands within conservation units, and to non-public lands, if necessary to ensure the federal subsistence priority on public lands. Substantial Kuukpikmiut lands fall within these various categories which means that Nuiqsut resident subsistence on them is subject to oversight by the Federal Subsistence Board (Haynes 1996 personal communication).

4.5.2.2 Environmental Consequences

Impacts of Proposed Action (Alternative #2)

The only direct impacts of the proposed project on local, state, and federal government institutions will involve planning, regulatory, and fiscal matters. The NSB will have to apply its land use plans (Comprehensive Plan and Coastal Zone Management Plan [CZMP]) to the specific project by re-zoning some lands to the Resource Development category. Permitting, regulation, and compliance will be the responsibility of the appropriate agencies of all three levels of government, particularly in the area of environmental protection. The costs of these government services will be compensated by net earnings derived from increased tax and royalty revenues.

The major impact on governing institutions will be enhanced revenues. The NSB will acquire an important addition to its property tax base. The state stands to realize a net increase in revenues from royalties and other taxes levied on oil and gas production and transportation. A fiscal scenario that develops this revenue picture for a marginal (100-150 million barrel reserve) oilfield on the North Slope is presented in Oliver S. Goldsmith (1995) "Marginal Oil Field Development: The Economic Impact." [Study prepared for BP Exploration and The state of Alaska Oil and Gas Policy Council, ISER, University of Alaska (Anchorage, Alaska)]. The proposed Colville River Delta project conforms to the finding of this study in that it will "...generate jobs and income for Alaska workers, sales for Alaska businesses, and an increase in the state tax base more than sufficient to offset any additional costs to government from resource management and public service requirements from population increase (p. 1)."

The federal government will derive national security benefits and additional tax revenues from the ADP. In particular, oil and gas production from this development will partly compensate for the nation's declining domestic energy reserves (see Section 1.3, above). Although production will take place on the State of Alaska and Native corporation lands, the federal government will still benefit from corporate and personal income taxes levied on the project.

Impacts of Alternatives #3 - #8

The principal impact to government institutions by three of the alternative proposals (#6 - #8) would result from any involvement the NSB might have in using its public bonding authority to support and underwrite construction of infrastructure incidental to the proposed action. This would represent a major commitment of public spending authority for the NSB.

No additional impacts on government institutions other than those described for the proposed action would result from any of the alternatives.

4.5.2.3 Mitigation Measures for the Proposed Action (Alternative #2)

Costs associated with providing local, regional, state, and federal government services for the project will be more than offset by increased tax revenue and royalty share income. The for-profit Native corporations, Kuukpik and ASRC, will similarly benefit from enhanced incomes derived from their land surface and mineral rights holdings and business pursuits directly linked to the development project. Greater employment opportunities for corporation shareholders and local residents will also occur with the proposed development.

Two potential major benefits for the Kuukpikmiut community will result from the development: (1) road access to Nuiqsut via the winter ice road system linking the oilfield network to the village would continue to be available during certain phases of the ADP; and (2) supplies of natural gas or electricity will be made available to the NSB and thence to Nuiqsut for heating fuel and energy generation (see Section 2.9, Mitigation Measures - Nuiqsut).

4.5.3 Economic Institutions

4.5.3.1 Affected Environment

Native villages of rural Alaska are commonly described and analyzed based upon two distinct, but interactive, sets of economic institutions (Kruse et al. 1983); the subsistence and the cash economy. In making this distinction between two sets of economic institutions, it is recognized that they are complementary. It takes considerable cash to acquire the capital necessary to pursue subsistence activities (boats, snowmachines, firearms and fishing gear, fuel, etc.).

Kuukpikmiut society of the Colville River Delta area can be characterized by reference to the dual set of economic institutions briefly described here. This section is a description of the cash economy and its institutions. The economic context of subsistence is treated in Section 4.5.4.1.

Public Sector

North Slope Borough. Alaska is unlike the rest of the country because of the disproportionately large role government plays in economic activity. This is due to the state government's principal earnings being derived from ownership of and taxing powers over oil and gas production, transportation, and sales. Similarly, the NSB, by virtue of its taxing powers over oil and gas production properties that lie within its jurisdiction, exercises the decisive role in the local cash economy. It is the principal capital investor and the largest employer in the region. The NSB's ability to raise bond revenues for public capital investments has been, for nearly two decades, the driver of the local economy, including that of Nuiqsut.

The operations and maintenance jobs associated with NSB facilities, including the school, accounts for two-thirds (62.5%) of all wage incomes earned by Nuiqsut residents (Harcharek 1994). NSB jobs in the education, administration, facilities operations, and maintenance sectors of the village form the backbone of the local cash economy.

State of Alaska. The State of Alaska contributes to the local economy by providing grants for specific community projects and through the distribution of Permanent Fund dividend checks to each resident. However, there are no state government jobs in the village.

Private Sector

Kuukpik Corporation. Under ANCSA, for-profit Native village corporations are the trustees and guarantors of the principal assets received from the settlement act: land and seed money funds for business investment. The Kuukpik Corporation will ultimately receive title to approximately 115,200 acres of surface land ownership. While one of its major functions as trustee and guarantor of the land is to assure its preservation for subsistence purposes, the Kuukpik Corporation is also charged with managing its land to generate income for the corporation and its shareholders. This is done by charging for access and damage to corporation lands for purposes of oil and gas exploration, development, and production. Any earnings to be acquired from oil and gas production on its holdings will necessarily be derived through an agreement with ASRC, the mineral estate owner, or possibly from ARCO, as an oil and gas operator.

Within the village, Kuukpik has been responsible for providing roughly 20% of locally available jobs (Harcharek 1994). Kuukpik is thus the second largest employer in Nuiqsut. Kuukpik plays a leading role in creating and fostering seasonal job opportunities through its joint ventures.

Arctic Slope Regional Corporation. ASRC is one of the largest private businesses in Alaska. Much of its earnings are acquired from the same sources as those of Kuukpik: outright ownership or joint venture arrangements with oil industry and oilfield service companies, engineering, and construction firms. However, ASRC's specific importance to the Kuukpikmiut is derived from three sources. Virtually all Inupiat residents of Nuiqsut (whether they are Kuukpik shareholders or not) are ASRC shareholders and, therefore, are entitled to dividend earnings from their regional corporation. Second, ASRC owns the subsurface resources underlying Kuukpik surface lands. If commercial quantities of oil and gas are discovered and produced from those lands, the principal economic beneficiary would be ASRC with possible revenues accruing to Kuukpik through separate agreement. Third, ASRC's numerous subsidiaries doing business on the North Slope represent an important source of local employment.

The division of land ownership rights between ASRC as the subsurface estate owner and Kuukpik Corporation as the surface owner creates potential for conflict between these two closely linked, but separate, business entities.

Commercial Fisheries. The Helmericks family has operated a commercial fishery in the Colville River Delta for the past 45 years (Hoffman et al. 1988). Most fish are taken in the under-the-ice gillnet fishery when the Arctic and least cisco return in the fall from summer feeding in the nearshore coastal waters to over-wintering holes in the Colville River's main channels.

Although the Kuukpikmiut engage in the same autumn gillnet fishery, none have established a commercial fishery under license with ADFG.

Oilfield Service Industry. The oilfield service industry is based in two locations: the Deadhorse service area complex 70 mi east of Nuiqsut, and the Kuparuk Industrial Center (an NSB-owned facility) adjacent to the KRU operations center of ARCO Alaska, Inc., approximately 38 mi northeast of Nuiqsut. With the steady production declines from the Prudhoe Bay reservoir and a lessening of exploration on the North Slope, the number of oilfield service companies has also declined. However, those remaining are an additional source of employment for Nuiqsut residents.

Nuiqsut workers do not make up a large percentage of employees in this industry (Galginaitis 1990). Explanations to account for this include: the availability of well paid jobs in the village during the period of the main CIP program; the inflexibility of service area work schedules that do not accommodate scheduling of subsistence activities; lack of technical training for other than low or entry level jobs; and feelings of cultural unease by Natives in a predominantly non-Native work force. The most recent survey revealed that only three Nuiqsut residents held permanent jobs with the oil industry (Harcharek 1994, although many more residents were seasonally employed on various projects.

Even though the number of oil industry service firms operating on the North Slope has declined along with the total number of employees, the share of firms and volume of business represented by Native corporation subsidiaries—especially ASRC—has grown. Thus, Nuiqsut's economic stake, both direct and indirect, in oil industry-related companies has also enlarged.

Land Ownership Patterns and Owner Interests

Native Corporation Holdings. Nuiqsut's resettlement on the Nechelik (Nigliq) Channel near the head of the Colville River Delta placed it on lands reserved by the federal government as the NPR-A and inside delta lands that had previously been selected by the state of Alaska as part of its statehood entitlement. However, ANCSA enabled the Kuukpikmiut to claim acreage generally within the vicinity of the village (Figure 4.5.3-1). Through a series of adjustments in the laws governing federal land withdrawals (NPR-A) and negotiations over lands where both the state and subsequently Kuukpik had made claims, the Kuukpik Corporation selected lands in both areas. Meanwhile, ASRC agreed with the state to jointly hold undivided rights to the subsurface on those lands, mainly within the delta, over which Kuukpik had successfully asserted its claim. In addition, a provision of the Alaska National Interest Lands Conservation Act of 1981 (ANILCA) allowed ASRC to exchange its subsurface interests in other areas for lands that had previously been unavailable for selection in NPR-A (Alaska Consultants 1983).

As of 1996, the bulk of its land entitlement has been conveyed to the Kuukpik Corporation. Remaining selections of approximately 12,000 acres have yet to be conveyed. Much of this acreage lies within NPR-A, west of the village. ASRC holds subsurface rights on of all this property; however, it must acquire the consent of Kuukpik Corporation to proceed with leasing and developing certain portions lying in NPR-A. A consent agreement between Kuukpik, and ASRC was reached in September 1997.

The rationale behind the Native corporation land selections was twofold. On the one hand, it gave the Kuukpikmiut territories known to be rich in subsistence resources. On the other hand, these lands were regarded as promising for the discovery and production of oil and gas. It remains a core part of their charters as for-profit corporations that ASRC and Kuukpik both pursue investments in and development of the potential mineral resources.

Private Holdings and Native Allotments. The only privately owned lands in the Colville River Delta region, other than ASRC and Kuukpik holdings, are those of the Helmericks family and a small number of Native allotments. The oil industry has not acquired title to land, but has acquired oil and gas leases, which leave ownership in the hands of either the state or federal governments or private landowners.

The Helmericks obtained title to various locations in the delta and offshore island areas of the Colville through land laws administered by the state. Their main holding on Anachlik Island (Colville Village) was acquired through the old Territorial statutes providing for ownership of trade and manufacturing sites. A small site on Thetis Island was conveyed under the same provisions. They are currently pursuing a claim for another small site near the mouth of the Nechelik (Nigliq) Channel.

Figure 4.5.3–1

Land Tenure

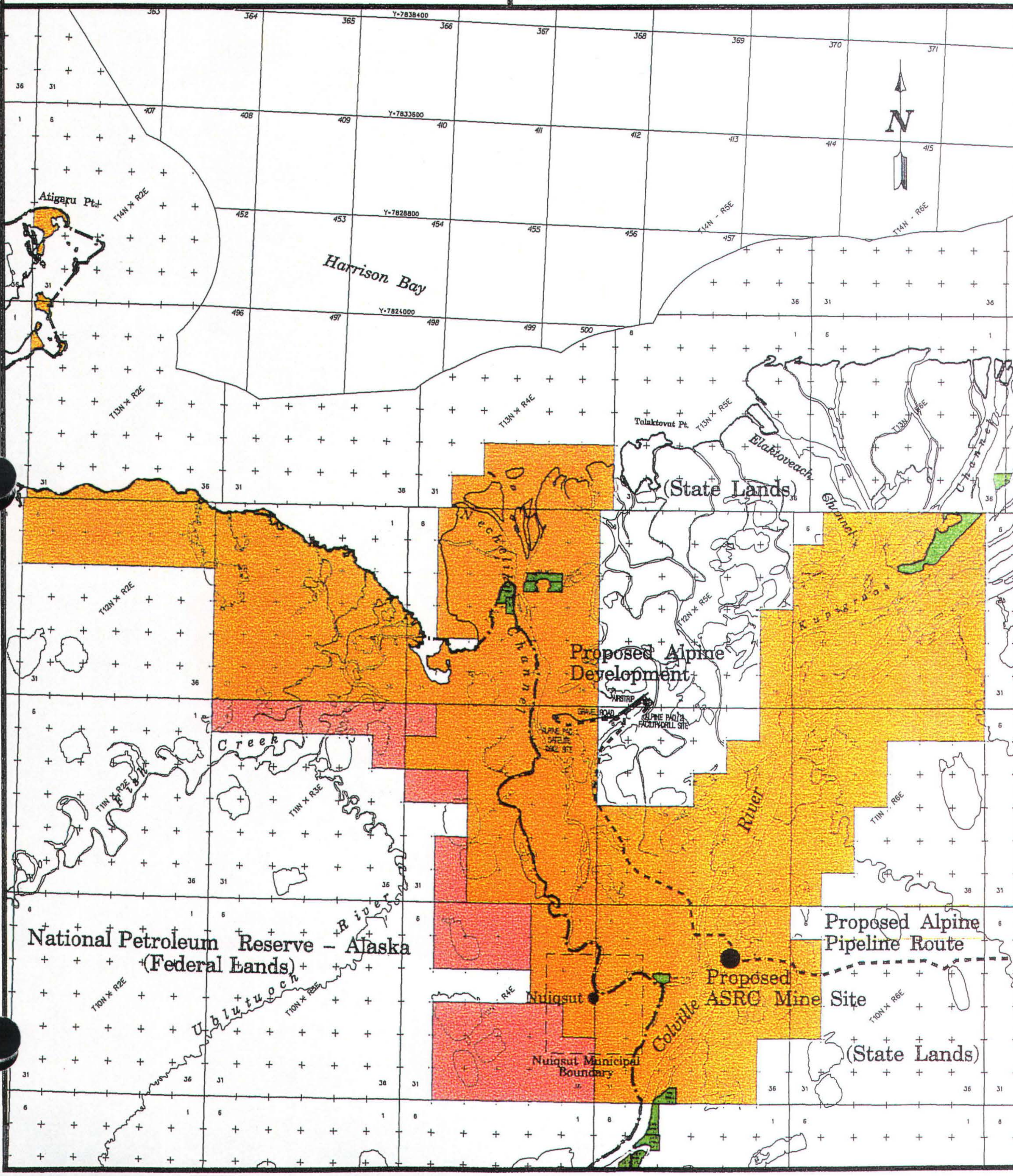
With Proposed Alpine Development and Alternate Pipeline Routes

Legend

- Kuukpik Corporation Selections /ASRC Subsurface
- Kuukpik Corporation Conveyed Lands /ASRC Subsurface
- Native Allotments

Scale: 1" = 4 Miles

96032701b00



Native Allotments are individual 160-acre holdings by Alaska Natives who could demonstrate that they or their parents had traditionally hunted and fished on these sites for sustained periods prior to 1965. These lands are not part of ANCSA, and pre-date the settlement act. The BLM did convey allotments to a number of Kuukpikmiut claimants by the early 1990s. One group of allotments at the mouth of the Nechelik (Nigliq) Channel is owned by the heirs of George and Nannie Woods. Locations of other allotments are shown on Figure 4.5.3-1.

Native Allotment owners do not possess subsurface rights; but they do control rights of access. Both the Woods' allotments and those at the mouth of the Itkillik River are also important archeological and cultural sites that contain valuable evidence of Kuukpikmiut historical occupation and land use (Hoffman et al. 1988).

Public Lands. The largest landholdings in the region are owned by the state of Alaska and the federal government. Essentially, lands east of the Nechelik (Nigliq) Channel of the Colville River and south to the Brooks Range foothills are state lands, with the exception of Kuukpik surface ownership and jointly held ASRC/state subsurface in the delta (see Figure 4.5.3-1). Except for the Kuukpik and ASRC holdings in the delta and some private property ownership, state-owned land extends eastward to the Canning River. It encompasses all the producing oilfields, the first stage of the TAPS right-of-way, and the Dalton Highway (haul road). Second to the state in land ownership is the federal government, which owns the predominant share of NPR-A lands that lie west of the Nechelik (Nigliq) Channel. Native land ownership in NPR-A (see Figure 4.5.3-1) occurs immediately west of the Nechelik (Nigliq) Channel where Kuukpik owns the surface estate and ASRC owns the subsurface estate, except for some lands where the subsurface is ASRC/state jointly owned.

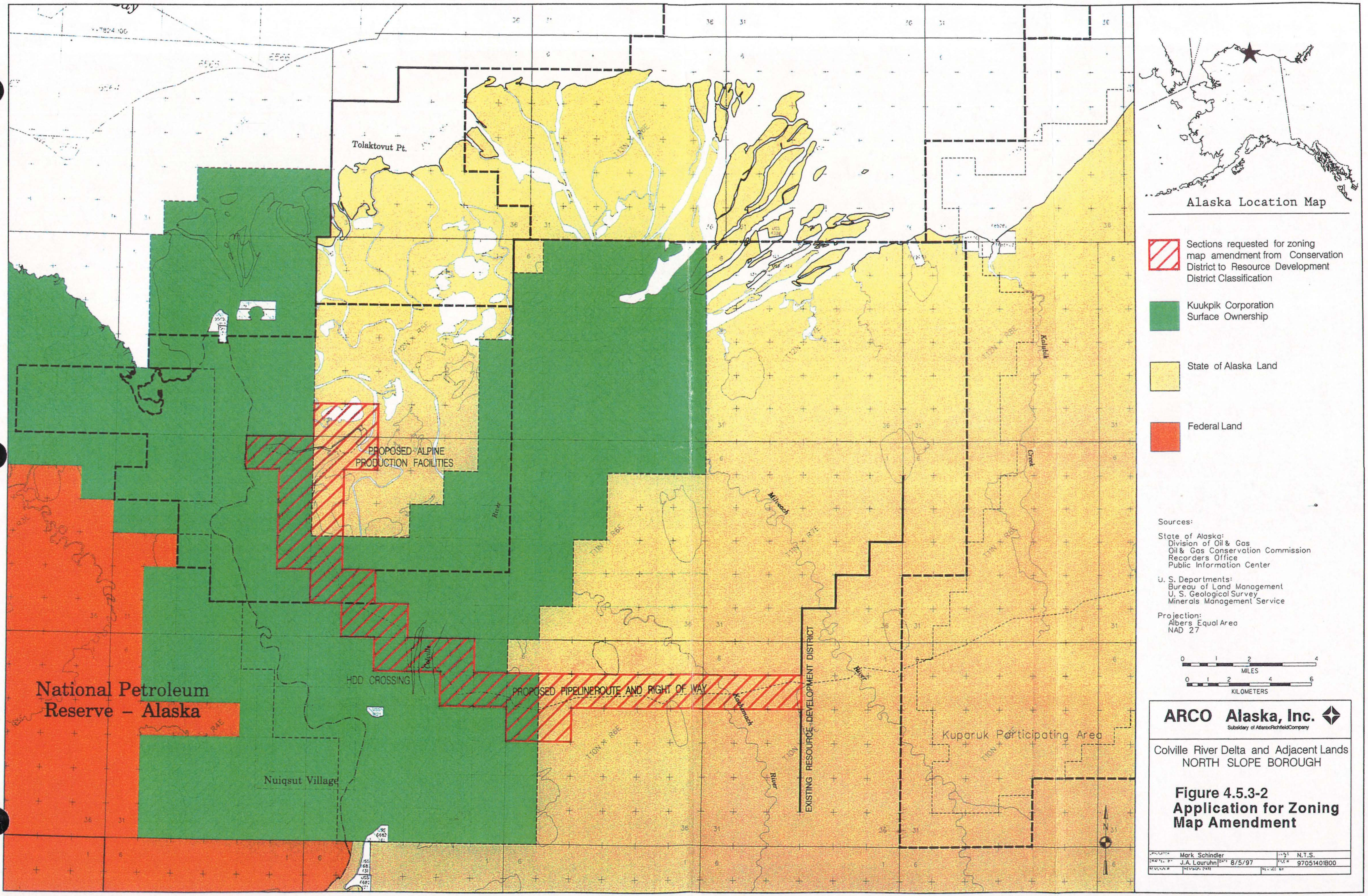
Besides wildlife conservation, a primary management objective on both federal and state lands is to conduct oil and gas leasing programs for both exploration and production.

Land Use Plans and Coastal Management Programs. Land use planning is the responsibility of the NSB, which operates both under an adopted master use plan and the provisions of the approved CZMP. Neither the CZMP nor the master plan prohibit exploration and development of oil and gas if activities are found to be consistent with provisions of the CZMP. Since most exploratory activities are conducted from ice roads or over the frozen tundra during freeze-up, they are considered to be non-destructive and do not require a rezone. An application for re-zoning the lands on which the ADP in-field facilities will be constructed and the pipeline ROW will be built from the in-field facility to the Kuparuk River unit, was submitted to the NSB on August 20, 1997 (Figure 4.5.3-2). The re-zone classification will be from the current Conservation District category to Resource Development category. Permanent oil and gas facilities will be constructed. An application requesting a Zoning Map Amendment to rezone the areas to be used for facilities construction and pipeline right-of-way from Conservation District classification to Resource Development District was made to the NSB planning commission in August 1997 (Appendix P). A public hearing on the application has been scheduled for September 1997.

Employment and Incomes

The size of the Nuiqsut labor force in 1994 was 193 individuals within a total population of 418. The unemployment rate in the village was 5.21%. However, underemployment in the village is a larger issue. Respondents to the village census survey who regarded themselves as underemployed constituted nearly 30% of the labor force; and nearly 40% of individuals in the labor force reported working less than 40 weeks out of the preceding year (Harcharek 1994). Many jobs in the area are seasonal, primarily those in construction or with oilfield service companies (such as winter ice road building and maintenance). Unemployment and underemployment are viewed by the workforce as persistent, serious problems.

The breakdown by employer for the regularly employed workforce is as follows: two-thirds (62.5%) were employed by the NSB, while the Kuukpik Corporation employs roughly one-fifth (19.8%) of the workforce in locally available jobs. The city government has three employees, the state none, and the federal government one (postmaster). All other employers provide 13.5% of the employment. The figures given here are compiled from responses by individuals who participated in the NSB census survey. This represents 96 respondents, or one-half the total labor force of 193 individuals.


Alaska Location Map
Sections requested for zoning map amendment from Conservation District to Resource Development District Classification
Kuukpik Corporation Surface Ownership
State of Alaska Land
Federal Land
Tolaktovut Pt.
PROPOSED ALPINE PRODUCTION FACILITIES
HDD CROSSING
PROPOSED PIPELINE ROUTE AND RIGHT OF WAY
National Petroleum Reserve – Alaska
Nuiqsut Village
EXISTING RESOURCE DEVELOPMENT DISTRICT
Kuparuk Participating Area
Sources:
State of Alaska:
Division of Oil & Gas
Oil & Gas Conservation Commission
Recorders Office
Public Information Center
U. S. Departments:
Bureau of Land Management
U. S. Geological Survey
Minerals Management Service
Projection:
Albers Equal Area
NAD 27
0 1 2 4
MILES
0 1 2 4 6
KILOMETERS
ARCO Alaska, Inc.
Subsidiary of AtlanticRichfieldCompany
Colville River Delta and Adjacent Lands
NORTH SLOPE BOROUGH
Figure 4.5.3-2
Application for Zoning Map Amendment
Mark Schindler
J.A. Louruhn 8/5/97
N.T.S.
97051401B00

Per capita and household income averages in Nuiqsut (1993 data) reveal a number of distinctive features. First, there is a substantial difference between per capita and household incomes of Inupiat and non-Inupiat residents: the non-Inupiat per capita average is $33,333 and household average is $49,999 as contrasted to the Inupiat figures of $8,745 per capita average and $37,999 per household (Harcharek 1994). Inupiat households are generally larger than non-Inupiat households, which consist primarily of salaried school teachers with mostly one or two person households and no children.

Second, a third of the Inupiat households (32 of 90) qualify as very low income households under federal regulations. Over half of these households contained 3 to 5 members. One-sixth of Inupiat households (16 of 90) had incomes within the low-to-moderate income standards established by federal regulations. These sub-totals indicate that incomes for roughly one-half (42 of 90) of Inupiat households are in the moderate or above income standards category.

What these averages do not reveal is the total income contributed by subsistence production. Since it is extremely difficult to place a cash equivalent economic value on subsistence products and consumption, such income is addressed in the subsistence discussion in Section 4.5.4.1, below, and is not aggregated with the incomes summary derived from the NSB census and economic profile. However, while subsistence production substantially contributes to household incomes in Nuiqsut, cash expenditures for subsistence activities are also quite high (Harcharek 1994).

Household costs and expenditures in Nuiqsut are high compared to both state of Alaska and national averages. While rents and mortgages tend to be equalized through various federal and NSB housing subsidy programs, heating and utilities costs, transportation (both local, inter-village and outside the NSB), and prices for imported goods are often twice those of state averages (Harcharek 1994).

4.5.3.2 Environmental Consequences

<u>Impacts of Proposed Action (Alternative #2)</u>

Impacts on economic institutions from the proposed ADP will be in three major areas: enhanced revenue potential for both public and private sector institutions, a net increase in locally available jobs, and the potential availability of natural gas or electricity as the major energy source for Nuiqsut.

Public sector (NSB, State of Alaska, and federal government) revenues will be derived from taxes on oilfield and pipeline facilities, oil and gas production, and corporate/personal incomes. Value-added goods and services will be created both in-state and in some of the lower 48 states. Multiplier effects will be realized. In addition, the state will receive royalty income from any hydrocarbon production occurring on lands it possesses, in its entirety or jointly with ASRC. This covers much of the acreage presently leased for oil and gas exploration and development in the Colville River Delta, including tracts forming the basis of the ADP proposal. Actual estimates of the potential earnings are conditioned upon many factors (future prices for crude oil and natural gas, actual versus predicted production volumes, etc.), but in both low and high case estimates there is a net earnings value for the state (Goldsmith 1995).

The two main private sector economic institutions, Kuukpik Corporation and ASRC, could profit from the ADP both by their respective land and resource ownership positions and from opportunities to contract their services to the operator and its contractors. Kuukpik, as the principal owner of various affected surface estate, may be entitled to seek surface damage and rights-of-way charges for use of portions of its property. ASRC, as the subsurface owner (with the state), will be entitled to royalty earnings from any oil and gas production from its affected subsurface interests. Kuukpik will also share in ASRC's royalty earnings by virtue of its separate agreements with ASRC. Such earnings are potentially substantial. ASRC, Kuukpik, their subsidiaries, and various joint venture business arrangements are in a favorable position to generate income from the project by providing contracting services in both construction (e.g., gravel mine) and production phases. Business participation between these local, Native-owned businesses and the developer, ARCO Alaska, Inc., was established in Prudhoe Bay and KRU, and conducted in previous winter exploration and summer studies programs in the Colville River Delta since 1991.

Job opportunities will become generally available in all phases of the ADP. Employment opportunities for local and regional resident workers will likely be associated with the construction phase of both production facilities and pipeline. Other seasonal job opportunities, such as those associated with winter ice road and drill pad(s) construction and maintenance, will be generally available during certain years of the project's life. Once built, the production facilities will need fewer personnel and support services, and most jobs would require technical and engineering skills. However, there will be opportunities for local residents and local native corporations to compete for these positions and services.

As stated in Section 2.9, Mitigation Measures - Nuiqsut, ARCO will make a certain quantity of natural gas available, most likely to the NSB, for shipment to or the generation of electricity for Nuiqsut. This would lower heating and power generation costs for Nuiqsut while providing a reliable fuel source to the village. It would also result in contracting opportunities for the construction and operation of a gas pipeline, and associated facilities, to Nuiqsut.

Impacts of Alternatives #3 - #8

The economic impacts of the alternative development proposals, which include construction of roads or camp, airstrip, and staging areas in Nuiqsut, would be significant. Use of NSB facilities, such as the Nuiqsut airport (#6 - #8), would likely generate fee income. Use of Kuukpik facilities or land in Nuiqsut would likely also produce rent and fee income for that corporation. The economic impacts of an all-weather road system linking Nuiqsut to the KRU network would be significant because of lowered costs of freight and travel during those periods when ice road access is unavailable. The economic benefits to Nuiqsut of natural gas or electricity supplied from the ADP production facilities would remain the same as in the preferred alternative.

4.5.3.3 Mitigation Measures for the Proposed Action (Alternative #2)

The measures stated in Section 4.5.2.3 would also mitigate any economic impacts of the proposal.

4.5.4 Kuukpikmiut Subsistence

4.5.4.1 Affected Environment

Socio-cultural Context

The ability to pursue a subsistence lifestyle lies at the heart of the Kuukpikmiut socio-cultural value system. This ability defines not only human relationships with the land and its resources, but it also structures social relations between members and families of Kuukpikmiut society.

Hunting, Fishing, Trapping, Gathering. Hunting can be done as a solitary activity or with partners. The major social context of caribou, moose, seal, and bird hunts is the wide-scale sharing of the harvest and not the act of hunting. This differs from the bowhead whale hunt, which requires cooperative effort among crews, although the sharing of the harvest plays an equally central role.

The summer fish camp is where one or more families camp at a traditional location to fish with gillnets or rod and reel. Most historical sites in the Colville River Delta are associated with fish camps (Hoffman et al. 1988). Unlike Barrow and some other North Slope villages whose residents must often travel long distances to reach summer fish camps, the Kuukpikmiut camps are easily accessed by boat from Nuiqsut. Consequently, extended camping periods are not required for even an intensive fishery, but camping remains popular with some families.

Since Nuiqsut's resettlement in the early 1970s, there has always been some level of trapping activity (*nuiqsut paisanich* 1979). Trapping, however, no longer occupies a prominent role in Kuukpikmiut subsistence, because raw fur values are low and fur clothing has been largely replaced with manufactured clothing.

Gathering wild edible plants has never been a major subsistence activity among the Colville River Delta residents since there are very few species available for harvest. Traditionally, plant material has been gathered for purposes such as dwelling construction or fuel (driftwood, coal, mosses, sod, etc.) rather than food. The construction of the modern village and the availability of grocery stores has eliminated the need for gathering plants.

Bowhead Whaling. Bowhead whaling has provided the most culturally dominating and socially defining elements of the local subsistence lifestyle. Whalers from Nuiqsut pursue the bowhead during open-water conditions in late summer/early fall on its return migration to its Bering Sea wintering areas (Burns et al. 1993). Cross Island, 9 mi directly north from the Prudhoe Bay oilfield complex, is the main base for the whaling camp and the principal butchering location. The advantage of this site is its proximity to the migratory path of the whales. The disadvantage is that Cross Island is located over 90 boating miles from the village of Nuiqsut; this makes costly and elaborate logistical and staging activities necessary.

The hunt is conducted by whaling crews operating small boats employing a technology developed in the commercial whaling era (hand-held darting harpoons with time delay bombs, shoulder-held bomb guns, lines, and floats).

The whaling captains (*umialiq*) are organized locally as the Nuiqsut Whaling Captains Association and are also members of the Alaska Eskimo Whaling Commission (AEWC) which establishes the number of whales they may strike and land each year. That number has grown from a single landed whale in the mid-1980s to a presently permitted take of up to four whales annually.

Strong emphasis has been placed on the socio-cultural dimensions of bowhead whaling among the Kuukpikmiut. First, the position of *umialiq* bears enormous prestige and leadership obligations within the community. Second, the entire community participates in the harvest after a successful landing: butchering and distribution of the whale meat, *muktuk* (outer skin and blubber), and baleen. Third, the hunt provides the most prized articles for sharing among all members of the community, friends, and relatives. And, fourth, the successful hunt initiates important community festivals and celebrations. Consequently, the institution of bowhead whaling provides social cohesion to Kuukpikmiut culture.

Economic Context

Subsistence Harvest Patterns. Studies of subsistence harvest patterns (Hoffman et al. 1988; Pedersen 1995; Galginaitis 1990) address two themes: the use of specific territories for given species or the spatial distribution of subsistence efforts; and the annual subsistence harvest cycle, or temporal dimension. For discussion of subsistence species, ranges, and locales, see Sections 4.4.1 and 4.4.2.

While there is annual variability in distribution and abundance of the subsistence species, the resource base of the Kuukpikmiut is sufficiently diverse for harvesting a range of fish, land animals, birds, and marine mammals in most years. Since the re-establishment of Nuiqsut, none of the main subsistence species (caribou, anadromous whitefish, seals and whales) has declined. Moose populations have demonstrated the most variability among land mammals. In particular, Colville area moose populations have experienced distress and decline over the past two seasons (1994-1996). A number of moose were found dead in a single location. Toxicological veterinary study indicates they were suffering from nutritional deficiencies. There also appears to have been no calf production during the current season (comments of Craig George and Warren Matumeak: Pre-Application Workshop May 16, 1996). Although there has been a steady increase in hunting and fishing activity as Nuiqsut has grown in population, there is no indication that subsistence harvests have placed serious pressure on the biological health or abundance of any of the wildlife resources (Pedersen 1995).

The seasonal harvest cycle begins in late spring following the ice break-up of the rivers. Its first major components are waterfowl hunting and gillnet fishing for whitefish and, if any are present, salmon. Caribou are not normally hunted in spring and early summer as this is the calving season. Seals are hunted in late spring, before the ice break-up, and into the open-water summer season.

Gillnet fishing for whitefish continues through August. August is also the month to start caribou hunting, which continues through fall until most of the animals migrate to the uplands areas. Moose hunting is confined by state regulations to late August/September.

The bowhead whale hunt normally begins from Cross Island around mid-September and may last into mid-October depending on the success of the hunt or prevailing environmental factors.

The gillnet fishery for Arctic cisco, least cisco, and other whitefish species begins in October and is the most important subsistence fishery to Nuiqsut residents. These fish are caught as they return from offshore summer feeding areas to deep over-wintering holes in the main river channels. The fall fishery continues through November when increasing ice thickness makes this under-the-ice gillnet effort more difficult and less productive. One reason why this fall fishery has been so important and productive is that fishing locations can be easily reached by snow machine (as was earlier the case when dog teams were used) and the fish are naturally preserved by being frozen whole for convenient storage.

Most hunting and fishing slows in December (except for caribou, if present). Jigging for fish through the ice is also done. Furbearers are also hunted and trapped at this time, although the trapping effort has declined in recent years.

Some caribou hunting and fishing occurs from December through February, but subsistence activities increase again in March. The trapping season ends in mid-April, but hunting for wolf and wolverine increases because travel by snow machine is usually best in spring before break-up. With the arrival of break-up, the annual cycle is completed.

Subsistence Contributions to Diet. Recent studies (Fall and Utermohle 1995; Harcharek 1994) indicate that Nuiqsut has one the highest rates of consumption of subsistence resources of any village in Alaska. The rate was measured in pounds per capita of fish and game consumed, by the regularity of consumption, and by the number of households in the community in which wild resources constituted the primary dietary source.

These high annual levels of wild resource consumption were 742 lbs per person (Pedersen 1995) for 1993. The resource composition, by category, was one-third terrestrial mammals (caribou and moose), one-third fish, and one-third marine mammals. The high volume of marine mammal products in that year was due to the success of the bowhead whale hunt, which varies from year to year. The 1994 season was not successful because no bowheads were landed by Nuiqsut crews. The full quota entitlement was taken in 1995. However, the volume of fish and terrestrial mammals contributing annually to the diet has remained fairly constant. Waterfowl and egging add roughly 2% each year to the total volume of the subsistence harvest. In addition to the relatively small numbers of these species, grizzly and polar bears are harvested and eaten. The other large mammal that has recently occupied the Kuukpikmiut subsistence territories is the musk ox. To date, musk ox are not hunted in the vicinity of Nuiqsut although the Federal Subsistence Board has found that the Kuukpikmiut do possess customary and traditional rights to use musk ox as a subsistence resource. However, no hunting has yet occurred pending completion of a federal musk ox management plan for the area (Haynes 1996 personal communication).

Subsistence Costs. Although the subsistence lifestyle is central to the Kuukpikmiut socio-cultural sphere, its monetary costs are high. In the NSB 1993 survey (Harcharek 1994) 25 of 69 Inupiat households spent more than $4,000 per year on subsistence. Seven of these households spent over $10,000, in all probability the bulk of the expense in each case being required by the needs of an *umialiq* assembling a crew and equipment for the bowhead whale hunt. An additional 31 of the 69 households surveyed spent $500 to $4,000 on subsistence each year. The most common costs are associated with snow machine purchase and maintenance, boats and outboard motors, fuel, and hunting and fishing gear.

Primary Subsistence Concerns of Kuukpikmiut

Maintenance of "Subsistence Lifestyle". One of the main perceived threats to subsistence is the lack of adequate income-producing jobs (Galginaitis 1990). As previously discussed, a cash income is a principal ingredient of a subsistence income.

Historically, many Kuukpikmiut workers believed that the demands of salaried work schedules conflicted with the ability to participate in subsistence activities. This was true of oilfield and other jobs where time off for Native employees to participate in subsistence activities was discouraged by employers (Worl et al. 1981). Most employers have now adopted policies that provide for time off (without wage penalty) to engage in subsistence activities.

The more traditionally construed cultural threats to the subsistence lifestyle are briefly summarized below. There is a perceived lack of opportunity for experienced hunters to teach the young the skills, and outlook, required of subsistence work. Formal schooling, not life-experience training in the practice of subsistence, has become the focus of village life for students and their families. Some fear that this eliminates the core values embedded in the subsistence way of life (NSB Contract Staff 1979). For these reasons, serious efforts have been undertaken both locally and regionally to institutionalize and celebrate significant events associated with subsistence. Most symbolic of these is the *naluqatak*, the community festival staged by successful whaling captains to celebrate their achievement.

Another perceived threat is competition for wild resources from non-residents. Virtually all oil industry and related companies have policies prohibiting hunting by their employees during regular work shifts on the North Slope. However, some residents fear that improved access to the Kuukpikmiut traditional hunting areas may increase the number of non-resident hunters. This is most vocally expressed through opposition to the opening of the Dalton Highway to general traffic which would provide many recreational hunters easier access to prime subsistence territories (Lampe 1995 personal communication).

Finally, there is the issue of general social and cultural change. Nuiqsut, like most rural Alaskan communities, experiences its share of social trauma. Alcohol and drug abuse have created problems of public order; but more importantly, they have damaged the basic societal unit, the family. The question is what relationship do these conditions bear on the subsistence lifestyle. The traditional model was one in which the family or small group was the productive unit, teacher, provider of all human services and enforcer of social discipline. The roles of that model have been transformed; now incomes from jobs, formal schooling, and government-supplied human services and enforcers of public order are the norm.

Regardless of its major contribution to diet, subsistence in some ways has become secondary to a lifestyle that is bound up in a whole range of new governing and economic institutions. The Kuukpikmiut of present day Nuiqsut have attempted to address this issue by adopting a cultural plan (*nuiqsut paisanich)*, that places the maintenance of a modern subsistence lifestyle as their leading priority and most cherished goal.

<u>Availability of Subsistence Resources</u>. The most commonly expressed Nuiqsut concerns about impacts of oil and gas development on subsistence involve potential damage to biological resources and habitats (Town Meeting 1995). The concern is that fish and animals will become less abundant within the Colville River Delta area because of oil production infrastructure and pipelines. The essence of public comments from Kuukpikmiut subsistence users is to take every precaution to ensure the continued health and abundance of fish and game resources and their habitats.

<u>Access to Subsistence Resources</u>. The other key local concern regarding subsistence involves freedom of access to harvest areas. One comment often made by Nuiqsut hunters and trappers is that the expansion of oilfield facilities and roads has closed access to traditional use areas (Galginaitis 1990). Hunting in KRU has never been prohibited (although it is in the PBU and in a corridor along the Dalton Highway/TAPS). However, Nuiqsut hunters feel the presence of production pads, roads and pipelines, and the discouragement of oilfield use for hunting by its operator have effectively placed Kuparuk off-limits for subsistence uses.

Nuiqsut residents have also raised concerns about a pipeline impeding their movements across the delta. Similar comments were expressed regarding the potential impacts of roads constructed for a development project and whether these would increase or decrease subsistence-user access to hunting and fishing areas. These issues are of major importance to the local community. From its perspective, maintenance of the subsistence lifestyle is the central issue to be addressed.

4.5.4.2 Environmental Consequences

<u>Impacts of the Proposed Action (Alternative #2)</u>

Primary concerns expressed by the North Slope residents (see Chapter 5) about the impacts of the project on their subsistence way of life are the following: (1) reduced fish and game populations, (2) disturbance to traditional fishing camps, (3) restrictions on access to traditional hunting and fishing areas, (4) increased competition for fish and game from non-residents, and (5) loss of fish and wildlife habitat from an oil spill. Any activity that reduces the resource or access would directly effect the diet of most local Kuukpikmiut. This impact would be reflected in higher costs of buying replacement foods. Each concern is discussed below.

Two types of direct effects would influence the economy of the subsistence user community in the Colville River delta as a consequence of the ADP. One, enhanced incomes of some subsistence users as a result of employment and wages earned from ADP related work or Native corporation dividends may be, in part, invested in subsistence gear and equipment (boats and motors, snow machines, fuel, fishing and hunting gear) that are essential elements of contemporary subsistence practices. Two, such investment may produce increased pressure on some basic subsistence resources (e.g., caribou, moose, waterfowl, fish). However, any anticipated increase in such pressure on resources is not likely to be significant other than the contribution that may be made to greater efficiency in subsistence harvests. As a foreseeable consequence of the ADP, there will be no distortion of the subsistence economy nor of the subsistence users' heavy and direct dependence on it for supplying food and basic cultural needs. Insuring that local subsistence practices, access, areas, and time periods are not adversely impacted will be the basic work and concern of the Subsistence Oversight Panel formed jointly between members of the subsistence user's community and the project operator (ARCO).

Matters involving the maintenance of the diverse mix of river and wetland habitats are being addressed directly in the proposed design of the facilities planned for the ADP. The only conceivable impact to streams and rivers that might result from the project are linked to oil spill scenarios in which pollutants could enter watercourses and possibly render small areas unusable for subsistence harvest in the course of the season in which the spill occurred. There will be minimal loss of wetlands habitat in the delta (97 acres) owing to the placement of gravel for pad, facility, and road construction. Engineering characteristics designed specifically to preserve delta wetlands functions and waterflow (i.e., bridge, culverting, facility alignment, and site placement to avoid obstructions, etc.) are fundamental components of the project. Therefore, wetlands habitats used principally by migratory waterfowl will be affected only minimally.

Reduced Fish and Game Populations. Potential project impacts to fish and game populations used by subsistence hunters and fishers are addressed in Sections 4.4.1 (Fisheries), Section 4.4.2 (Wildlife), and briefly discussed below. Key issues raised by the North Slope residents include disruption or displacement of caribou migratory routes crossing the delta, noise disturbance to caribou and waterfowl, and habitat loss because of facility and pipeline construction. The main potential barrier to inhibiting caribou movement across the delta will be the pipeline. Studies on the North Slope demonstrate that elevating the pipeline at least 5 ft above the tundra will allow caribou to freely pass under pipelines. Noise disturbance will be caused by aircraft, vehicles, and equipment during construction and operation of the project. However, construction will be during winter when caribou and waterfowl are not present in the region. Aircraft and vehicles will be used year round (see Section 2.9, Mitigation Measures - Airport Construction and Operation for Restrictions) during the life of the project, but use will substantially decrease over time as the project goes into operation. Vehicle use during the period that game use the delta will be restricted to the 3 mi of road connecting the drilling pad(s), since ARCO is not proposing to build a permanent gravel road to the project facilities. Drilling and production equipment at the facilities will be a constant source of noise that may affect caribou and waterfowl use in the immediate area. Nanuk Lake, a waterfowl hunting site about 1 mi from the facilities, should not be affected by the equipment noise but may be disturbed by aircraft traffic. Consequently, impacts to subsistence hunters and fishers relative to these issues, except for aircraft noise, should be confined to the immediate area surrounding the in-field facilities, which represents a small proportion of the delta.

Disturbance to Traditional Fishing Camps. Traditional fishing camps occur along the Nechelik (Nigliq) Channel. Although the facilities will not physically encroach on the camps, people using the camps will hear noise both from equipment operating at the facilities and aircraft. The equipment noise will persist at a relatively constant level over the life of the project, but as mentioned above, aircraft traffic will be restricted and will dramatically decrease after the initial year of operations.

Access to Traditional Hunting and Fishing Areas. Safety procedures for avoiding injury around the facilities and pipeline should not impact hunter and fisher access to traditional subsistence areas. Subsistence users want free access to anywhere in the delta or transportation corridor. Policies on this issue have varied among oilfield units on the North Slope. ARCO does not plan to restrict subsistence users access in areas containing the facilities or pipeline. Policies addressing safety, firearm transport and use, and hunter access will be developed through cooperative agreements between the operator and the local community by way of the SOP (see Section 2.9, Mitigation Measures - Nuiqsut).

The ADP does not include facilities that will improve subsistence use access. The proposed pipeline connection with existing Kuparuk facilities will not provide or improve human access to the area (e.g., no connecting road is proposed). Accordingly, the only land access associated with the project will be on ice roads during winter, which is outside the principal fishing season. Moreover, the ADP will not increase competition between local and non-resident oil company employees or contractors transported to the project via aircraft because ARCO has agreed to apply a no-fishing policy to non-residents. ARCO's airstrip will not be open to the public.

At present, project area subsistence fishers consist primarily of Nuiqsut residents, with some participation by other North Slope residents primarily from Barrow. Although the area experiences the normal cycles of abundance and scarcity for subsistence species, subsistence harvests in the area have not resulted in reduced fish populations due to over-fishing. Although it is possible that the ADP will create a limited number of new jobs, which may attract new residents from Barrow or other North Slope villages to reside permanently in Nuiqsut, the number of potential new permanent residents attributable to the project will be small. Given the existing capacity of the resources and the small number of potential additional subsistence users attributable to the project, the ADP employment opportunities are not anticipated or likely to have any adverse affect upon the present subsistence fishery.

<u>Competition with Non-Residents for Fish and Game</u>.The project should not increase competition between local subsistence users and non-residents for fish and game for the following reasons. Under the proposed development alternative, the only land access to the delta and adjacent lands would be by ice roads during winter; this timeframe is outside of the principal hunting and fishing seasons. In addition, hunting by oil company employees or contractors within the existing producing oilfield units has always been prohibited by operators. Sport fishing has been limited to a small number of employees. Since ARCO would apply the no hunting or fishing policy to the ADP, non-residents would not significantly impact subsistence use of the area.

<u>Impacts of Alternatives #3 - #8</u>

The impacts of alternatives on subsistence would remain the same as in the proposed action except for potential increased hunting by non-local persons using the permanent gravel road from KRU proposed in some of these alternatives.

4.5.4.3 Mitigation Measures for the Proposed Action (Alternative #2)

See Section 2.9, Mitigation Measures, for a detailed description of subsistence related mitigation. Primary mitigation for subsistence will be achieved through planning and policies developed between the Subsistence Oversight Panel and ARCO. Open access will be maintained to traditional subsistence areas. Habitat restoration is addressed in the wildlife and fishery sections of this chapter. The Subsistence Oversight Panel will be funded by ARCO up to a certain dollar amount. It will meet on a scheduled basis and provide guidance to ARCO for establishing policy and procedures to manage the development relative to concerns of local interest. The Panel will provide the mitigative mechanism to ensure conservation of the subsistence resource base, guarantees of free access to subsistence resource areas, and maintenance of a close working relationship between the operator and local residents.

The applicant recognizes that maintenance of these socio-cultural components of the subsistence lifestyle are central to its practice. The Subsistence Oversight Panel will also conduct a multi-year study of socio-cultural and socio-economic trends of the Nuiqsut community to determine any impacts associated with the proposed ADP.

Chapter 4.6

4.6 OIL SPILL IMPACT ASSESSMENT

4.6.1 Oil Spill Scenarios

An oil spill is the single event with the greatest potential impact to the environment during the operation of the ADP. The protection of waters and landforms of the ADP and all areas potentially affected by it, including the pipeline ROW, will be accomplished through implementation of an Oil Spill Contingency Plan designed to meet impacts produced as a consequence of accidental spills. Planning is underway for creation of an Alpine Oil Discharge Prevention and Contingency Plan (ODPCP) when the production facilities begin to operate. This plan will become part of the larger, region–wide effort to create an oil spill plan with individual components (e.g. Prudhoe Bay, Kuparuk, NSB etc). The effort to create the area–wide plan is presently in progress under the direction of the North Slope Spill Response Project Team whose membership includes the NSB and its villages, regulatory agencies, response organizations (ACS for example), and oilfield operators.

This EED selected three oil spill scenarios to satisfy the NEPA process. This section includes an analysis of the potential environmental consequences from three oil spill scenarios: the "most likely worst case," the "reasonable worst case," and the "extreme worst case." The following discussions (1) review the history of oil spills on the North Slope, (2) describe the process used to determine the three scenarios, and (3) describe each scenario and the relative risk of each scenario occurring.

4.6.1.1 North Slope Oil Spill History

The history of oil spills reported by ADEC (Jeanine Groner personal communication 1996) on the North Slope of Alaska since 1990 shows the number of spills has dramatically decreased; the largest single spill was much less than 1,000 bbl (Table 4.6.1-1). In fact, spills have declined by over 70 percent (180 to 55) since 1990 (Figure 4.6.1-1), and most (98 percent) spills have been considerably less than 25 bbl. Only four spills exceeding 150 bbl have been recorded with the largest being 650 bbl (a pump failure which caused a tank to overflow into a lined containment area). The most common known cause of oil spills is human error, specifically overfilling fuel tanks or leaving pipe valves open (Table 4.6.1-2).

Causes of spills have been, in decreasing order of occurrence, leaks, faulty valve/gauges, vent discharges, faulty connections, ruptured lines, seal failures, and well blowouts; causes of approximately 30 percent of the total spills are not known (Figure 4.6.1-2). Most of these spills were contained on gravel work pads. These statistics show that the oil industry, in cooperation with the regulatory agencies, has developed oil spill prevention plans and construction and operation standards that have greatly reduced the number of spills and the likelihood of a major oil spill (> 1,000 bbl) on the North Slope.

4.6.1.2 Process Used to Determine Oil Spill Scenarios

To help identify possible oil spill scenarios, a workshop was held that brought together expert consultants specializing in fisheries, wildlife biology, geomorphology, and spill modeling and cleanup. The workshop participants created a matrix that listed 14 spill scenarios (Table 4.6.1-3). Each scenario included the potential oil source (truck rollover, water pipeline rupture, gathering line rupture, tank rupture, oil pipeline rupture, and well blowout); the terrain type that would be affected (thaw basin, river channel, active floodplain, upland tundra, and coastal delta); the time of year (spring break-up, summer, freeze-up, and winter); and the relative potential environmental impact (high, moderate, and low). The scenarios were then divided into two categories; "worst case" which were the most environmentally damaging and "most likely" which had the highest probability of occurring.

From the original 14 hypothetical scenarios, three (gathering line rupture, well blowout, and oil pipeline rupture) were selected for environmental analysis based on discussions and recommendations from permitting agencies. The three represent the "most likely worst case," the "reasonable worst case," and "extreme worst case," respectively (Table 4.6.1-4).

The "most likely worst case" is a damaging event that likely would occur during the operating history of the project. It was decided that, based on North Slope history, this scenario has the highest probability of occurrence. The "reasonable worst case" is a more damaging event that could conceivably occur, although there is a low probability of occurrence. The "extreme worst case" is defined as the most environmentally damaging event that can hypothetically occur,

Table 4.6.1-1. North Slope crude oil spills by year (in bbl).

		Spills less than 25 Barrels[1]				Spills Between 25 and 1,000 Barrels[2]			
Year	Total Spills[3]	Number of Spills	Total Spilled	Barrels per Spill	Largest Spill	Number of Spills	Total Spilled	Barrels per Spill	Largest Spill
1990	180	53	64.7	1.2	6.0	1	600	600	600
1991	181	47	63.1	1.3	5.5	0	—	—	—
1992	107	25	49.8	2.0	10.0	0	—	—	—
1993	92	28	96.5	3.4	20.0	7	1,936	277	650
1994	74	21	27.6	1.3	3.0	3	465	155	198
1995	55	25	97.5	3.7	19.0	0	—	—	—
1996[4]	31	11	32.5	3.0	10.7	1	150	150	150

Source: ADEC (1996).
1 This category does not include spills less than 10 gallons.
2 There were no spills over 1,000 bbl.
3 This includes all spills greater than 1 gallon.
4 Data obtained through June 15, 1996.

irrespective of the likelihood or probability of occurrence which is extremely small based on the history of North Slope oil spills. Accordingly, this event would probably not occur during the estimated 20–25 year operating history of the project.

The severity of a spill impact is related to the quantity of oil spilled, the proximity of sensitive habitats, the season during which the spill occurs, and the relative response time and difficulty of cleanup. For this oil spill scenario analysis, oil entering a channel of the delta from a blowout or pipeline rupture was arbitrarily assumed to eventually flow into the coastal waters of Harrison Bay (coastal delta scenario). Spill prevention and responses measures discussed in Section 2.7 would be used to control and contain a spill from reaching Harrison Bay. Other scenarios were not selected, partially due to resource agency advice, because the size of a spill would be relatively small (truck rollover, tank rupture), detection and cleanup would be easier to accomplish (truck rollover, tank rupture), or damage would be restricted to limited areas of tundra exclusive of rivers, streams, and waterbodies (water pipeline rupture).

4.6.1.3 "Most Likely Worst-Case" Oil Spill

Hypothetical Description

The "most likely" scenario considered includes an oil leak caused by corrosion in the 20-inch in-field gathering line during winter. Under this hypothetical scenario, the line would be at approximately 50 percent capacity with a flow rate of less than 4 bbl per minute, a typical flow for this type of gathering line. Approximately 19 bbl of oil would flow in each 100-ft section of gathering line. The leak would result from a pinhead-sized hole in the pipe and would be detected by the daily visual inspection survey. The maximum leak over 24 hours would be 2% of the total flow; this represents approximately 400 bbl. The location would be in the floodplain with thaw depression lakes approximately 100 yd from the spill site. Oil would flow over the snow surface and most would be absorbed into the snow. If not contained, however, some crude oil and produced water could drain onto a lake's surface which would likely be frozen due to dominant seasonal conditions. Winter conditions would optimize responses, containment, and cleanup.

Relative Risk

Of the three scenarios analyzed, a leak in a gathering line has the greatest potential for occurring. Gathering lines are multiple-phase lines that carry oil, water, and grit. Over time, the grit can wear small "pin-point" holes in the gathering lines causing oil and water to spray out. Several factors will reduce the likelihood of a major spill resulting from a gathering line leak at ADP: (1) gathering lines will be constructed of welded high-strength steel according to federal and state

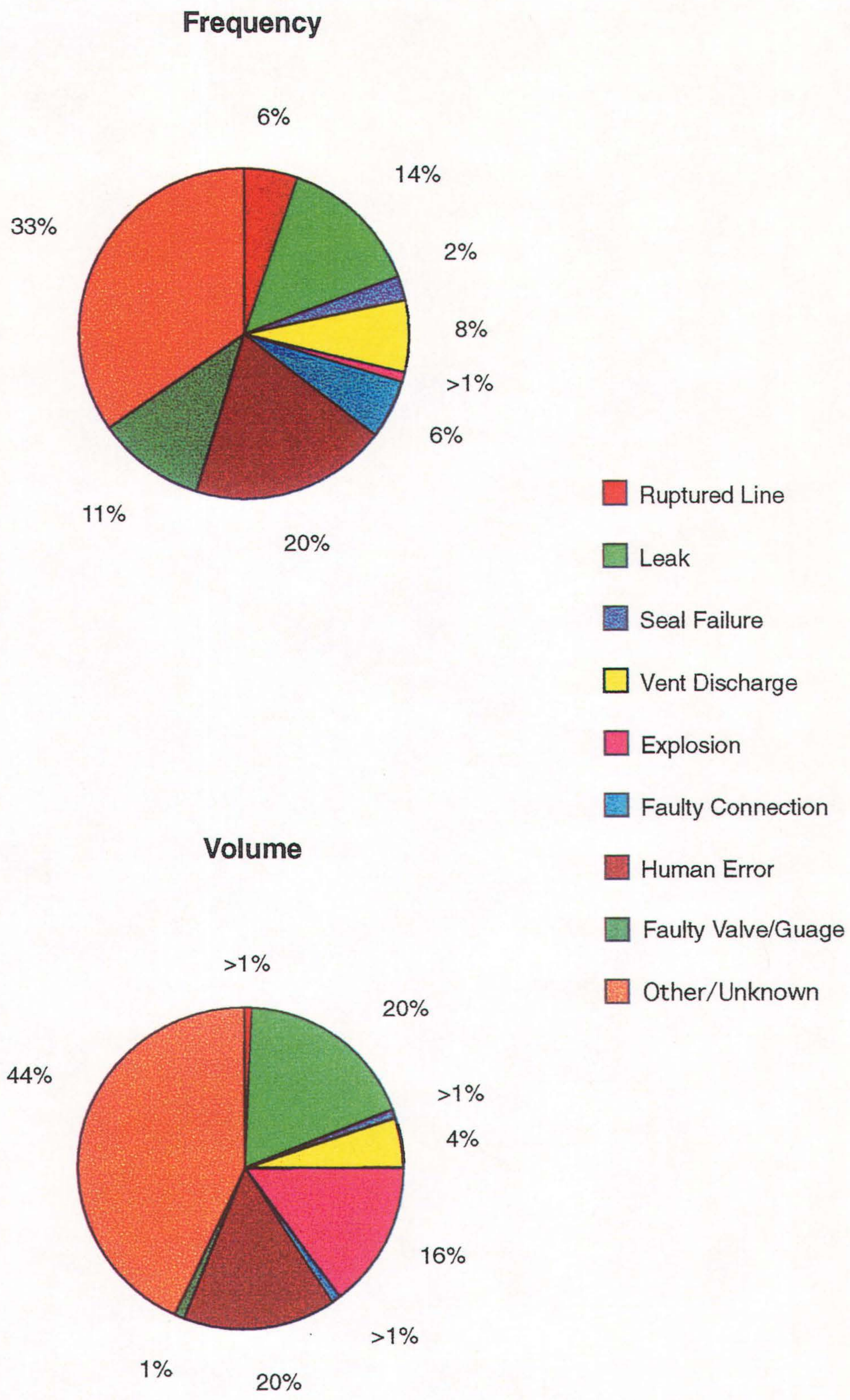
Figure 4.6.1-1.
Total Spills of Crude Oil on the North Slope (1990-1996)

Table 4.6.1-2. Cause of crude oil spills greater than 10 gallons on the North Slope from 1990 to June 15, 1996[1]

Cause of Spill	1990	1991	1992	1993	1994	1995	1996	Total 1990-96	Percent of Volume
Ruptured Line	6.1 (5)	1.8 (2)	0	3.9 (2)	0.7 (1)	0.5 (1)	0.3 (1)	16.3 (12)	0.44
Leak	0.4 (1)	8.9 (8)	2.9 (4)	576.0 (6)	132 (6)	6.9 (2)	4.3 (2)	731.4 (29)	19.77
Seal Failure	0	0	0	0	0.7 (1)	2.0 (2)	0.2 (1)	2.9 (4)	0.08
Faulty Connection	13.3 (9)	1.2 (2)	0	0	0	0	2.9 (1)	17.4 (12)	0.47
Faulty Valve/Gauge	6.3 (9)	9.9 (5)	1.2 (2)	3.2 (3)	3.1 (1)	0.7 (2)	0.2 (1)	24.6 (23)	0.66
Vent Discharge	7.8 (4)	6.4 (6)	135.0 (5)	1.4 (2)	0	0	0	150.6 (17)	4.07
Explosion	600.0 (1)	0	0	0	0	0	0	600.0 (1)	16.22
Other/Unknown	18.1 (14)	22.3 (16)	24.9 (10)	1,114.0 (10)	206.2 (9)	60.7 (10)	150.8 (3)	1,597.0 (72)	43.18
Human Error									
Valve Left Open	5.8 (7)	7.2 (4)	1.4 (2)	1.7 (2)	0	1.6 (2)	0	17.7 (17)	0.47
Tank Overfill	7.0 (4)	0.8 (1)	0	0	0	5.5 (2)	20.7 (3)	34.0 (10)	0.91
Other Error	0	4.6 (3)	6.3 (2)	332.0 (10)	150.0 (6)	13.5 (4)	0	506.4 (25)	13.69
Total	664.8 (54)	63.1 (47)	171.7 (25)	2,032.2 (35)	492.7 (24)	91.4 (25)	179.4 (12)	3,698.3 (222)	

Source: ADEC (1996).

[1] Total spill volume in bbl followed by total number of spills in parenthesis.



Source: Alaska Department of Environmental Conservation 1996.

Figure 4.6.1-2.
Oil Spill Causes by Frequency and Volume (1990-1996)

*Data for spills over 10 gallons in size.

Table 4.6.1-3. Oil spill scenarios considered.

Situation	Source-Based Scenarios						
	Well Blowout	Oil Pipeline Rupture	Gathering Line Rupture	Tank Rupture	Water Pipeline Rupture	Truck Rollover	Coastal Delta[1]
Worst-Case							
Terrain	Thaw Basin	River Channel	Active Floodplain	Active Floodplain	Upland Tundra	Thaw Basin	Distributary Channels
Season	Post Break-up	Break-up	Break-up	Break-up	Summer/Winter	Break-up	Break-up
Potential Impact	High	High	High	High	High/Moderate	Moderate	High
Most Likely Worst-Case							
Terrain	Active Floodplain	Upland Tundra	Active Floodplain	Active Floodplain	Thaw Basin	Upland Tundra	Beaufort Sea Coast
Season	Winter	Winter	Winter	Winter	Winter	Winter	Summer
Potential Impact	Low	Low	Low	Low	Moderate	Low	High

[1] Coastal Delta scenarios are independent of oil source.

regulatory requirements designed to minimize the possibility of leaks, (2) all gathering lines will be regularly visually inspected as often as practicable during severe weather conditions and periods of 24-hour darkness, and (3) all lines will be properly maintained, and repaired as appropriate, to prevent leaks. Based on the history of North Slope operations, the probability of a 400 bbl spill occurring at Alpine is extremely low.

4.6.1.4 "Reasonable Worst-Case" Oil Spill

Hypothetical Description

The "reasonable worst-case" spill would involve a well blowout at Alpine Pad 1 during break-up. It is estimated, based on typical KRU field data, that the spill would amount to 1,000 bbl/day. Typically a blowout would be controlled within three days using heavy muds or other "top kill" intervention. However, if a relief well needed to be drilled, and the on-site drill rig were damaged, it is conceivable that another rig would be required and 34 days could elapse prior to controlling the well. The plume fallout and the oil that would spread from the wellhead and drill pad(s) would be deposited and flow over snow and ice surfaces that are in the process of breaking up. Gas, oil, and produced fluids would be discharged from the wellhead as (1) a plume that is forced into the air, then as liquid droplets that fall back to the ground, and (2) liquids forced out of the drill pipe that coat the well-head equipment before flowing onto the drill pad(s). The area affected by the plume would be determined by the plume size and wind dispersion. The plume size is controlled by the flow pressure and the diameter of the orifice. Typically 30% or more of the oil evaporates before settling on land. The oil droplets settling out from the plume could cover up to several acres of adjacent terrain in downwind directions. Under this scenario, oil flowing from the drill pad(s) would initially spread downslope following the terrain and flow into adjacent lakes, the Sakoonang Channel, and eventually Harrison Bay. The Sakoonang Channel is approximately 1/10 mi east of the spill site.

Relative Risk

If a well blowout on Alpine Pad 1 were to occur during break-up, several factors would work together to limit the environmental damage. First, the cold air temperatures would make the oil more viscous. This would slow its movement either from the plume or the wellhead and allow more time for cleanup crews to

Table 4.6.1-4. Oil spill scenarios analyzed.

Scenario	Location	Season	Risk "Window"	Hypothetical Spill Size	Duration	Material(s) Spilled	Potential Impact
Most-Likely Worst-Case Scenario							
Gathering Line Rupture	Colville River Delta – 1 mi west of Alpine Pad 1	Winter	250-300 days/yr	400 bbl	Continuous for less than 24 hours	ANS crude and produced water	On land or downstream resources within 100 yards at risk
Reasonable Worst-Case Scenario							
Well Blowout	Colville River Delta – Alpine Pad 1	Break-up	10-21 days/yr	3,000-34,000 (1,000 bbl/day)	Likely 3 days to gain control, if not, 34 days to drill relief well	ANS crude	All downstream (not including coastal unless relief well necessary) resources at risk
Extreme Worst-Case Scenario							
Sales Oil Pipeline Rupture	East bank of Colville River	Break-up	10-21 days/yr	Initial loss of 100 bbl followed by gravity drainage of up to 1,000 bbl	Single-event batch loss	Sales-grade ANS crude	All downstream (including coastal) resources at risk

mobilize. Second, the blowout well would be on a gravel facility pad. Equipment and trained personnel would already be at the site to initiate cleanup thereby decreasing mobilization time. Finally, one side of the pad is located close to the Sakoonang Channel. The channel would act as a containment basin and a manageable barrier to substantially prevent further oil disbursement throughout the delta.

In the past thirty-year history of North Slope oil exploration, drilling and production activities, there has not been an uncontrolled release of crude oil. Loss of well control has occurred on some operations resulting in the release of dry gas from high-pressure zones and the consequent showering of rocks and sand over areas reached by the blowout plume (Dave Johnston AOGCC, personal communication of 3 September 1997). Given the present technology associated with blowout prevention and effective well control, it is extremely unlikely that an uncontrolled release of crude oil could occur at the ADP.

4.6.1.5 "Extreme Worst-Case" Oil Spill

Hypothetical Description

The "extreme worst-case" spill would involve a rupture of the pipeline that transports sales quality oil to KRU for processing. This hypothetical scenario assumes that the pipeline would be aboveground immediately east of the Colville River crossing at the above ground below-ground pipeline transition point (approximately 300 ft from the bank of the Colville River). A fracture east of the transition point would cause a spill from the 14-inch-diameter oil pipeline. The pipeline isolation system would cause the flow to cease when the line is depressurized. The oil flow rate through the pipeline (48 bbl/minute maximum) would result in an initial uncontrolled discharge of less than 50 bbl before the flow ceased. Approximately 20 bbl of oil would be in each 100-ft section of 14-inch pipe. Without mitigation (mitigation to be determined through the Joint Pipeline Office SPCO pipeline ROW permit process), there would be a downgradient pipeline drainage from west of the Kachemach River to the pipeline rupture, a distance of approximately 14,000 ft. All of the approximately 2,800 bbl of oil contained could be released. The river stage would be in the middle of the break-up cycle with high, overbank flow conditions and broken ice moving downstream during the accident. Within 20 minutes, the oil would be carried by the flood flow into the Colville River. Within 4 hours, the oil would reach Harrison Bay.

Relative Risk

The risk of the sales oil pipeline rupturing is extremely low, and the size of a potential spill will be substantially minimized through pipeline design and response plans. The history of spills on the North Slope shows that breaks in single phase pipelines are rare for several reasons. Pipelines are constructed of welded, high-strength steel and are regularly inspected for cracks and other signs of failure. Inspections are conducted visually and remotely by airplane (FLIR) and by "automatic pigs." In the case of the ADP, breaks are even more unlikely because cross-county block valves have been eliminated and replaced with vertical loops and the pipeline will be underground for approximately 300 ft on each side of the river, before being elevated aboveground on VSMs. The pipeline section closest to the river will be located close to natural topographical basins that would potentially contain (subject to season) all of the spilled oil thereby preventing it from reaching the river. This, combined with ARCO's commitment to implement a comprehensive spill prevention and response plan (see Section 2.7); the use of state-of-the-art pipeline engineering and spill detection equipment or systems (see Section 2.7), and the low probability of a crack developing during the short time duration (10 to 21 days) of spring break-up hypothesized in this scenario, will greatly reduce the likelihood of this sort of a major spill.

4.6.2 Oil Spill Impacts Associated with Hypothetical Scenarios

4.6.2.1 Hydrology, Geology, Geomorphology

"Most Likely Worst-Case" Oil Spill Scenario

The effects of this hypothetical 400-barrel spill and its cleanup operations on frozen tundra during winter would be negligible for two reasons. First, the area affected would be small because snow, low temperatures, and surface topography would limit the amount of flow. Second, surface disturbance would be minimized by using standard cleanup procedures such as flooding, use of skimmers, and surface flushing. Although heavy scraping to remove oil at the soil surface, as was done at the DS-2U oil spill in the

Kuparuk oilfield (Jorgenson and Cater 1992), can cause minor thaw settlement, such surface disturbance can be avoided, as was done at more recent spills at the DS-2C/2Z and DS-1Y/1R spills sites in the Kuparuk oilfield.

"Reasonable Worst-Case" Oil Spill Scenario

Even for a well blowout that releases 1,000 bbl per day, the impacts to terrain from oil and surface disturbance associated with cleanup would be minor. Disturbance to the ground surface would include placement of sandbags or sheet-piling for containment, trampling during cleanup, and the compaction of organic surface soils associated with moving supplies and personnel. The effects of disturbance would be minimized by the use of boardwalks, but some trampling would be unavoidable because of the size of the spill. Although high microtopographic relief associated with low-centered polygons would help contain the oil, standing water from snowmelt would reduce the holding capacity of the polygons. The volume of oil released would exceed the estimated "holding capacity" (approximately 4,000 bbl per acre) of the low-centered polygons at Alpine Pad 1 and some oil would flow into the Sakoonang Channel if initial containment were insufficient. Surface disturbances associated with containment and cleanup would include transportation of cleanup crews by low-ground pressure-wheeled vehicles (rolligons), trampling, and raking and scraping. Even from the cleanup of large volumes of oil, the geomorphic and hydraulic impacts would be minor (limited to thermokarst in heavy traffic areas) because best management practices would be implemented to minimize surface disturbances.

"Extreme Worst-Case" Oil Spill Scenario

Under the hypothetical worst-case scenario involving the rupture of a pipeline located approximately 300 ft from the east bank of the Colville River during peak stage of a 5-year flooding event, the terrain impacts would be minor or negligible because best management practices would be used to minimize surface disturbance. Although there is a slight possibility that oil could spread over the broad floodplain during high stage, it is unlikely because peak stage usually persists for less than a day. Consequently, most oil would be stranded along erosional cutbanks and riverbed sandbars that are usually barren and highly disturbed by flooding events. Thus, additional surface disturbance associated with cleanup along river banks would have negligible impact on terrain stability. Flushing of oil from highly erodible cutbanks would be avoided to reduce erosion potential. The greatest potential impact would be associated with mobilization and deployment of personnel during containment and cleanup. The effects of mechanical and fluid removal of oil from sandbars and mudflats should be negligible.

4.6.2.2 Water Quality

During project operations, the primary threat to water quality would be an oil spill. Water quality impacts from an oil spill include short-term lethal and sublethal effects on wildlife and fish and the negative aesthetic impact of a visible oil sheen and oil residues. The impacts to wildlife and fish are described in detail in Sections 4.6.2.4 and 4.6.2.5. The extent and duration of biological and aesthetic impacts would depend on the location, volume, season, and duration of spill and the timeliness and effectiveness of containment and cleanup operations.

"Most Likely" Worst-Case Oil Spill Scenario

Some crude oil and produced water could reach lake surfaces, if a gathering line ruptured. However, since the lake would likely be frozen, oil would not directly contaminate open water. Following contaminated snow and ice removal, water quality impacts from the residual oil would be very limited in extent and duration.

"Reasonable Worst-Case" Oil Spill Scenario

An oil spill from a well blowout would primarily impact water quality during summer and fall due to the presence of residual oil. In addition to direct contact of oil and water, equipment used to contain and recover spilled oil likely would damage the tundra surface, potentially leading to thermal and hydraulic erosion causing local water quality degradation. This could slightly increase turbidity and suspended solids near the sites of disturbance, but the impacts would be insignificant compared to the naturally high sediment load in the delta and coastal waters (see Section 4.3.1).

"Extreme Worst-Case" Oil Spill Scenario

Water quality impacts from this hypothetical scenario would be similar to those in the reasonable worst case scenario, except that shoreline disturbance would be substantially greater because oil would quickly spread to Colville River channels and Harrison Bay and require cleanup over a much more extensive area.

4.6.2.3 Air Quality

Air quality impacts from an oil spill would vary according to the magnitude of the spill. The primary sources of pollutants would be volatile gases from the oil and exhaust emission from cleanup equipment. Organic vapors released from the oil would rapidly disperse into the air after the spill. Dispersion should be particularly quick because the arctic is windy. Similarly, exhaust emissions from heavy equipment involved in cleaning up the oil spill would disperse rapidly because of arctic weather. If weather is calm, impacts from emissions and volatile gases would be temporary and localized at the site of the spill. The duration and magnitude of the impacts would be least with the "most likely worst case" and greatest with the "extreme worst case." In no cases would it result in any exceedances of federal and Alaska state air quality standards. In this assessment, it is assumed that clean-up would not include burning the oil.

4.6.2.4 Fisheries

"Most Likely Worst-Case" Oil Spill Scenario

The most likely worst-case oil-spill scenario, a leak in an in-field gathering line during winter, may deposit oil onto a lake surface. Since all lakes would be frozen, oil would not enter the lake directly, and there would be sufficient time to remove the oil and contaminated snow and ice before spring break-up. Little residual oil is likely to remain by break-up, and effects from residual oil would be minimal and of short duration.

"Reasonable Worst-Case" Oil Spill Scenario

The reasonable worst-case spill scenario, a blowout at Alpine Pad 1 during break-up, would result in oil entering adjacent lakes, the Sakoonang Channel, and possibly Harrison Bay. Oil entering lakes and river systems could affect fish both directly and indirectly. Direct effects result from exposure of various fish life stages to high concentrations of hydrocarbons or ingestion of contaminated prey. Such exposure could lead to mortality, reduced growth, or lower reproductive success. Indirect effects could result if prey populations are reduced by an oil spill, thus reducing food supply. Predator populations could also be affected, which would then effect the dynamics of fish populations.

The reasonable worst-case oil spill could affect least cisco, broad whitefish, ninespine stickleback, and Alaska blackfish in several of the lakes within the project area. Since oil would be blown into the lakes under this scenario, it is unlikely that large volumes would be introduced. The concentrations of hydrocarbons needed to cause direct mortality are not likely to be reached under this transport mode. Acute toxicity to other salmonids, such as pink salmon and Dolly Varden char, occurs at aromatic hydrocarbon concentrations exceeding 1,200 ppb (Moles et al. 1979; Rice et al. 1979; Moles and Rice 1983). Deleterious responses occur at much lower levels with growth inhibition observed in cutthroat trout fry when the water-soluble fraction of crude oil exceeds 100 ppb (Woodward et al. 1981), or 400 ppb in pink salmon fry and juveniles (Moles and Rice 1983; Rice 1985). Ingestion of oiled prey would also decrease growth if the prey become heavily oiled. Pink salmon juveniles raised on food containing 370 ppm crude oil showed significant reductions in growth after two weeks (Carls et al. 1993). Impacts in lakes are most likely to be expressed as reduced juvenile growth. If large quantities of oil enter the lakes, direct toxicity is possible.

Oil entering the Sakoonang Channel during break-up could also affect fish in the same manner as oil entering the lakes, along with the potential for impacts to a wider variety of age classes (young-of-the-year and juveniles) for whitefish, ciscos, arctic grayling, burbot, and rainbow smelt eggs and larvae. Under this scenario, oil would likely be transported into tapped lakes along the Sakoonang Channel, thereby substantially increasing the area affected. Rainbow smelt spawn in the minor channels and channels connecting tapped lakes during or immediately following break-up. Larvae are present in the tapped lakes into early August. Consequently, the eggs and larvae would be vulnerable to oil introduced into the

Sakoonang Channel during this period. Smelt larvae are similar in size to herring larvae, which experience elevated mortalities when the water-soluble fraction of crude oil is 2 to 3 ppm for 6 days, or 0.9 ppm for 12 days (Rice et al. 1986). Premature hatch has been reported in herring eggs exposed to 0.22 ppm fresh oil (Pearson et al. 1985). Assuming an adequate response and clean-up effort, the effects should be confined to the year of the spill.

Under this hypothetical scenario, oil may eventually enter Harrison Bay and could be transported westward into coastal estuaries. During early summer, broad whitefish, Arctic cisco, least cisco, and humpback whitefish juveniles, along with a variety of other freshwater and estuarine species, feed heavily in these areas (LGL Alaska 1990). Oil consumed by fish, either directly as particles or in oiled prey, could potentially reduce growth. Direct mortality is unlikely as the oil would likely be substantially diluted and weathered by that time. Impacts would likely be confined to the year of the spill.

"Extreme Worst-Case" Oil Spill Scenario

Under this hypothetical scenario, high break-up flow would carry the oil downstream and into the Colville River, eventually reaching Harrison Bay. Because the spill is assumed to occur at the peak of break-up, containment is not possible. Oil would be spread into a number of lakes along the east side of the Colville River, but because of the high flow, little is likely to remain within the lakes. The oil would be spread and diluted by the high break-up flows. Some oil would be stranded in the various wetlands and along the high water line. Oil entering Harrison Bay would have similar effects, as described in the previous scenarios.

4.6.2.5 Wildlife

Accidental spills are an inherent risk associated with oil extraction in both the construction and operation of an oilfield development. The major contaminants associated with an oilfield include crude oil, diesel fuel, seawater, brine, and glycol (Jorgenson and Joyce 1994). Some types of disposed drill muds and cuttings are also potential contaminants but these will be properly disposed in the Kuparik oilfield. Spills of hydrocarbons and other fluids degrade wildlife habitats by physically covering vegetation, thawing permafrost, and exerting toxic effects on plants and animals. Exposure to and ingestion of contaminants (including minor incidents of fouling and oiling) in the North Slope oilfields occasionally injure and kill small numbers of animals (Amstrup et al. 1989; ABR, Inc. unpublished data), but the population-level effects of such incidents have been negligible. A major oil spill into the channels of the Colville River Delta could result in serious environmental consequences; however, the likelihood of such an accident is remote, and its impacts would depend on the quantity of oil, the proximity of sensitive habitats, and the time of the year. Large oil spills pose a significant threat to high-use waterbird and shorebird habitats, such as Salt Marsh, Brackish Water, and Tidal Flats on the outer Colville River Delta; the periods of greatest susceptibility in those areas would be during spring breakup flooding and open-water storms during late summer and fall. Significant impacts to such resources can occur if pipelines and facilities are improperly engineered or located, so substantial effort has been invested by ARCO in state-of-the-art engineering design and spill prevention and detection to minimize the likelihood of an oil spill and maximize response time.

Hydrocarbon spills affect wetland communities in northern Alaska by physically covering and killing the vegetation (Haag and Bliss 1973; Deneke et al. 1974; Brown and Grave 1979; Everett 1978) and by increasing the depth of the seasonal thaw layer (Brown and Grave 1979; Lawson et al. 1978). Moist wetland and upland communities such as Moist Tussock Tundra, Moist Sedge-Shrub Meadow, and Riverine or Upland Shrub are more susceptible to damage than Wet Sedge-Willow Meadow and marsh communities because oil disperses slowly in the drier types, where it tends to be absorbed by mosses and the underlying organic soil (Linkins and Fetcher 1983; Holt 1987; Walker et al. 1987). Diesel spills have greater effects on habitats than do crude- or motor-oil spills, because soil penetration is greater and higher concentrations of volatile toxic compounds are present (Hutchinson and Freedman 1978; Everett 1978; Walker et al. 1978; Holt 1987). Like hydrocarbons, seawater and brine spills affect wetland habitats by killing vegetation and contaminating the soil (Simmons et al. 1983; Jorgenson et al. 1987; Walker et al. 1987). The wetland habitats most sensitive to seawater and brine spills are shrub- and forb-dominated types; graminoid communities are also affected, but for shorter duration. Other, less common contaminants (such as glycol and fire retardant) generally are localized within limited impact zones. Both of these contaminants can kill aboveground plant biomass and affect soil salinity, depending on the concentration of salts in the spilled substance (Cater and Jorgenson 1994).

Residual oil on the tundra in summer could potentially oil small numbers of birds (primarily waterbirds) with the degree of impact (mortality and depressed reproduction) depending on the level of exposure. Avian reproduction can be affected through two primary exposure pathways: (1) direct contact through transfer of oil from incubating adults to eggs (King and Lefever 1979; Albers 1980) and (2) indirect physiological effects through oil ingestion during preening or feeding by adults (Holmes et al. 1978; Fry et al. 1986; Stubblefield et al. 1995). Direct contact of oil with eggs can have acute toxic effects on embryos (Albers 1977; Hoffman 1978; Couillard and Leighton 1991). In addition, oil in tundra ponds can deplete invertebrate populations and reduce emergent vegetation, thereby reducing food availability and escape cover for waterbirds (Abraham 1975; Howard 1974; Bergman et al. 1977). Cleanup activities can damage vegetation, alter drainage, or, by adding fertilizer to aid bioremediation, affect birds. In the Kuparuk oilfield, birds were attracted to an oil spill site that was fertilized to expedite natural breakdown of oil (ABR, Inc. unpublished data), enhancing forage availability for birds. Birds attracted to the spill area increased their risk of exposure to residual oil.

"Most Likely Worst-Case" Oil-Spill Scenario

The effects of this hypothetical oil-spill scenario on wildlife would be minimal due to the winter timing of the spill and its relatively small magnitude, assuming that most cleanup is completed before summer. Only a few species (common raven, ptarmigan, lemmings, weasels, and foxes) would be present in the spill area during winter. The impacts of this spill on mammals would be limited to the possible mortality and localized loss of habitat for small mammals and to localized habitat degradation for a small number of herbivores such as caribou. Minor effects of this spill on birds would result from exposure during the following breeding season (from residual oil missed during cleanup) and from physical damage of wildlife habitats caused by the spill and cleanup operations. Some waterbirds would be exposed if residual oil remained in or near the lakes and wetland communities immediately surrounding the in-field facility.

"Reasonable Worst-Case" Oil-Spill Scenario

The effects of this hypothetical spill scenario would potentially be severe for birds because of the timing of the spill during breakup (near peak bird arrival) on the delta and the movement of oil into the Sakoonang Channel. Local breeding birds and terrestrial mammals downwind of the spray plume could die from direct oiling or be susceptible to indirect physiological effects, which would depress breeding production in the year of the spill. Pre-nesting birds using open water near the channel during breakup would be affected by oil flooding across the tundra during spring high water. This channel traverses portions of the northwestern delta that contain salt-marsh habitats; these habitats are especially vulnerable to oil spills and are highly used by many bird species (Bergman et al. 1977; Derksen et al. 1981). Oil reaching the Beaufort Sea would be redistributed in other sensitive coastal areas in Harrison Bay. Degradation of coastal habitats by the spill and cleanup activities could potentially affect thousands of shorebirds that stage on the outer delta in fall (Andres 1989, 1994; Smith and Connors 1993).

Direct oiling of large numbers (potentially thousands) of birds is likely during this spill because many birds flock to areas of open water (which would contain oil); the early availability of open water on the Colville River Delta attracts coastal migrants when most other habitats are still snow-covered and water is frozen. The geographic scope and possible duration of this spill also increases the likelihood of exposing large numbers of birds to oil, including birds migrating eastward along the coast to breed elsewhere. There would be some waterbird mortality because of oil fowling their feathers (McEwan and Koelink 1973; Holmes et al. 1978; Stickel and Dieter 1979). Nonlethal oiling of birds is also likely, accompanied by some oil transfer to eggs by incubating females; such exposure could cause egg failure. Nonlethal exposure of birds to oil may also render them vulnerable to predators or diseases. Secondary transfer of oil to predators and scavengers feeding on oiled birds also is likely.

Of secondary importance would be the disturbance to birds caused by cleanup operations; the level of disturbance would depend on the geographic scope, intensity, and duration of the cleanup. In areas contaminated by oil or subject to cleanup, nesting would likely be precluded during the summer following the spill, and effects on birds could potentially be longer where habitat disturbances are more severe (particularly those with limited distributions on the delta or which occur in low numbers; e.g., yellow-billed loons, brant, spectacled eiders). Long-term effects, which may last 2-3 years, would result from the loss of breeding adults, reduced nesting in the year of the spill and in subsequent years, lower productivity from disturbance and residual contamination, and abandonment of nesting areas.

Marine mammal impacts under this spill scenario would be limited because of the seasonal timing of the spill. The relatively small numbers of ringed, spotted, and bearded seals present in the waters off the outer delta would be affected as oil spreads. The number of seals affected would increase as oil spreads farther offshore in Harrison Bay, and mortality or sublethal physiological effects could affect those oiled directly. Oil on the river draining into the ocean would spread under the ice, as the water drained through fractures and "strudel scour holes" in the ice. Oil spreading under the ice would be virtually impossible to detect or contain, and effects on the under-ice food web could reduce prey availability for some seals in Harrison Bay.

<u>"Extreme Worst-Case" Oil-Spill Scenario</u>

The effects of this hypothetical oil spill scenario are likely to be severe for birds because of the timing of the spill at mid- to late breakup when birds have arrived on the delta. Impacts would be similar to those discussed for the "reasonable worst-case" scenario but of greater magnitude, particularly in the following areas. Oil reaching Harrison Bay (within 4 hours after the spill) would be redistributed and contaminate some coastal habitats. The movement of oil in the East Channel and distributaries would likely oil some major bird nesting areas on the delta (Johnson et al. 1996). Oiling would be especially severe for the major brant nesting colonies on the delta (the Anachlik colony complex) because they lie directly within the path of oil moving down the East Channel. Residual oil, particularly in salt-marsh habitats used by brant, could oil newly hatched birds as they move to brood-rearing areas. Disturbance associated with cleanup in the East Channel could also affect brant nesting or rearing broods in the area. The long-term effects of this spill on bird habitats could be significant, particularly if oil or cleanup activities degrade habitats. Degradation of relatively scarce estuarine habitats on the outer delta (Salt Marsh, Tidal Flats, and Brackish Ponds), which are important to brant and fall-staging shorebirds, could also cause reduced nesting and brood-rearing by brant in subsequent years. Impacts on marine mammals would be similar to those described under the preceding scenario, and impacts on terrestrial mammals would be negligible.

4.6.2.6 Threatened and Endangered Species

<u>"Most Likely Worst-Case" Oil Spill Scenario</u>

The effects of this spill on spectacled and Steller's eiders would be minimal given both the winter timing of the spill and its location at the in-field facility. Spectacled and Steller's eiders are not present in the project area during winter and would not be exposed to oil unless an isolated pair encountered residual oil in the spring or summer following the spill.

<u>"Reasonable Worst-Case" Oil Spill Scenario</u>

The effects of this spill and its movement into the Sakoonang Channel, which drains across one of the major nesting areas for spectacled eiders (Johnson et al. 1996) could be severe for spectacled eiders because of the timing of the spill during breakup when eiders arrive on the delta. Pre-nesting eiders use open water near the channel during breakup and could be oiled if contaminated water floods low-lying tundra. In addition, oil in Harrison Bay could be redistributed in coastal areas during subsequent tidal events and further contaminate estuarine habitats used by nesting spectacled eiders. Mortalities of spectacled eiders from oiling would likely occur. Non-lethal oiling of birds would also be likely, and transfer of oil to eggs by incubating females could contaminate eggs and cause nest failure. Of secondary importance would be disturbance to eiders during cleanup operations; the level of disturbance would depend on the geographic scope and intensity of the cleanup. It is likely that nesting would be precluded in some areas (because of habitat degradation or disturbance by cleanup activities) during the summer following the spill. Because little is known about the nesting behavior of spectacled eiders, it is not clear whether displaced birds would renest elsewhere (studies in the Kuparuk oilfield suggest that eiders are traditional in their use of nesting areas [Anderson et al. 1996]). If long-term degradation of habitats occurs from oil and/or cleanup activities, there could be long-term effects on spectacled eider populations on the delta (i.e., reduced nesting, lower productivity, abandonment of nesting areas).

The effects of the oil spill on the other species of concern are of lower magnitude than for spectacled eiders. Small numbers of Steller's eiders could be affected during spring and summer (when most Steller's eiders are seen on the delta and in the oilfields [Johnson et al. 1996; ABR, Inc. unpublished data]). Peregrine falcons are unlikely to be directly affected by the oil (i.e., fouled by oil) because they use the delta mainly during late summer. However, peregrines might experience secondary effects from the oil by eating oil-fouled prey. It is not likely that bowhead whales would be affected by this spill because their spring migration occurs far offshore from the Colville River Delta.

<u>"Extreme Worst-Case" Oil Spill Scenario</u>

As with the preceding scenario, the effects of this spill are likely to be severe for spectacled eiders because of the timing of the spill and the movement of the oil into the East Channel and its distributaries; this would increase the risk of oil spreading to the major nesting areas for spectacled eiders on the delta. In addition, oil in Harrison Bay could be redistributed during subsequent tidal events and further contaminate estuarine habitats used by spectacled eiders. The effects of this oil spill on the other species of concern are of lower magnitude than for spectacled eiders, being similar to those described for the preceding scenario.

4.6.2.7 Human Use

<u>Communities of the Colville River Region</u>

The major socioeconomic impact on Nuiqsut, produced by an oil spill (most likely and extreme worst case scenarios), would be the immediate call-up and in-field response of the Nuiqsut OSRT. The team will be a central unit of the operator's approved ODPCP. Depending on the nature, extent, and duration of the spill, this might involve the lease of local support equipment (boats and ATVs) to reach pre-staged response equipment. Since all team members also hold regular jobs, there would be an impact on NSB, Kuukpik, and village services to the extent that their employees are engaged in spill response and clean-up activities. Should clean-up conditions persist for any length of time, there would also be employment opportunities for other local residents.

<u>Government Institutions</u>

Local government institutions and services would not be directly impacted by any of the oil spill scenarios.

<u>Economic Institutions</u>

Various entities might benefit economically from participation in the oil spill contingency planning process. These would include the Nuiqsut OSRT, which receives paid professional training in the technical areas of spill response, and subsidiaries of ASRC and Kuukpik which specialize in oil spill response, containment, and clean-up operations. If a spill occurred, the services of both the Nuiqsut OSRT and competitive contracting firms would be used by the operator.

A major adverse economic impact would occur on the commercial fishery located at Colville Village. Under the extreme worst-case scenario, the commercial catch could not be sold during the year in which the spill occurred. Impacts on the subsistence fishery, which naturally have important economic dimensions, are discussed in Section 4.5.4.4.

<u>Kuukpikmiut Subsistence</u>

The magnitude of an oil spill on subsistence would depend on the time, volume, location, and duration of a spill, but in no cases would a spill be large enough to preclude subsistence activities, and in most cases subsistence would be restricted for no more than one season in the affected area. The three worst-case oil spill scenarios are discussed below.

"Most Likely Worst-Case" Oil Spill Scenario. The impact of a spill of this magnitude would be low on subsistence activities. There would be little or no hunting or fishing during the time (winter) of the spill, clean-up of the oil would be completed before the start (spring) of subsistence activities, and a small proportion (<1 acre) of the delta would be affected by the spill. It is assumed that the Nuiqsut Village OSRT would be involved in responding to and managing the spill.

"Reasonable Worst-Case" Oil Spill Scenario. The impact of a spill under this scenario would be greater on subsistence activities than the above scenario. The affected area would be largely confined to a corridor centered around the Sakoonang Channel. An oil spill would hinder access by subsistence users to hunt waterfowl and fish the channel and lakes in the area. In addition, hunting success would likely be lower because of reduced waterfowl abundance, particularly brant. Subsistence users may also perceive waterfowl and fish to be tainted by the spill and this may cause them to avoid the area. Nanuk Lake, a traditional subsistence area, should not be affected by the spill, because it is south of the spill site, and the spill should be carried north by spring flows. While subsistence use would be affected by this type of spill, the proportion of the delta rendered unsuitable for hunting or fishing would be relatively small (<1 percent of 164,479 acres) and subsistence use could resume the following year. In addition, most subsistence occurs in areas that would be unaffected by the spill, including the Nechelik (Nigliq) Channel and East Channel of the Colville River.

"Extreme Worst-Case" Oil Spill Scenario. This type of spill would have the greatest impact on subsistence use of the delta. The impacts would be similar to those described above, except that the magnitude would be greater and commercial fishing would be affected in the East Channel, as would seal hunting in Harrison Bay. At least ten traditional Native fishing camp sites and the commercial sites associated with Colville Village would be affected by a spill of this magnitude. If the effects of a spill persisted into fall, they would also affect the under-ice gillnet fishery (commercial and subsistence), which produces the largest catches (primarily Arctic and least cisco) in both fisheries. Subsistence and commercial use should fully resume in the year following the spill.

4.6.3 Mitigation Measures for the Proposed Action (Alternative #2)

As described in Section 2.7, the Proposed Action incorporates the following mitigation measures intended to prevent, detect and respond to spills:

- Employee spill prevention training
- Ground-based and overflight visual inspection of pipeline and facilities
- Regular facility and pipeline inspection, including internal smart pig inspection of pipelines, and appropriate maintenance
- High-strength steel pipelines of thicknesses equal to or greater than regulatory requirements
- X-rayed welds and hydrostatically tested pipeline
- Fusion-bonded epoxy coating on the pipeline to prevent corrosion
- Vertical expansion loops replacing most shut-off valves on pipeline
- Cased pipeline under Colville river crossing with cathodic protection
- Computerized Pressure Point Analysis (SCADA) and mass balance leak detection systems supported by fiber optic communication system
- Use of under-river leak detection system if feasible
- Spill response plan, including logistical planning, staff training, and equipment prestaging and predevelopment.

Taken together, these mitigation measures greatly lower the likelihood of the "worst-case" scenarios from occurring, and furthermore improve ARCO's ability to minimize both the size of a spill and the impacts to the natural and human environments.

Chapter 4.7

4.7 CUMULATIVE IMPACTS ASSESSMENT

4.7.1 Introduction

In determining whether an EIS is needed, the CEQ regulations [40 CFR 1508.27(b)(7) (emphasis added)] require agencies to consider

> . . .whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment . . .

"Cumulative impacts" are, in turn, defined by NEPA (40 CFR 1580.7) as

> . . . the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or 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.

The following text describes past, present, and possible future oil- and gas-related developments on the Alaska North Slope. Not all of the projects described have had or will have impacts on the environment impacted by the ADP Project, and thus not all of the projects are regarded as relevant to a consideration of cumulative impact. They are included, however, for the sake of completeness.

This section has been revised to reflect additional information and in response to requests by several agencies and private parties for some additional analysis of potential future oil and gas development. The revisions adopt an analytical approach for addressing such potential projects that is based on an outline circulated to the lead federal agencies by the USACE. This approach is structured in terms of four questions:

> What oil and gas development is reasonably foreseeable?
>
> Of the oil and gas development that is reasonably foreseeable, what projects are related to or induced by the ADP?
>
> Of the reasonably foreseeable oil and gas development projects that are related to or induced by the ADP, what are the specific additional construction implications (e.g., additional gravel roads, other Colville River crossings, pipeline segments, gravel pads and other facilities) and what impact do they have on the environment (e.g., fisheries, wildlife, water quality, and oil spill effects)?
>
> Will a further EA be required before such future oil and gas development is permitted to take place?

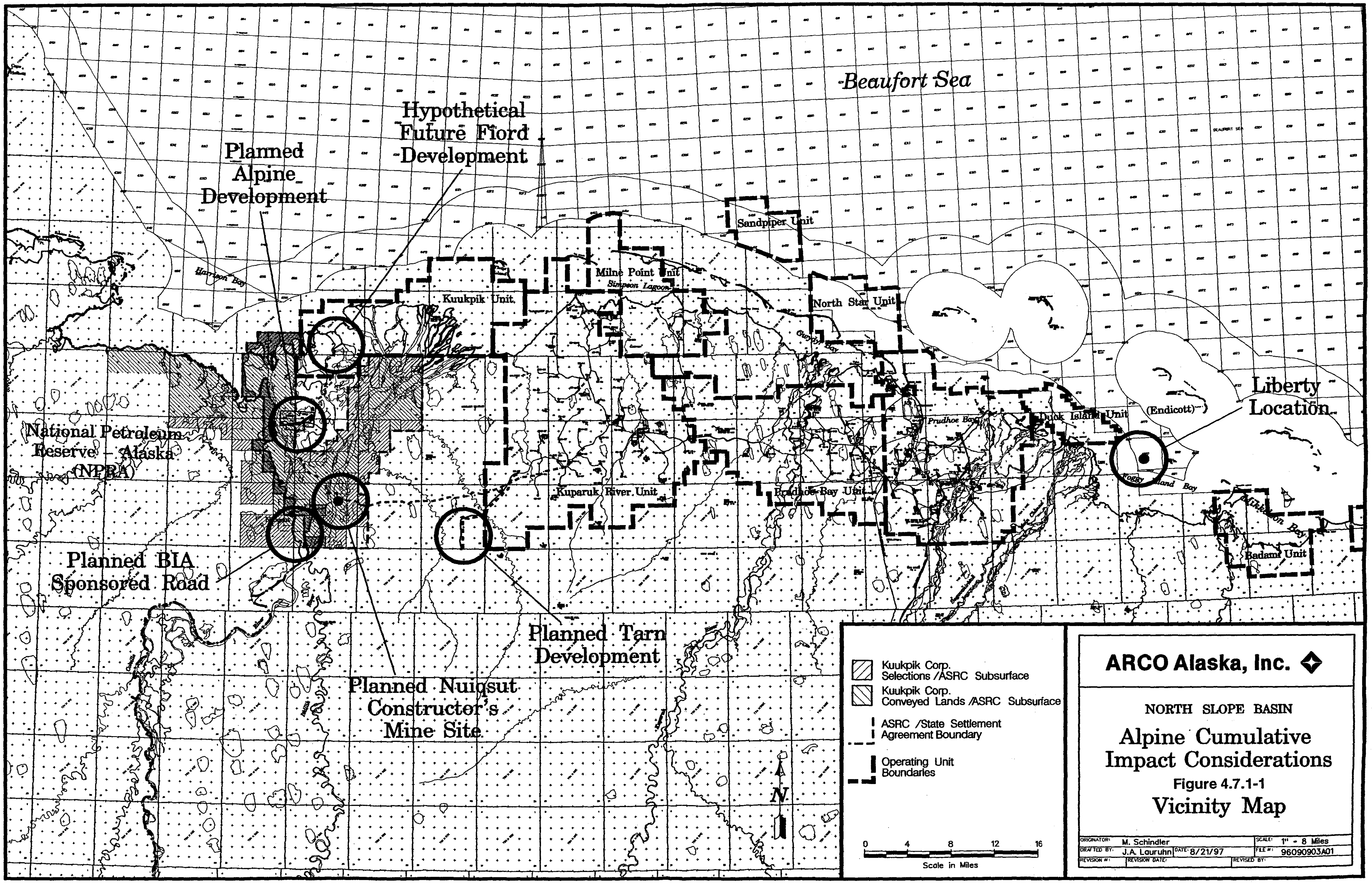
The discussion of future projects that follows is structured to respond to these questions. In terms of forseeability of development, ARCO has focused on whether leasing has taken place, whether drilling has occurred and whether there is a reliable basis for determining that sufficient hydrocarbon deposits exist to justify their recovery. In making this evaluation, ARCO has expanded the temporal parameters from 10-15 years and expanded the geographic scope to 30 mi from the ADP. The further out in time that a potential development is anticipated, the more speculative the development. Similarly, the further away from ADP the development might occur, the less likely that such development will impact the ecosystem affected by ADP and the less likely it will use the ADP infrastructure.

This treatment of cumulative impacts is divided into three parts. The first part discusses existing, planned and future projects, within 30 mi of the ADP. To the extent that existing or reasonably foreseeable future projects would impact the same environment affected by ADP, those additional impacts are discussed on a project-by-project basis. The second part discusses existing, planned and future projects, more than 30 mi from ADP and, therefore, outside the region potentially impacted by the ADP. The third part discusses the cumulative impacts on physical, chemical, biological and human use resources of the ADP, and other existing and reasonably foreseeable future projects impacting the same environment.

4.7.2 Projects Within 30 Miles of ADP

4.7.2.1 Planned Development

BIA-Sponsored Nuiqsut Road. The Native entities of Nuiqsut have proposed (through ASCG) construction of an access road to the Colville River (**Figure 4.7.1-1.**) The Nechelik (Nigliq) Channel is



Scale: 1" = 8 Miles

too shallow during summer and early fall to provide consistent boat access to the main channel of the Colville River. To address this problem, the ASCG secured a permit from the USACE in May 1995 to build a 3.8-mi addition to the existing Nuiqsut road (Appendix T). The road would begin at the end of the existing freshwater lake road, proceed southerly along the western bluff above the freshwater lake, and continue southeast to the Colville River (see Figure 4.7.1-1). The 3-ft-thick roadway embankment would be placed over the tundra on a geotextile fabric. Rigid insulation was proposed to minimize thermal penetration. Construction of the road would require approximately 200,000 yd^3 of gravel; approximately 350,000 yd^3 are stockpiled in Nuiqsut for building the road. Funding for the road is uncertain. The proposed road, which begins south of Nuiqsut, is independent of, and not related to, the ADP and will have no role in either the construction or operation of the proposed ADP field.

The USACE analyzed the impacts of the proposed road in a Permit Evaluation and Decision Document released in May 1995, finding that issuance of the permit would have no significant impact on the quality of the human environment. More specifically, it was found that, because of the insertion of culverts, the road would have only a minor impact on drainage or fish passage. The road's 26-acre footprint would result in a loss of habitat and minor displacement of wildlife. It would not adversely affect threatened or endangered species. The road would have a positive impact on human use issues, providing improved access to subsistence hunting and fishing for Nuiqsut residents and further promoting the subsistence life-style of the Village of Nuiqsut.

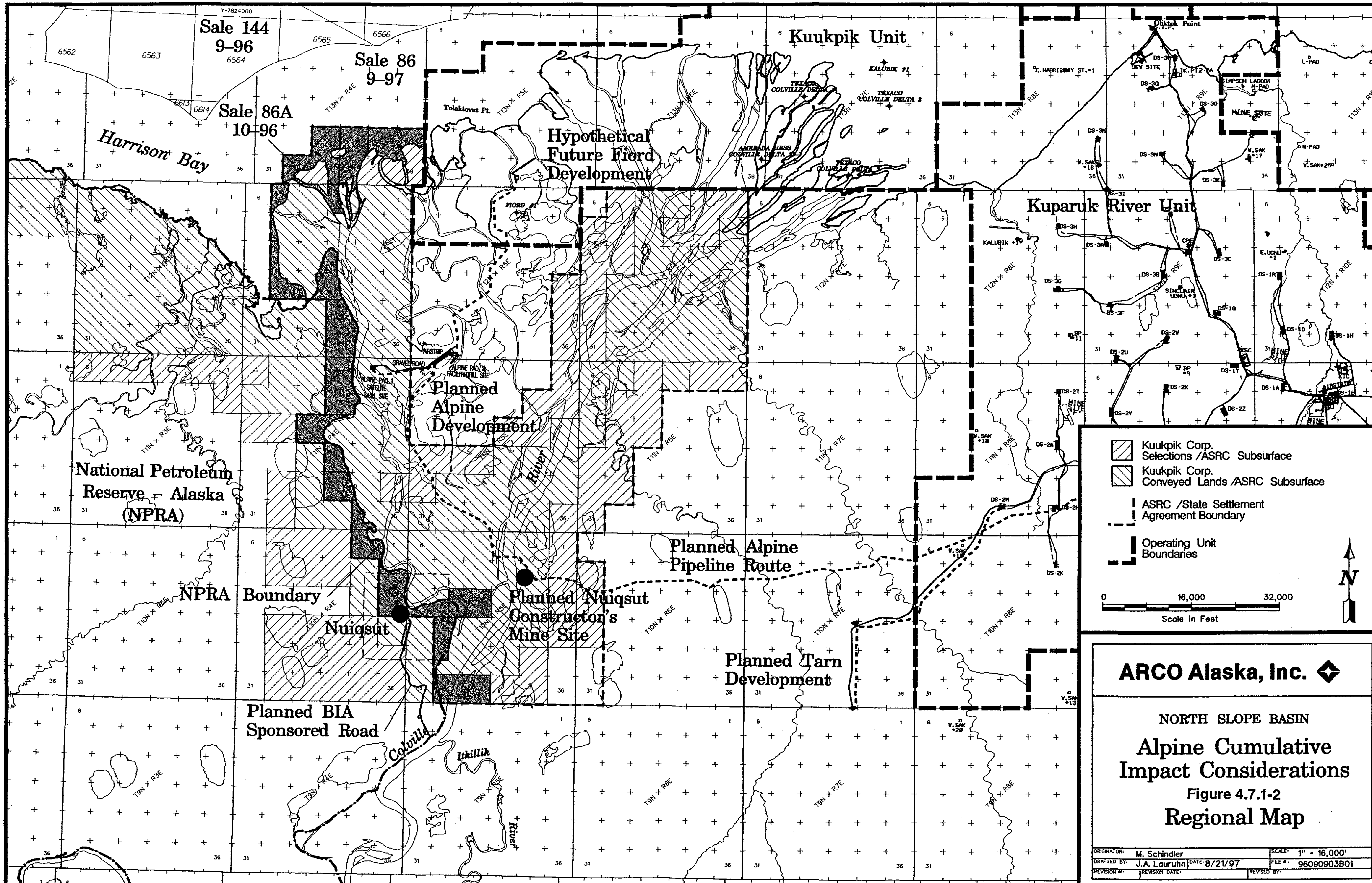
Nuiqsut Constructors Inc. (ASRC) Mine Site

Nuiqsut Constructors Inc. has been granted a permit for operation of a new mine site (primarily gravel) located approximately 4.5 mi east of Nuiqsut just across the east bank of the Colville River (Figure 4.7.1-2 and Appendix O). This mine will be the source of gravel for the ADP Project and for local public work projects. Initially, the mine would occupy an approximately 50-acre material site, with phased development over ten years not to exceed an additional 100 acres. All excavation would be conducted during winter, and, as a condition of the permit, overburden would be placed back into the gravel excavation pits prior to spring break-up with no permanent overburden or gravel stockpiles placed on wet tundra. The proposed mine project envisions phased on-site reclamation on a scale commensurate with phased development. Thus, if the entire 150-acre material site is developed, that area will be contoured to create approximately 122 acres of lakes of varying sizes with approximately 30 acres of islands. The permit contains detailed performance design standards and consultative procedures to guide the reclamation process. The permit also restricts high noise activities to avoid potential disturbance to spectacled eiders.

The USACE determined that the grant of this permit would have no significant impact on the quality of the human environment. Because the gravel mining would be conducted entirely during the winter season, effects on wildlife and surface disturbance would be reduced or eliminated. More specifically, owing to physical and chemical characteristics, some thermal erosion would occur around the pit, and would cause slumping of the fringe area around the reclamation lake; any negative impacts are regarded as transitory and trivial. With respect to biological characteristics, the planned reclamation would enhance the habitat for fish and other aquatic organisms, as well as wildlife, provided the design incorporates appropriate features (e.g., shallow/littoral zones). Neither the spectacled eider nor the Steller's eider regularly nest or breed in the mine area. With respect to Human Use characteristics, the only appreciable impacts will be the positive aspects of providing additional employment and, through reclamation, improved subsistence hunting opportunities.

Tarn

The Tarn prospect was initially drilled in the winter of 1991 with the Bermuda 1 exploratory well, which was announced as a discovery later that year (see Figure 4.7.1-1). Delineation well results were obtained in the winter of 1992 from the Tarn 1 well. In the winter of 1997, three additional delineation wells were drilled. Additional delineation wells are planned for 1998. In August 1997 ARCO applied for a USACE permit for the Tarn oil and gas development project (Appendix V) approximately 6-9 mi southwest of Drill Site 2M in the Kuparuk River Unit oilfield and approximately 18 mi southeast of the proposed ADP (see Figure 4.7.1-1). The Tarn project will consist of two drill sites, an access road, pipelines, and powerlines. The drill sites and access road will occupy roughly 74 acres and the pipeline, elevated on VSMs, will essentially parallel the road. The project is independent of ADP; the reservoir is entirely distinct and separate, as is the pipeline



Scale: 1" = 16,000'

although the ADP pipeline will cross the Tarn pipeline road corridor.

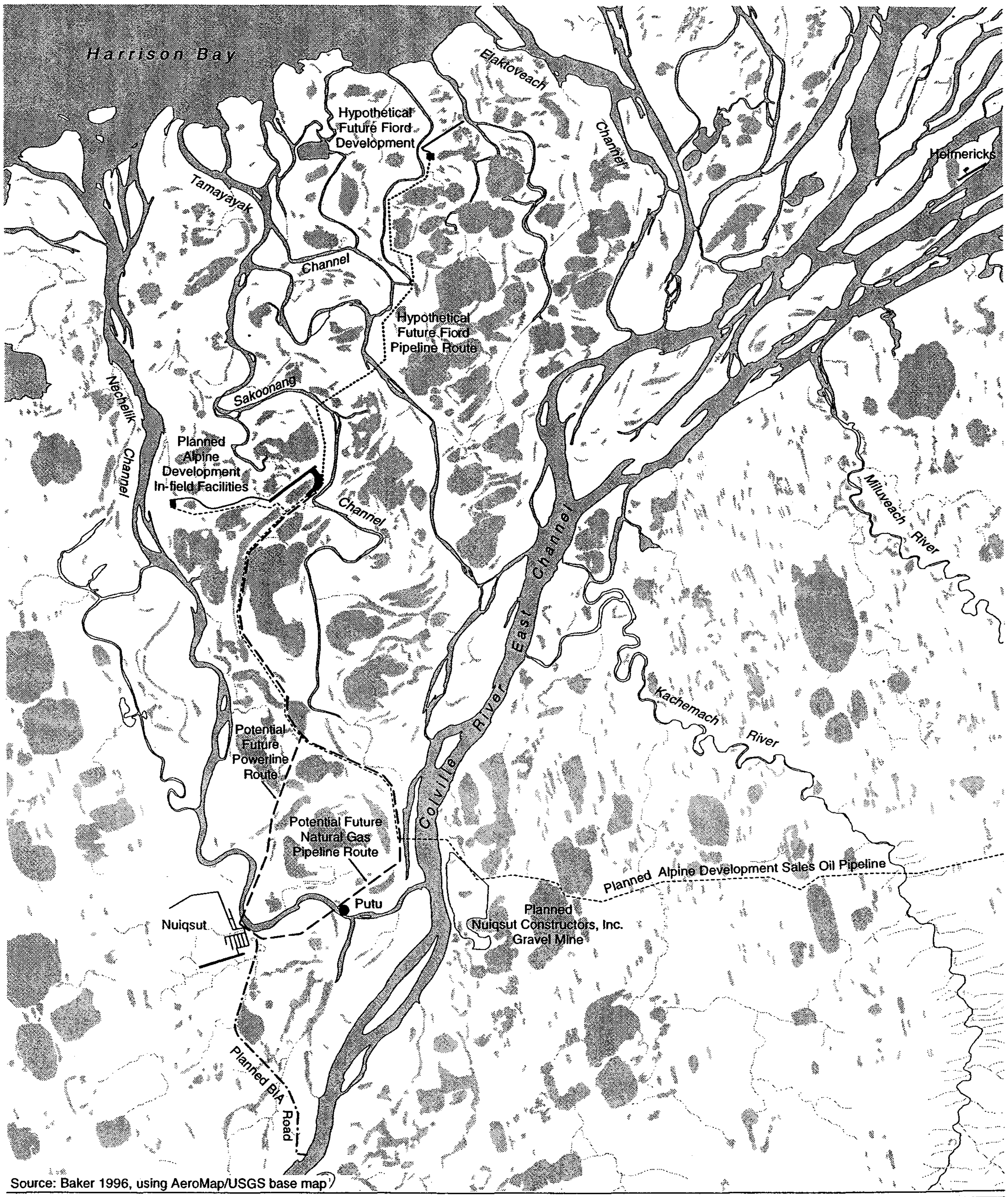
The Tarn Project will have no anticipated impact on the physical and chemical environment of the Colville Delta Region unless a major spill enters the Kachemach or Miluveach rivers and reaches the delta before containment (see Section 2.7). The environmental consequences of the project are described in detail in Appendix A of the Tarn permit application. The two habitat types most affected by the 74 acres of pads and roads, Moist Sedge-Shrub Meadow (37 acres) and Moist Tussock Tundra (33 acres), are the habitat types most abundant in the area, comprising respectively 21,300 and 16,247 acres in the project area; the loss of these habitat types would be 0.2%. The direct effects of gravel placement on wildlife population will be limited. Thermokarst has both negative (visual) and positive (enhanced decomposition) effects, the net result of which is uncertain. While noise from the project may have a slight behavioral impact on wildlife near the facilities, the scheduling of gravel placement during the winter, when few birds and mammals are in the project area will minimize disturbance during the construction phase. Attraction of wildlife to the Tarn facilities will be minimized by proper containment and removal of garbage and wastes. There will be limited direct and indirect project effects on the spectacled eider because of their relatively low abundance in the Tarn area; virtually no effect is expected for Steller's eiders or peregrine falcons which rarely occur in the area. Caribou will be displaced within 1,500 to 3,000 ft, and up to 1 to 2 mi, of the Tarn access road during the calving season.

4.7.2.2 Future Projects

Whether future projects in the Colville River Delta region (Figures 4.7.1-2 and 4.7.1-3) can be regarded as "reasonably foreseeable" is largely a function of access to prospective lands, pre-lease and post-lease exploration/discovery/delineation, production testing, engineering analyses, economic evaluation and successful permitting. Specifically, for a project to be developed, at a minimum the following tasks are typically required:

- Ascertain availability of acreage or tracts
- Analyze geology
- Acquire geophysical data
- Interpret geophysical data
- Identify prospects
- Complete economic analyses
- Obtain leases in the prospective area
- Complete environmental permitting
- Resolve other restrictive barriers
- Locate the prime area and specific location of the wildcat well
- Drill the well(s)
- Interpret well results
- Conduct focused seismic data acquisition
- Drill more exploratory wells or delineation wells
- Perform further economic evaluation
- Conduct production tests
- Evaluate development potential
- Study options
- Gather site data
- Define development
- Design/engineer development
- Construct/fabricate development
- Drill pre-development wells
- Conduct commercial production/complete development well drilling
- Complete environmental permitting for development

The fewer tasks on this list that have been completed, the more speculative the project. This general observation is particularly true for oil and gas projects on the North Slope of Alaska, where the time frame required to complete each stage is uniquely long. Operations are seasonally restricted to the eight months of winter when ice roads provide site access and ice pads permit exploratory, discovery and/or delineation operations; permanent roads and pads are prohibited for remote exploratory operations. Moreover, during winter work, productivity decreases approximately 40 percent and operating costs are comparably higher. Onshore seismic operations are also restricted to winter when the moist tundra and rivers and streams are frozen, thereby allowing access. Offshore open water seismic acquisition is constrained by ice conditions and coordination with marine mammal activities. Movement of large facility modules is either limited to an eight week open water barging season or winter ice road/ice bridge access, which dictates maximum production module tonnage limitations. Within Alaska, the Colville River Delta region is exceptionally challenging, since it is a remote area lacking the broad-based infrastructure that would otherwise streamline operations.



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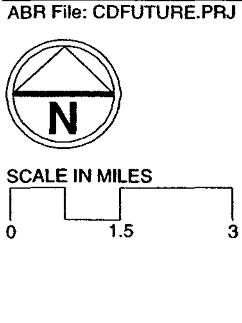

Figure 4.7.1-3.
Planned and Potential Future Projects on the Colville River Delta

As a result of the harshness of the arctic environment, even where oil and gas development projects can be deemed to be reasonably foreseeable, most projects will likely not materialize for at least 10-17 years. Possible exceptions are the Fiord prospect, which may be developed as a remote satellite of ADP, and Tarn, which is proposed to be developed as a satellite of Kuparuk. Obviously, the longer the time period until potential commercial development, the more uncertain it is that development will occur; over time, the inherent volatility of the petroleum market increases the likelihood of a price collapse, drastically changing the economic threshold for commercial viability.

Even more important, the tasks listed above—from leasing to exploration to discovery to commercial production—do not automatically or inexorably follow one another. The oil and gas business is unusually and inherently risky. Over the last 30 years, for every ten exploration wells drilled, only one resulted in a discovery, and for every five discoveries, only one was delineated as commercial. In Alaska, only 4.2% of exploratory wells drilled resulted in oil and gas development. The Kuvlum and Sunfish projects are two recent examples of successful exploratory and discovery drilling that did not result in oil production. Based on this experience, it is not reasonable to consider an oil and gas development to be "foreseeable" at least until wells delineating the actual size of a discovered reservoir have been drilled and commercial quantities of oil and gas have been confirmed. Thus, in the following discussion, a distinction is drawn between exploratory, discovery and delineation drilling, on the one hand, and commercial development, on the other. While the former will have environmental impacts, these impacts are relatively minor and transitory and include: (1) construction of ice roads and ice pads (which temporarily compress tundra vegetation and result in short-term habitat loss); (2) additional noise; and (3) temporary reduction of water resources.

Discoveries In The Far Northeastern Colville River Delta Region

Figure 4.7.1-1 depicts a cluster of announced discoveries that are approximately 15 mi northeast of the proposed ADP Development. These discovery wells include:

Well	Operator
Kalubik 1	ARCO Alaska, Inc., Operator
Texaco Colville Delta 1, 2, and 3	Texaco, Original Operator, ARCO Current
Amerada Hess Colville Delta 25-1	Amerada Hess, Original Operator, ARCO Current

These discoveries, which were made approximately 6-10 years ago, represent the only successful drilling activity in this area. All of these discoveries are presently included in the Kuukpik Unit approved by the State of Alaska and operated by ARCO Alaska, Inc. If these discoveries are developed, such development would need to await additional exploration/delineation, production testing, engineering, permitting, and construction. However, as explained above, it is not reasonable to simply assume development will occur based on these discovery successes. Moreover, were such development to occur, separate EAs would likely be required.

These discoveries do not depend in any way on, or relate to, the ADP development. Furthermore, due to the substantial distance separating these discoveries from the ADP field, it is very likely that potential pipelines from these prospects would immediately exit east out of the delta and tie into the nearby KRU infrastructure, roughly 7 mi from ADP.

Fiord

Figures 4.7.1-1 to 4.7.1-3 depict hypothetical Fiord future development located approximately 6 mi northeast of the proposed ADP. Present well information indicates that a small accumulation of oil exists at Fiord. Due to the modest size of this reservoir, potential commercial production will depend on confirming existing and potential reserves and keeping development costs very low. Accordingly, if Fiord is developed, there would be no permanent access road; major equipment would be transported through ice roads or by air. Oil spill response and routine access issues would have to be addressed with regard to operation of a remote satellite production pad. As shown in Figures 4.7.1-1 to 4.7.1-3, a 7.8-mi pipeline, connecting Fiord to ADP, would be entirely aboveground, including the crossings of the Tamayayak and Sakoonang Channels. Unlike ADP, no large processing or pumping equipment would be located at the site, as such activities would take place once the oil arrives at ADP. The Fiord pad is estimated to be 600 ft by 700 ft to accommodate the expected 40 wells, associated storage and equipment, and up to ten people. The pad would be connected to an adjacent airstrip, sized to accommodate Hercules aircraft capable of transporting relief well rigs, and would not need to be large enough to land commercial jets.

Because the reservoir has been discovered, and because it can be assumed that the ADP infrastructure may be producing by the year 2000, the time frame for potential development (almost exclusively in winter) of the Fiord 1 project will depend on how quickly ARCO can further delineate and production test the reservoir and perform the necessary engineering, permitting, and construction. Again, a separate EA would likely be required before development.

While there are many remaining uncertainties, if the Fiord project were built, it would have an incremental impact on the environment in the ADP region. The roughly 20 acres of gravel pad, airstrip and connecting road would be designed and sited to minimize its affect on high-value wildlife habitat, cross drainage and fish passage. Spectacled eiders use this general area more than other areas on the delta, and the Fiord project is located near high-value estuarine habitat on the delta. Given its remoteness from the Village of Nuiqsut, there should be virtually no impact upon human use characteristics. Nor should the project have an effect on whale harvesting. Gravel would not likely come from the Nuiqsut Constructors, Inc. mine site, and therefore, not involve use of winter ice roads.

Prospects in the Colville Region

National Petroleum Reserve-Alaska (NPR-A) Lands. The NPR-A is an area extending approximately 120 mi west of the Colville River Delta region (see Figures 4.7.1-2 and 4.7.1-3). It is bounded on the east by the Nechelik (Nigliq) Channel of the Colville River, on the north by the Beaufort Sea coastline, and on the south by the Brooks Range.

While land ownership within NPR-A is predominantly federal, some Native lands lie immediately west of the Nechelik (Nigliq) Channel where Kuukpik owns the surface and ASRC owns the subsurface either solely or jointly with the state, or where Kuukpik owns the surface and the subsurface is jointly owned by ASRC and the State. At present, access to all federal NPR-A lands for oil and gas activities is limited to geophysical seismic acquisition and geological field work. Geophysical and geological operations are allowed through special use permits issued by the federal land manager, BLM. In the case of Native lands within NPR-A, oil and gas activities can occur through separate agreement with the Native surface and subsurface owner.

Non-Federal NPR-A Lands. Originally, the ANCSA did not allow Native Corporations to acquire land in the NPR-A. In 1980, the ANILCA provided that opportunity, and thereafter Kuukpik and ASRC entered into the 1987 1431(o) Agreement. Under that Agreement, Kuukpik concurred with ASRC exercising its option under ANILCA to acquire subsurface lands within the NPR-A underlying the surface lands selected by or conveyed to Kuukpik. In return, Kuukpik reserved its right to consent to oil and gas activities. The present status of these Native acquisitions in the Colville River Delta region is depicted in Figures 4.7.1-2 and 4.7.1-3.

ARCO has obtained leases on a portion of these non-federal lands in the NPR-A, the most recent ones acquired in Sale 86A in October 1996. However, since neither ARCO nor any other oil and gas operator had the right to drill exploratory wells on Native lands in NPR-A until August 1997, development in this area is not reasonably foreseeable. For development to occur, prospects would have to be targeted and refined and successful exploration, discovery, and delineation wells would need to be drilled. In addition, there would have to be production testing, engineering, permitting, and construction. Further, an EA would likely be required.

The most reasonably foreseeable activity would be winter exploratory wells on these lands or the addition of high deviation exploratory or delineation wells to the proposed ADP Pad 2 to determine whether the ADP reservoir extends into Sale 86A and adjoining ASRC subsurface lands. If this extension were confirmed, development could occur within a relatively short timeframe. However, it is likely that such development would have virtually no cumulative impact since any additional wells would be drilled from the proposed ADP Pad 2.

Federal NPR-A Lands. Although the federal government previously conducted lease sales within NPR-A, there are no active oil and gas leases from the federal government and no wells being presently drilled. Indeed, today non-Native lands within NPR-A are not available for oil and gas leasing. Whether or not the government offers such leasing is the subject of an ongoing EIS. There is no certainty that leasing will be allowed, or if allowed, whether lease sale bids will be submitted and/or successful exploratory, discovery and delineation wells will be drilled leading to oil and gas production. It is notable that while the previous leasing program in the NPR-A resulted in more than $100 million in bonuses paid on 44 leases, there were no commercial discoveries. Indeed in the final lease sale in that program, industry interest was so low that there were no bids.

In a draft Appendix to the new EIS being prepared for the NPR-A, entitled Reasonable and Foreseeable Development Scenario, the authors advance a number of statistical cases hypothesizing oil and gas development, including an exploration only-no development case. Significantly, the development cases make a number of assumptions, including that "Industry will be aggressive in their exploration efforts and very successful in discovering new commercial-sized oilfields" (App. A at 11). Thus, development is predicted because oil in commercially recoverable quantities is assumed. That assumption, however, has no current, reliable basis. In this connection, it is significant that the 1983 Final EIS on Oil and Gas Leasing in the NPR-A similarly contained hypothetical cases predicting oil and gas development. The most conservative case assumed the discovery of two production fields with reserves of 1.08 billion barrels of oil which would be drilled with 298 wells and begin production in 1990; the most aggressive case, assumed the discovery of five production fields with reserves of 2.3 billion barrels of oil which would be with 631 wells and begin production in 1990, with additional production to commence in 2002 and 2003 (1983 EIS at 56). These assumed discoveries did not materialize. The authors of the current draft Appendix effectively concede that NPR-A development is not in fact "reasonably foreseeable" when they state in their Introduction: "At this time, there is no guarantee that leasing will occur in the NPR-A Plan area or that commercial discoveries will be made" (App. A at 1).

Onshore Lands East of Nechelik (Nigliq) Channel

Land ownership east of the Nechelik (Nigliq) Channel is a mixture of 100% State surface and subsurface, 100% Kuukpik surface, and ASRC/State jointly held subsurface (see Figures 4.7.1-2 and 4.7.1-3). Virtually all of the state 100% acreage is currently under an oil and gas lease. Kuukpik lands east of the Nechelik (Nigliq) Channel are available for oil and gas exploration, delineation, production, testing, and production activities pursuant to existing oil and gas leases and the Settlement Agreement between Kuukpik and ASRC dated November 23, 1992 affecting the surface of the ASRC/State subsurface (see Figure 4.7.1-2 for boundaries).

Prior exploratory and delineation drilling on these lands occurring within the delta did not identify commercial reserves other than ADP. Potential development of these onshore lands occurring outside of delta is speculative due to a lack of exploratory drilling to date. It would depend on positive results in refining and targeting prospects and success with exploration, discovery and delineation drilling. It would depend, as well, on production testing, engineering, permitting, and construction. However, at present there have been no successful exploration wells, rendering any assumption of development speculative. If development were deemed feasible and practicable, a separate environmental assessment would likely be prepared.

Offshore Lands North of Colville River Delta Region

These tidelands, nearshore waters, and deep waters are owned by the State, ASRC, and the federal government. State ownership extends, in most cases, up to 3 mi from the shoreline mean high water line, and federal ownership begins beyond the 3-mi limit and extends to approximately 200 mi.

Portions of these State waters on State/ASRC subsurface land near the mouth of the Nechelik (Nigliq) Channel were offered in State Lease Sale 86A in October 1996, and the remainder of state waters on State lands just offshore of the Colville River Delta were offered in State Lease Sale 86 in April 1997. Federal waters in the region were offered in September 1996 in Lease Sale 144. However, interest and successful bids were limited to a small area northeast of Colville located approximately 5 mi offshore and approximately 23 mi northeast of ADP. Oil and gas industry interest in upcoming offshore lease sales is unknown.

Potential offshore development in State waters abutting the Colville River Delta region is feasible within a 15-year time frame as is potential offshore development in federal waters for Sale 144 leases. Once again, such development would require success in refinement and targeting of prospects and success at each stage in the drilling process. Therefore, as above, at this early stage when leasing has just occurred or is being planned, it is premature and speculative to assume that commercially sized reserves will be found. If they were, an EA of the impact of such a project would likely be conducted.

Other Potential Projects

Upgrading of Energy Supply to Nuiqsut. The village of Nuiqsut has expressed interest in improving its energy supply system. A new energy supply would create the additional benefit of improved air quality compared to the current use of diesel fuel. ARCO has committed in a specific agreement to make available to the village the natural gas or electricity generated at ADP. That commitment did not expressly conclude in a specific agreement the transfer of the natural gas or electricity from ADP. A July 1997 study evaluated options available to the Native entities for building a gas pipeline, erecting a powerline, or upgrading its existing power plant in the village. ARCO has no preference for gas or electrical supply, and it will make either power supply available at the backdoor of the processing facility. There is no known funding or pending permit applications for any of these options, which creates uncertainty as to what, if anything, can be regarded as reasonably foreseeable.

If Nuiqsut elects to upgrade its existing power plant, and the "do nothing" option were adopted, the incremental environmental impacts would be largely limited to noise and disturbance affecting the village residents during the construction period.

If a powerline is constructed, the route and mode preferred by the engineering consultants would parallel the ADP pipeline to the greatest extent possible and then would be routed overland to the village, avoiding lakes, and crossing the Nechelik Channel at the narrowest possible location (see Figure 4.7.1-3). Other than the positive impact on village life and improved air quality from a reduction in diesel emissions, this approach would have little, if any, impact on the environment. The line would be strung along treated timber poles imbedded 12 ft in the ground and rising approximately 45 ft high. Once erected, these poles would have a minimal effect on habitat and hydrology and no impact on air. The elevated system would not impede the migration of caribou and other mammals. The 9.5 mi pipeline crossing on the inner delta would pose a localized risk of collision for flying birds, particularly in poor weather as has been observed in the Prudhoe Bay oilfield.

If a 4-inch gas pipeline is constructed from ADP, the optimal approach, as discussed in the July 1997 report would route the gas line on the ADP VSMs that carry the oil and water pipelines from the ADP field to the west bank of the Colville River pipeline crossing (see Figure 4.7.1-3). This approach, maximizing the utility of the VSMs and consolidating facilities, would route the pipeline to within 4.2 mi of the village. At this point, there would be an insulated transition and underground burial for the remainder of the route. The trench, which would be 4 to 6 ft deep, would be dug in the winter and backfilled with cuttings to compensate for thawing and settling with the active ground layer. Bentonite trench plugs would be inserted where slopes could cause erosion. Reseeding and revegetation would also be undertaken. Although corrosion rates for natural gas lines are low, a fusion-bonded epoxy coating would be applied to the exterior of the line, along with a cathodic protection system. This design would have a minimal impact on habitat and the chemical and biological characteristics of the ADP environment. It probably would have minimal effects on hydrology, drainage, and wildlife, although disturbance caused by trenching ice-rich soils may create the potential for thermokarst in localized areas of the 12.7-mi gas line route.

4.7.3 Projects Beyond 30 Miles

The projects described below, both existing and planned, were developed or will be developed independent of ADP. The region impacted by ADP is separate and apart from the regions impacted by the projects described below. While these projects are not pertinent to an analysis of cumulative impacts on the Colville River, they do provide an historical and developmental context for understanding the ADP field.

4.7.3.1 Existing Oilfield Developments

Several existing oilfields lie east of ADP. These fields are discussed below in the order of their distance from the proposed ADP site. The fields are referred to as units. A unit is a combination of existing oil and gas leases that, by agreement among the lessees of record and the lessor (State of Alaska in these fields), is combined into one lease (or unit) to promote optimal development of the oil and gas resource. Surface infrastructure is then required to produce the oil and gas reservoir, and, on the North Slope, that infrastructure (excluding pipelines, powerlines, etc.) is primarily placed on gravel pads, which have a "footprint" on the moist tundra. In ARCO's 20 years of North Slope operating experience, it has developed construction and operation practices that (1) do not require gravel pads for pipelines, (2) substantially reduce the size of gravel pads for production facilities, (3) minimize use of permanent access roads, and (4) eliminate reserve pits.

Kuparuk River Unit (KRU)

Located between 30 and 40 mi east of ADP, the KRU was the second oil producing area on the North Slope (Figure 4.7.1-2). About 1% of that area is impacted by a gravel pad footprint. Kuparuk production began in 1981. Production is expected to remain relatively constant at 300,000 bbl of oil per day through the year 2000. Major construction has been completed and the field is primarily in an operation and maintenance mode, with the exception of the West Sak Project and satellite developments (such as Tarn).

The West Sak reservoir, if deemed commercial and begun in the near term, would be developed from existing gravel pads. However, long-term development may involve new pads or pad expansions. New construction would primarily occur in areas south of KRU. ARCO, as operator of the KRU, recently announced strategies to explore and produce satellite reservoirs within or near unit boundaries. Most of these satellites, if deemed commercial, would be developed from existing gravel pads. New pads or pad expansions may be required in isolated locations, as discussed earlier with regard to the Tarn project.

Milne Point

Located approximately 40 mi east of ADP (north of Kuparuk), the Milne Point Unit was the third oil-producing area on the North Slope. Production began in 1985, but was suspended early in 1987 due to the collapse of world oil prices. The field resumed production in 1989 at a rate of approximately 30,000 bbl of oil per day; it may increase to 50,000 bbl of oil per day under new operatorship by British Petroleum (BPXA).

Prudhoe Bay Unit (PBU)

Located between 40 and 70 mi east of ADP, the PBU was the first oil-producing area on the North Slope (Figure 4.7.1-1). About 2% of that area is impacted by a gravel pad footprint. Prudhoe was discovered in 1968 and production began in 1977. Production is now in a state of decline with a current rate of approximately 900,000 barrels of oil per day.

Recent developments within the PBU include Lisburne, Point McIntyre, West Beach, North Prudhoe Bay State, and Niakuk. With the exception of Point McIntyre and the West Dock Seawater Treatment Facility, all of PBU's production facilities are located onshore. Although Point McIntyre and the seawater treatment facility are technically located offshore, they are connected to the shoreline via a gravel causeway extending into the Beaufort Sea.

The operators of the PBU, BPXA and ARCO, recently announced strategies to explore and produce satellite reservoirs (puddles) within or near unit boundaries. Most of these satellites, if deemed commercial, would be developed from existing gravel pads. New pads or pad expansion may be required in isolated locations.

Endicott

Located approximately 80 mi east of ADP, Endicott was the fourth producing area on the North Slope and the first offshore producing field in the Beaufort Sea (although its causeway provides year-round access) (Figure 4.7.1-1. Discovered in 1978, the field began producing in 1987 and is currently producing approximately 120,000 bbl of oil per day. Almost 100 wells have been drilled from its two drill pads. Major construction has been completed and the field is primarily in an operation and maintenance mode.

Trans-Alaska Pipeline System

Built between 1974 and 1977, the 48-inch-diameter TAPs stretches 800-mi, from the North Slope to the ice-free port of Valdez, on Alaska's southern coast. It begins at Pump Station 1 on the southern edge of the Prudhoe Bay field. In early 1996, the pipeline was handling about 1.2 million bbl of oil, condensate, and natural gas liquids per day. No expansion of the pipeline will be required to transport oil from the ADP.

4.7.3.2 Planned Developments

Badami

BPXA is planning the Badami Development project, located approximately 100 mi east of ADP—the first oil and gas production east of the Sagavanirktok River (see Figure 4.7.1-1). The project includes an onshore production well pad, an onshore facilities pad, an approximately 28-mi pipeline, a dock, a short in-field road system, gravel sources, and an airstrip. No plans exist for a permanent gravel access road to connect Badami with existing Prudhoe Bay-area facilities.

Northstar

BPXA is also interested in developing the Northstar unit, located approximately 60 mi east of ADP (Figure 4.7.1-1). The proposed project would be the first remote oil production project in the Alaskan Beaufort Sea without a causeway. The Northstar unit is located between 2 and 8 mi offshore in the Gwydyr Bay area. A Draft EIS for this project is currently being prepared with the USACE as the lead agency.

Because of its distance from shore, it is not likely that the Northstar unit can be developed from land using current drilling technology. Offshore structures will likely be necessary to develop the field. Development options may include reconstructing and enlarging an existing artificial gravel island (Seal Island), placing bottom-founded structures in the area, or employing other alternatives. Construction may include wells, drilling equipment, injection wells, construction camp/crew quarters, water and other utilities, fuel storage, a boat ramp, and a helipad located on offshore structures. Production facilities could include drilling equipment, water and/or gas injection facilities, oil separation or other processing facilities, and pipelines between the shore and the offshore production structures.

Liberty

BPXA intends to proceed with development planning of this offshore prospect located approximately 80 mi east of ADP (Figure 4.7.1-1). Details of this planning effort are preliminary and general. The development options are similar to those identified above for Northstar, with a possible pipeline connection to existing Endicott facilities.

4.7.4 Other Colville River Delta Development Scenarios

In a letter dated June 6, 1997 to the USACE, the USFWS suggested that the USACE assess three development scenarios. These scenarios do not set forth "reasonably foreseeable" future actions because the tasks listed in Section 4.7.2.2 have not been performed and it is uncertain whether they will occur nevertheless. The following information is provided to assist the USACE in responding to the USFWS's request.

USFWS's three scenarios are discussed below:

Scenario #1 - A reservoir smaller than the ADP reservoir, developed by a satellite production pad and oil delivered to the ADP facility. This scenario should consider a field north of the proposed ADP facility (such as the Fiord reservoir) and a possible find directly to the south of ADP between ADP and Nuiqsut. The impacts of facility and infrastructure (such as roads, pipelines, and their stream crossings) development, as well as operational impacts should be carefully considered.

Section 4.7.2.2 above discusses and depicts the hypothetical future Fiord development which constitutes the northern satellite scenario as requested in Scenario #1.

With regard to a southern satellite scenario, ARCO has drilled exploratory and delineation wells in areas substantially south of ADP, between ADP and Nuiqsut, which have failed to identify commercial oil and gas reserves that cannot be developed from the proposed ADP drill sites. Therefore, a southern satellite scenario is entirely speculative.

However, a hypothetical southern satellite scenario would likely resemble the hypothetical future Fiord development scenario described in Section 4.7.2.2 since it would be well within the 25-mile radius in which ARCO has stated that it may be feasible and practicable to use ADP processing facilities and avoid new processing facilities (see ARCO Response To Comments Dated May 21, 1997 justifying 25-mile radius from ADP, see Appendix L). This southern scenario likely would not have a gravel road connecting to ADP, Kuparuk, or Nuiqsut unless justified as the environmentally preferred alternative. However, depending on reservoir size and fluids characteristics, two drill sites could be required. If required, they would likely be connected by a short gravel road. A gravel airstrip, sized to accommodate Hercules aircraft (capable of transporting an emergency relief well rig) would likely be built and used primarily during the construction and drilling phases. Pipeline stream crossings to ADP would likely be aboveground VSM supported due to the size and character of the required crossings. Operational impacts would be concentrated in the construction and drilling phases which primarily occur during winter. Operational impacts during the long-term operation would be similar to ADP but likely smaller in scope due to the smaller reservoir size.

Any potential satellite scenario would be thoroughly analyzed in an EA prepared by the USACE.

An assessment of the cumulative impacts of scenario #1 on the environment is necessarily speculative given the uncertainty of development north and south of ADP. However, if such development occurred, presumably those facilities, like ADP, would incorporate state-of-the-art design and technology to minimize the impact of the development on the environment. Like ADP and the hypothetical future Fiord prospect, the southern satellite's orientation would be designed to minimize its effect on hydrology, fisheries resources, wildlife and high value habitat. The most likely direct impact of this southern scenario would be the loss of about 20 acres to gravel placement for Fiord-like project. The impact would be small; affecting less than 1% of the delta habitat. The impacts on water quality should be limited to relatively small localized increases in suspended solids and minor contaminants. Impacts to air quality would be minimal since the hypothetical northern and southern satellites will likely use ADP processing facilities. Other than the positive impact that commerce might have on the Nuiqsut economy, it is unlikely that development under this scenario would have a substantial impact on the communities in the Colville River Delta region. The majority of the workforce at any such facility would likely be nonresident and remote, and access to Nuiqsut, in the absence of a road, would be difficult. Nor given the restrictions on hunting and fishing typically placed on oil and gas personnel, would their presence be likely to place additional pressure on the subsistence economy.

Scenario #2 - A reservoir equal to, or smaller than ADP, within 20 miles due west of the ADP facility (across the Nechelik Channel). This scenario should consider the potential demand for a road (from either the ADP facility or Nuiqsut), a gravel source, and a pipeline crossing of the Nechelik Channel.

The above geographical description would place this scenario in NPR-A. The current status of potential development on federal and non-federal NPR-A lands is discussed in Section 4.7.2.2. The impacts of potential development of the NPR-A lands cannot be determined until either non-ADP related drilling occurs on non-federal NPR-A lands or decisions by the Department of Interior are made as to whether, when, where and how such development might occur on federal NPR-A lands. Until then, any attempt to measure the possible impacts of such development would be speculative. Moreover, the possible impacts of any such development would be thoroughly analyzed in an EA or EIS prepared by a government agency prior to commencement of development activities.

The following discussion of this scenario, therefore, merely attempts to describe, generally and conceptually, the hypothetical impacts of such a scenario in NPR-A, if it occurred within 20 miles of ADP. Further, since this scenario assumes a reservoir equal to or smaller than ADP, and since the ADP incorporates state-of-the-art design and technology to minimize the impact of the development on the environment, this section assumes, as the BLM has done in their early NPR-A EIS planning meetings, that any future NPR-A development would also incorporate similar design features and advances in technology.

If an ADP-like or smaller reservoir were to be developed from a portion of NPR-A within 20 miles and due west of ADP, depending on fluids properties, that field may likely realize economies in being developed as a satellite of ADP (e.g. avoid on-site processing facilities and use those existing at ADP). An ADP-like reservoir would likely have two gravel pads connected by a gravel road (most likely about 3 mi long due to reasonable maximum deviation of development wells). A smaller reservoir compared to the ADP reservoir would likely have only one gravel pad. There would likely be no permanent access road to the new development from ADP, Kuparuk, or Nuiqsut, unless justified as the environmentally preferred alternative, and the development would likely have an airstrip sized primarily for construction and drilling phases and emergency relief well rig transport. Major construction equipment and personnel likely would be transported on ice roads or by air. There would likely be a multi-phase aboveground pipeline supported on VSMs connecting the new development to ADP. This pipeline would likely cross the Nechelik Channel near ADP Pad 2 on a bored HDD mode similar to ADP's Colville River crossing. Gravel would likely come from the permitted Nuiqsut Constructors, Inc. mine site (USACE Colville River 17). Oil spill response and routine access issues would need to be addressed in light of the remote nature of the development.

Given the tremendous uncertainty about the location and nature of any possible oil and gas development in the federal NPR-A, it is impossible to describe the potential impacts of such development under this scenario with any specificity. However, if development did occur 20-30 miles due west of ADP, the footprint of the related facility would presumably be a function of the reservoir size and fluids characteristics, and the facility's orientation would be designed to minimize its effect on hydrology, fisheries resources, wildlife, and high-value habitat. Two of the most sensitive wildlife issues in the NPR-A, calving caribou and molting geese, are located in western portion of the NPR-A, beyond the zone of direct ADP effects. If development occurred with this scenario, the most likely impact of such a facility would be the loss of 100 acres to gravel placement; assuming that the reservoir was of the same order of magnitude as the ADP field. This is far less than 1% of the Colville River delta. Gravel for the pads and airstrip could be purchased from the Nuiqsut Contractors, Inc. mine, until that mine was exhausted. As with scenario #1, the impact on water quality should be limited to relatively small localized increases in suspended solids and minor contaminants. Impacts to air quality would be minimal in part since the hypothetical project would likely use ADP processing facilities. Other than the positive impact that such commerce would have on the Nuiqsut economy, it is unlikely that fields of this description would have a substantial impact on the communities in the Colville Delta Region. The majority workforce at any such facility would likely be nonresident and remote, and access to Nuiqsut, in the absence of a road, would be difficult. Nor given the restrictions on hunting and fishing typically placed on oil and gas personnel, would their presence be likely to place additional pressures on the subsistence economy.

Scenario #3 - A reservoir of approximately equal size with ADP, 20-30 miles southwest of the proposed ADP facility. This scenario should examine the possible route of a pipeline and other infrastructure and the potential impact on Nuiqsut.

The above geographical description would place this scenario in NPR-A. If oil and gas were to be produced in a portion of NPR-A more than 25 miles from ADP, that field would likely be developed as an entirely separate facility. That is, like ADP, the development would likely have its own processing facilities located at the development and would resemble the proposed ADP development. However, depending on reservoir size and fluids properties, this development may elect to use ADP's processing facilities. Also, like ADP, the adjacent airstrip would likely be capable of accommodating not only relief-well-rig-capable aircraft but also commercial size jets. However, there would likely not be a permanent access road to the new development from ADP, Kuparuk or Nuiqsut (unless justified as the environmentally preferred alternative) due to economic thresholds such as ADP. Major equipment would likely still be transported on ice roads or air. The new development would likely have an aboveground pipeline that would either cross the Nechelik (Nigliq) Channel in a direct route (depending on compatible topography and geotechnical conditions) to Kuparuk (e.g. own processing facilities case) or near ADP Pad 2 on a bored HDD mode and then tie into the ADP infrastructure (e.g. using ADP processing facilities).

The potential cumulative impacts of Scenario #3 on the environment would be similar to those described under Scenario #2 above, except that impacts on air quality may be slightly greater if the hypothetical NPR-A development has its own processing facilities. Nevertheless, the impact on air quality would not be significant since pollutant concentrations would comply with the applicable NAAQS or PSD requirements.

USFWS's June 6, 1997 letter also recommended special conditions to be included in the USACE permit. Special condition #3 reads as follows:

"Additional oil and gas development between the East and Nechelik channels of the Colville River delta with pipeline connections to the ADP facility shall be accomplished with a minimum of additional gravel fill. Within this area, the design of fields with pipeline connections to the ADP facility shall incorporate the concept of roadless satellite production facilities. Exceptions may be granted in cases where alternative designs are environmentally preferable, or if roadless design is feasible."

ARCO would not object to this special condition, if required by the USACE.

4.7.5 Cumulative Impacts

The discussion below assimilates the impact of the ADP project and those planned and future projects regarded as reasonably foreseeable and occurring at locations which could potentially have common influence upon the environment of the Colville River Delta. Those projects include the BIA-sponsored Nuiqsut road, Fiord and Tarn, improvement of the Nuiqsut energy supply system, and the Nuiqsut Constructors mine site. The discussion is based on major environmental issues.

4.7.5.1 Hydrology, Geology, Geomorphology

Disturbance associated with oil exploration and development has occurred on the North Slope of Alaska since World War II (Walker and Walker 1991). Disturbances associated with early oil exploration included tracks in the tundra from vehicles during summer, temporary roads bulldozed in tundra in both summer and winter (Reed 1958), and drill sites (Lawson et al. 1978; Ebersole 1987). The greatest environmental effect of these disturbances was ground subsidence caused by the permafrost thawing. Many of those thermokarst impacts are still visible today, and the lessons learned have been applied in developing modern practices.

The cumulative impacts of oilfield development on hydrologic and geomorphic processes include both the direct impacts of continued development and the indirect expansion of thermokarst terrain associated with development in permafrost regions. As of 1993, the total area affected by gravel extraction and fill placement in seven oilfield units in the Prudhoe Bay region was estimated at 8,402 acres, comprising 6,890 acres of gravel roads and pads (including 262 reserve pits covering 756 acres) and 1,512 acres at 13 mine sites (including pit, overburden stockpiles, and access roads) (Table 4.7.2-1). In newer oil developments (Endicott, Pt. McIntyre, and Niakuk), reserve pits have not been used. Advances in drilling technology and project design for environmental protection have also reduced the footprint of in-field facilities. The facilities proposed for the ADP and other planned and reasonably forseeable future projects would add relatively little acreage (about 300 acres) to the total area affected by gravel in the North Slope oilfields (see Table 4.7.2-1). Indirect impacts on terrain occur as changes in the soil thermal regime and drainage patterns propagate and cause thermokarst to expand beyond the initially affected area (Lawson 1986; Walker and Walker 1991; Burgess et al. 1993a).

The extent of hydrologic impacts associated with development is closely related to successfully passing water through gravel fills. Current design criteria have evolved based on 20 years of experience dealing with different hydrologic settings that have been used to develop detailed design specifications for successfully passing water during different seasonal conditions and under different physical regimes. Projects that successfully match cross pad drainage structures to local requirements can minimize impacts to local hydrology.

Planned projects within the Colville River Delta, including ADP, the Nuiqsut Constructors Mine Site, the BIA-sponsored Nuiqsut road, and the potential future projects, including Fiord and upgrading of the energy supply to Nuiqsut, will have minor impact (with appropriate and parcticable mitigation) on hydrology. Planned gravel fill within the floodplain is limited to the 3-mi road between the two pads at ADP, an airstrip, two small HDD transition pads at the Colville River pipeline crossing, and a small helipad at the east HDD exit. At ADP, project criteria call for a bridge (440-ft bridge with a 402 ft opening) and culverts (2-12 ft in diameter) at about 200-600 ft spacing. These bridge and culvert structures are sized and located to provide seasonal passage of water such that fish will be able to move through the road, the structural integrity of the road will not be jeopardized, and wetland habitats will be maintained (see Appendix Q, Alpine Development Hydrology and Drainage Proposal). Fiord, if developed, will use a similar design, but likely with only one drill site, thereby minimizing the liklihood of a connecting road like ADP.

Projects outside the Colville floodplain will not impact local hydrology due to geographical separation and because similar design criteria will be used. Tarn has elected to install two bridges for its primary stream crossings, thus minimizing potential impacts on hydrology and fish movement.

The Nuiqsut Constructors, Inc. mine site will not be connected to the Colville River until final site rehabilitation and hence will not interact with local hydrology.

The success of minimizing impacts on local hydrology is having sufficient data to use with the most current design criteria for cross pad drainage. Thus, potential future projects can avoid significant impacts to hydrology by collecting appropriate data on local seasonal conditions.

Table 4.7.2-1. Cumulative onshore area (acres) affected by gravel extraction and fill for existing oilfields and planned projects on the North Slope[1].

	Reserve Pits		Gravel Mines[2]		Gravel Roads, Pads, and Airstrips[3]	Total Area of Gravel Extraction and Fill
	No.	Acres	No.	Acres	Acres	Acres
Existing Oilfield Units						
Prudhoe Bay	106	560	6	726	4,590	5,316
Lisburne	10	16	0	0	213	213
Endicott Duck Island	0	0	1	179	392	571
Niakuk	0	0	0	0	22	22
Milne Point	20	19	1	43	205	248
Point McIntyre	0	0	0	0	33	33
Kuparuk	126	161	5	564	1,435	1,999
TOTAL	262	756	13	1,512	6,890	8,402
Planned Projects						
Cascade Development	0	0	0	0	31	31
Badami Development	0	0	1	89	85	174
Nuiqsut (BIA) road	0	0	0	0	26	26
ADP Development	0	0	0	0	97	97
Nuiqsut Mine-Phase 1	0	0	1	50	0	50
Tarn	0	0	0	0	74	74
TOTAL	0	0	2	139	313	452
Hypothetical Future Projects (no proposal)						
Fiord	0	0	0	0	20	20
TOTAL	0	0	0	0	20	20

1 Data for existing oilfields were provided by BP Exploration (Alaska) Inc. (S. Lombard personal communication 1994); data for planned projects were taken from their respective environmental documents.
2 Including mine pit excavations, overburden stockpiles, and access roads.
3 Including reserve pit areas (planned projects do not have reserve pits).

4.7.5.2 Water Quality

The impacts of ADP and the above mentioned planned and future projects on water quality should be limited to relatively small localized increases in suspended solids and contaminants caused by dust, alteration of drainage patterns, and fuel spills. Regionally, ADP impacts are not expected to contribute to impacts from similar sources at the current or planned North Slope oilfields.

Gravel placement for all planned projects will occur in winter to avoid contact between gravel fill and open water and resulting downstream sedimentation. When hydrologic models indicate flood stage will intercept gravel fill, those sections of fill will be protected to minimize potential for sedimentation to the receiving environment. In addition, the Tarn project, which crosses the Miluveach River (a tributary to the Colville River), will include a bridge at that crossing to further eliminate the potential for impacting water quality.

4.7.5.3 Air Quality

Currently, no emission sources exist at the ADP in-field facility location. A few sources, such as diesel generators, are located in Nuiqsut. Emissions from the ADP would result in insignificant cumulative deterioration of air quality in this region. Furthermore, emission sources of this scale would not cause exceedance of the ambient air quality standards. The pollutant concentrations at the in-field facility location would comply with the applicable NAAQS or PSD requirements. The compliance of the cumulative impacts from ADP and Nuiqsut will be demonstrated by a dispersion modeling analysis in the PSD permit application.

Other planned and potential projects also will not add significant detrimental increments to existing air quality conditions. Tarn will receive power from the existing Kuparuk source and will not be adding additional diesel generators. Fiord will most likely use power from ADP and will not add any increment to local diesel generators. The Nuiqsut Constructors, Inc. mine site and BIA-sponsored Nuiqsut road will not require generated power and, hence, not cause a deterioration in local air quality. ARCO has committed to placing a multi-year air quality monitoring device in Nuiqsut (see Appendix J) to monitor regional air quality.

The most significant change in air quality is expected to be a positive improvement in conditions at the Village of Nuiqsut, if a gas line or powerline to the village is completed. Air quality within residential homes and in the village will benefit from elimination of diesel generators.

4.7.5.4 Fisheries

The ADP project will be the first permanent oil and gas project in the Colville River Delta region, thus there are no existing impacts to resident fish within the delta, such as arctic grayling, round whitefish, and burbot. The project, as proposed, has no direct impacts to anadromous species; therefore, the proposed project will not contribute to the impacts from other regional projects on fish populations. The absence of a permanent road, river channel, bridges, and trenched or elevated pipelines across major river channels avoids direct impact to habitats used by anadromous fish. Since ADP, and potentially Fiord in the future, will prohibit assigned workers stationed at these locations (who are not residents of Nuiqsut) from hunting or fishing locally, the presence of these projects should not increase the local harvest, or create any competition between subsistence and sport fishing.

The BIA-sponsored Nuiqsut road (with appropriate and practicable cross pad drainage) and the potential future Nuiqsut gas line (buried in winter under the shallow Nechelik [Nigliq] Channel) or powerline (crossing overhead) will not directly influence fish habitat and, hence, should not contribute to incremental fish impacts. The Nuiqsut Constructors, Inc. mine site, which will be developed as a upland pit, will be rehabilitated as fish overwintering and spawning habitat. The Tarn project design includes a bridge crossing of the Miluveach River to avoid hydrology and water quality impacts to that river's fishery. Likewise culverts on a tributary to the Miluveach and a tributary to the Kachemach River, both crossed by the Tarn access road, will be designed to provide unimpeded fish passage at annual flows. The hypothetical future Fiord project would be designed without an access road (connecting to ADP) and the pad and airstrip would be sited to avoid aquatic habitat. Thus, it is also not expected that the Fiord project would have detrimental impacts on fish.

4.7.5.5 Wildlife

Most of the previous analyses of cumulative impacts from oilfield development on the Arctic Coastal Plain have focused on landscape-level and vegetative changes (Walker et al. 1986, 1987; Robertson 1989; Walker and Walker 1991); few attempts have been made to address cumulative impacts on wildlife (Walker et al. 1987; Maki 1992; Truett et al. 1994).

No habitats **in the delta and affected by oilfield development** are known to have become rare or limiting to wildlife populations **because of the extensive development of the PBU and KRU oilfields.** Most habitats within the oilfields are widely distributed across the Arctic Coastal Plain. Nevertheless, as future oil reserves on the North Slope are extracted over time, it is possible that some less-abundant habitats may become more limited, if these habitats are preferentially developed over others, either for geotechnical reasons or because they are deemed less sensitive to disturbance or less important to wildlife. Therefore, regulatory agencies have adopted a habitat protection strategy to minimize potential adverse effects on wildlife (Post 1990).

The cumulative impacts of existing and planned projects on wildlife on the Arctic Coastal Plain primarily involve loss of habitat from gravel extraction and placement, and alterations in habitats **and habitat use patterns** near gravel roads and pads (see Table **4.7.2-1**). Additional acreages of adjacent habitats altered by dust, impoundments, and associated thermokarst (Walker et al. 1987) are less easily quantified. The relative wildlife uses of those habitats lost to gravel placement were not assessed for the first generation North Slope oilfields (KRU, PBU); however, recent oil development projects have been designed to avoid valuable wildlife habitat (identified with agency participation). Habitat lost to gravel **excavation and** placement for planned **and hypothetical future projects** has been estimated for the BIA-sponsored road from Nuiqsut to the Colville River (26 acres), **the Nuiqsut Constructors, Inc. mine site (Phase 1) (50 acres), Fiord (about 20 acres) and Tarn (74 acres).** The incremental loss of habitat from these projects would further reduce habitat availability, but the impacts are relatively small compared with the existing infrastructure in the oilfields. A primary incremental effect of the proposed **ADP** on wildlife would be additional loss of habitat from the placement (and potential mining) of gravel for new facilities. This additional loss of habitat would be small (<1 %) in relation to the total gravel coverage existing in the oilfield region (see Table **4.7.2.-1**), and rare, high-use habitats would be avoided or minimally affected by the project. **The hypothetical future Fiord development would result in an additional loss of about 20 acres of habitat in the Colville Delta. Collectively, all planned and potential future projects in the Colville Delta would occupy less than 200 acres leaving over 99.5% of all delta habitat unaffected by gravel. East of the delta, the Tarn project will be developed on 74 acres, also leaving over 99.5% of the local habitats available to continue to support fish and wildlife.**

Advances in technology resulting in reduced gravel footprint and improved flexibility in siting surface facilities, combined with better knowledge of habitat use and value to fish and wildlife, allow each planned and potential future project to add small increments to regional cumulative impacts.

In addition to habitat loss, another important component in assessing cumulative impacts is the maintenance of unimpeded distribution and movement of the Central Arctic Caribou Herd (CAH). Evidence in recent years suggests that progressive displacement of caribou from the Kuparuk-Milne calving concentration area may be occurring as the Milne Point and Kuparuk oilfields continue to be expanded (Cameron et al. 1992; Cameron 1994). Since the late 1980s (Lawhead and Cameron 1988), calving by the western segment of the CAH has tended to be most concentrated in the area southwest of the Kuparuk oilfield, in areas where such concentrations formerly were not noted. The sensitivity of cow caribou with newborn calves to human disturbance is well-documented in the literature, and it is possible that the density of development in the Kuparuk-Milne Point area has reached a point where fewer cow caribou are tolerating the activity occurring there during the calving season. **However, the trend is not uniform because calving activity in 1996 inside the Kuparuk field was comparable with previous years.** Since caribou calving is minimal in the Colville River Delta, the ADP project would not incrementally influence CAH calving success.

Further since ADP does not use a road to Kuparuk across the caribou calving area, potential traffic impacts on calving distribution and success have been eliminated. Caribou passage across pipelines and roads is critical to maintaining the health of the CAH. The Tarn project was designed with elevated pipe (5 ft+) and separation of over 400 ft from the access road. In addition, the elevations of the Tarn pipeline across the Miluveach River will be raised to about 8 ft to accommodate that concentrated movement corridor. The hypothetical future Fiord project will not have road connections to ADP, and the pipeline will be elevated a minimum of 5 ft to allow unimpeded caribou passage. Other potential future projects, such as the transmission of natural gas or electricity to Nuiqsut by overhead or buried means, are not expected to have any positive or detrimental impact on caribou. Thus overall planned projects are expected to have minor or negligible incremental impacts on caribou of the CAH. The Tarn project will have the largest relative impact (during calving) on these projects.

The elevated pipeline without an associated permanent road (see Section 2.9, Mitigation Measures), is an important project design feature intended to minimize wildlife and habitat impacts. For species with limited distribution in the region (e.g., yellow-billed loon) or species of concern (i.e., spectacled eider [discussed in Section 4.4.3.2], tundra swan, brant), unavoidable loss or reduced use of habitat from behavioral disturbance in the project areas would be minimized through proposed mitigation (see Sections 4.4.2.3 and 2.9). The presence of additional airstrips, such as at Fiord, would increase the potential for impacts from aircraft disturbance, however, particularly on the other delta. In the transportation corridor, the presence of an elevated pipeline without a road should have a negligible effect on calving distribution and movements during the insect season. Increases in populations of predatory birds and mammals have accompanied development of the existing North Slope oilfields. The availability of food wastes and intentional handouts in large portions of the oilfields has provided supplemental food sources that are not easily eliminated. Progress has been made through worker education and the advent of covered refuse containers, but ample artificial foods still are available. In all likelihood, the increased populations of foxes, gulls, and ravens exert one of the largest impacts on the populations of birds and small mammals in the oilfields, although these effects are difficult to quantify. The incremental effect of the projects in increasing predator populations would be minimal since effective mitigation would be implemented, as described in Section 4.4.2.3. In conclusion, planning for the ADP project and the other reasonably foreseeable projects has focused or will focus on ways to avoid and minimize impacts and, therefore, the incremental contributions to regional cumulative impacts are expected to be minor.

4.7.5.6 Threatened and Endangered Species

The cumulative effects of existing projects in the region on wildlife were discussed previously (Section 4.4.2.2). For spectacled eiders, the cumulative impacts of oilfield development are unclear. The population of spectacled eiders using the oilfields apparently has been declining (Warnock and Troy 1992), but because the world-wide population also has been in decline, it is impossible to ascribe causation to factors occurring only in the oilfields. However, for a species that is threatened, the cumulative effect of habitat loss is a concern. No impacts of existing development on the other species of concern have been documented.

The cumulative effect of the proposed ADP on spectacled eiders is likely to be negligible, since the proposed facilities are located 3 to 4 mi inland from the area where most spectacled eiders nest on the Colville River Delta. As was mentioned above, the transportation corridor is not heavily used by spectacled eiders, and the relatively small amounts of habitat affected by pipeline construction would have little noticeable effect on spectacled eiders there.

Since the hypothetical future Fiord would likely occupy only about 20 acres if development occurs, and because past surveys in 1992-94 did not find nesting spectacled or Steller's eiders at the exact location of the potential Fiord facility, this project is not expected to add cumulative impacts for this species. This conclusion is tentative, however, pending more detailed surveys for eiders in the Fiord prospect. Of the projects considered here, Fiord has the greatest potential to affect eiders due to their relative abundance in that portion of the Colville delta.

Tarn, the BIA-sponsored road and the Nuiqsut Constructors, Inc. mine site are in locations where spectacled eiders rarely occur. For instance, the 74-acre Tarn footprint was surveyed for spectacled eiders in 1997 and none were found in the area proposed for gravel placement.

4.7.5.7 Human Use

Communities of the Colville River Region

It is unlikely that ADP and other reasonably foreseeable projects would combine to produce any significant cumulative impact to local population growth. The non-resident workforce of the projects would not permanently relocate and reside in the Colville River Delta area, and they would not, therefore, require housing or public services. Only if project infrastructure and housing were located in Nuiqsut (see Section 4.5.1.2) would there be significant demands placed on the community. Non-local project employees would not be competitors for subsistence resources and would not place additional pressure on the subsistence lifestyle of local residents.

Government Institutions

The major long-term cumulative impact to government institutions from ADP and other oil and gas development projects will be enhanced tax revenues from an expanded property tax base. Other cumulative impacts on government institutions would not expand beyond those described for the Proposed Action. Certain government actions will be required of the NSB to re-zone lands occupied by oil and gas development. The re-zoning will be from the conservation to the resource development categories. The NSB will also be required to give its consistency determination to any proposed changes in land use covered by the CZMP.

Economic Institutions

The cumulative effect of ADP and other existing and reasonably foreseeable oil and gas development projects will be to produce additional economic benefits. Incremental economic benefits would accrue to the economic institutions of the Colville River Delta area. The NSB, the State of Alaska and the federal government will derive tax revenue, and royalty earnings. ASRC and Kuukpik, as land and mineral estate owners, will acquire revenue from access fees; production royalties for both parties in the state, local, and private or joint ventures sector; and lease bonus payments. Oilfield construction and service firms, including those that are subsidiaries or joint ventures of ASRC and Kuukpik, will acquire increased revenue from the performance of contract services for the developer/operator, and local workers will have employment opportunities.

The planned development of the Nuiqsut Constructors, Inc. mine will also produce economic benefits to the local economy. If either natural gas or electricity is provided to Nuiqsut, the village would receive the major economic benefit of natural gas or electricity made available at ADP at no cost for transport to Nuiqsut (see Section 2.9, Mitigation Measures).

Kuukpikmiut Subsistence

Taken together, the ADP project and other planned and potential future projects may enhance access to subsistence hunting and fishing areas by local residents through construction of the BIA-sponsored Nuiqsut road. Collectively, these projects may also indirectly affect subsistence hunting and fishing by contributing to the cumulative reduction of fish and wildlife habitat in the region. As explained above, however, the impact on fish and wildlife habitat will be relatively small and will be mitigated. Finally, the ADP project and the other projects considered would not be expected to have a cumulative impact on competition for subsistence resources because project operators will prohibit non-resident employees from fishing and hunting in subsistence areas.

Chapter 5

5. CONSULTATIONS AND COORDINATION

Chapter 5 identifies agency and public consultations and coordination that have occurred for the ADP and summarizes meetings and major issues raised in those meetings.

5.1 CONSULTATION PRIOR TO PUBLICATION OF THE EED

5.1.1 Agency and Public Contacts

The following federal, state, and local agencies, Native corporations, and residents were contacted by telephone, letters, and in meetings to discuss the ADP, alternatives considered, potential environmental impacts and mitigation, and the environmental review process:

Federal

- U.S. Army Corps of Engineers (USACE)
- U.S. Fish and Wildlife Service (USFWS)
- U.S. Environmental Protection Agency (EPA)
- U.S. Department of Transportation (USDOT)
- U.S. Coast Guard (USCG)
- National Marine Fisheries Service (NMFS)
- Bureau of Land Management (BLM)
- Bureau of Indian Affairs (BIA)

State

- Alaska Department of Environmental Conservation (ADEC)
- Alaska Department of Natural Resources (ADNR)
  - Division of Oil and Gas (DO&G)
  - Division of Lands (DOL)
  - State (Joint) Pipeline Coordinator's Office (JPO)
- Alaska Department of Fish and Game (ADFG)
- Alaska Office of Management and Budget
  - Division of Governmental Coordination (DGC)
- Alaska Public Utilities Commission (APUC)

Local

- North Slope Borough (NSB)
- Native Village of Barrow
- City of Barrow
- Native Village of Nuiqsut
- City of Nuiqsut

Native Associations/Public

- Arctic Slope Native Association (ASNA)
- Alaska Eskimo Whaling Commission (AEWC)
- Kuukpik Corporation (Kuukpik)
- Arctic Slope Regional Corporation (ASRC)
- Residents of Nuiqsut, Anachlik Island and Barrow
- Environmental Interest Groups

5.1.2 List of Meetings

The following is the list of meetings held with agencies, organizations, and residents for the ADP:

1992 to Present	Environmental Interest Groups: various and ongoing contacts have been made since 1992; have received annual environmental study reports; invitations have been issued to participate in public meetings and workshops on the Alpine projects.
May 17, 1995	Meeting at JPO office with Jerry Brossia to discuss the process for obtaining a pipeline right-of-way permit and integration of the permit with the environmental review process.
May 25, 1995	Meeting at ARCO office with agencies (ADNR, ADFG and USFWS) to discuss the potential impacts of the project on wildlife and need for further wildlife studies.
June 1, 1995	Meeting with NSB and ASRC to discuss fieldwork and receive comments on the potential impacts of the various project elements. Also met to coordinate the environmental review with the NSB.

June 7, 1995 — Meeting at JPO office with EPA, USFWS, ADNR, DGC, APUC, ASRC, NSB and Kuukpik to give a presentation on the proposed ADP and receive comments and concerns from agencies, local government, and Native corporations.

June 8, 1995 — Meeting at USACE office with Lloyd Fanter to provide an update on the status of the ADP and to discuss USACE expectations concerning the EA.

June 9, 1995 — Meeting at JPO office with ADNR and DGC staff to give a presentation on proposed facility and pipeline elements of the ADP and receive agency comments.

June 16, 1995 — Meeting at EPA office with Ted Rockwell to discuss EPA's questions about the ADP.

June 24, 1995 — Meeting at Nuiqsut with Kuukpik to give a presentation on the ADP and receive comments and concerns from the local residents.

June 26, 1995 — Meeting at ADNR office with John Shively, K. Boyd, and ADNR and DO&G staff to give a presentation on the ADP and receive agency comments.

June 27, 1995 — Meeting at ADFG office with staff to discuss socio-cultural, socio-economic, and subsistence components of the ADP EA.

July 5, 1995 — Meeting at USACE office with Lloyd Fanter to obtain examples of EAs deemed satisfactory by the USACE.

August 2, 1995 — Meeting at Nuiqsut with residents of Nuiqsut and Anachlik Island, NSB, Native Village of Barrow, City of Barrow, Native Village of Nuiqsut, City of Nuiqsut, DGC, ASRC, Kuukpik, ADNR, ADFG, and AEWC to give a presentation on the ADP, answer questions, and receive comments and concerns on the proposal.

September 14, 1995 — Meeting at NMFS office with Jeanne Hanson to give a presentation on ADP and get NMFS comments on the proposal.

September 28, 1995 — Meeting at USACE office with Lloyd Fanter to discuss the EA outline for the ADP.

November 6, 1995 — Meeting at Nuiqsut with the Nuiqsut City Council regarding potential subsistence impact and mitigation issues.

December 8, 1995 — Meeting at USFWS office with staff to discuss letter of authorization for incidental take of polar bears.

December 11, 1995 — Meeting at Nuiqsut with Kuukpik and Nuiqsut residents to discuss Native allotment revocable use permits and oil spill response team contract and training.

January 17, 1996 — Meeting at USACE office with Lloyd Fanter to discuss the pre-application meetings.

February 6, 1996 — Meeting at USACE office with Lloyd Fanter to discuss the pre-application meetings, environmental documentation required for the project and permitting.

February 7, 1996 — Meeting at USACE office with Lloyd Fanter to discuss the permit review process and the schedule for meeting with the various agencies that will be involved in the project's review. Also discussed the pre-application meeting goals, project alternatives, oil spill scenarios and the scope of the summer environmental studies.

February 14, 1996 Meeting at USACE office with Lloyd Fanter to discuss the pre-application meetings.

February 29, 1996 Meeting at USACE office with Lloyd Fanter to discuss the pre-application meetings and the environmental document.

February 29, 1996 Meeting at ARCO office with EPA to discuss setting up field tour and issues relating to the river crossings.

March 7, 1996 Meeting at ARCO office with ADFG staff to discuss wildlife, habitat, and permitting issues.

March 11, 1996 Meeting at Nuiqsut with ADNR to receive public testimony on proposed oil and gas lease sale #86A (certain Kuukpik Corporation lands along the Nechelik Channel of the Colville River Delta).

March 19, 1996 Meeting at ARCO office with Kuukpik and Nuiqsut residents to hold a meeting between ARCO, its contractors, Kuukpik, City of Nuiqsut and the Native Village of Nuiqsut representatives to review results of field study programs (wildlife, fish, geomorphology, socio-economics and cultural site surveys) and receive comments and concerns.

March 20, 1996 Meeting at ADEC office with staff to give an update on the status of the ADP and to receive input on oil spill scenarios.

March 28, 1996 Meeting at USACE office with Lloyd Fanter to discuss the EA for the ADP.

April 10, 1996 Meeting at ARCO office with DGC to discuss agency contacts and the pipeline right-of-way permit.

April 29, 1996 Meeting in Washington D.C. with USACE, EPA, USFWS to present proposal to permit the ADP. Two main issues discussed included funding for the Alaska offices of the respective agencies to conduct permit review and schedule.

April 29, 1996 Meeting in Washington D.C. with staffs of U.S. Senator Frank Murkowski and the House Natural Resources Committee to present the proposed ADP. Discussion included purpose and need for the proposal and required environmental review procedures.

May 2, 1996 Pre-application workshop meeting at ARCO office with ASRC, DEC, USACE, ADNR/JPO, NSB, ASNA, ADFG, DGC/JPO, EPA, BLM and Kuukpik to receive comments and concerns about project (see Section 5.5).

May 3, 1996 Meeting at JPO office with JPO staff to discuss procedural requirements for the pipeline ROW permit.

May 7, 1996 Meeting at ARCO office with EPA, USFWS, ADFG and NMFS to discuss subsistence issues, wildlife habitat values, and threatened and endangered species.

May 15, 1996 — Meeting at EPA Region X office in Bellevue to give a presentation on the ADP and discuss any environmental concerns.

May 16, 1996 — Pre-application workshop at Nuiqsut with local residents from Barrow and Nuiqsut and DGC/JPO, ADNR/JPO, NSB, ASRC, USFWS, ASNA Kuukpik, and USACE to receive comments on the project from the Nuiqsut community (see Section 5.1.5).

June 4, 1996 — Meeting at USACE office with Lloyd Fanter to discuss regulatory and permit requirements for submission of permit applications for facilities and the pipeline.

June 10, 1996 — Meeting in Washington D.C. with U.S. Senator Ted Stevens and his staff to describe the proposed ADP. Discussion included nature and scope of the project, the project's potential benefits for U.S. energy needs and its environmental protection plans.

June 26, 1999 — Meeting at EPA office with Ted Rockwell to present alternative in-field configurations and discuss potential environmental issues associated with these alternatives.

July 11, 1996 — Meeting at Nuiqsut with Kuukpik Corporation to discuss the ADP specifically job opportunities, natural gas supply for Nuiqsut, and a permanent road.

September 17, 1996 — Meeting with USACE staff (Don Kohler, Robert Oja, Tim Jennings and Lloyd Fanter) at USACE's Anchorage office to brief USACE on the status of the ADP, particularly the date that a permit application will be submitted. Results of public workshops and field study programs were also discussed.

5.1.3 List of Site Visits

The following agencies or organizations were taken by ARCO to visit the site. These visits included a flyover and visits to the exploratory drill rig and project area.

March 1996 — Kuukpik, ASRC and NSB visited the exploratory drill rig at Alpine Pad 1.

July 1996 — USFWS visited the project site during field work.

August 1996 — EPA and NMFS were flown over the project area.

August 1996 — ADFG visited the project site for several days.

5.1.4 List of Phone Contacts

Numerous phone conversations were made with the following personnel concerning the ADP. Significant issues discussed during phone conversations are included in Section 5.1.5.

Name	Fax	Phone
State of Alaska		
Jim Haynes/Steve Schmitz State of Alaska Department of Natural Resources Division of Oil and Gas 3601 C Street Anchorage, AK 99503-5937	562-3852 269-8777	269-8775
Bill Van Dyke ADNR-ADOG (Anchorage)	562-3852	269-8786
Al Ott/Carl Heming Regional Supervisor Habitat Division	456-3091	459-7279

Name	Fax	Phone
State of Alaska Department of Fish & Game 1300 College Road Fairbanks, AK 99701		
Sverr Pedersen/Terry Haynes ADFG (Fairbanks)	479-5699	479-6211
Robert Watkins State of Alaska Dept. of Environmental Conservation 555 Cordova Street Anchorage, AK 99501	269-7652	269-7680
Laura Ogar ADEC (Anchorage)	451-2187	451-2360
Scott Bailey ADEC (Anchorage)	269-7508	269-7500
Al Bohn Manager, Air Quality Permits State of Alaska Dept. of Environmental Conservation 410 Willoughby Avenue, Suite 105 Juneau, AK 99801	465-5129	465-5100
Molly Birnbaum State of Alaska Division of Governmental Coordination Joint Pipeline Office (JPO) 411 West 4th Avenue Anchorage, AK 99501-2343	272-0690	271-4317
Jerry Brossia JPO (Anchorage)	272-0690	271-4336
Tony Braden JPO (Anchorage)	272-2901	271-4336
John Strawn USDOT@JPO (Anchorage)		

Name	Fax	Phone
Glenn Gray State of Alaska Division of Governmental Coordination P.O. Box 110030 (431 N. Franklin) Juneau, AK 99811-0300	465-3075	465-3562
Gary Schultz State of Alaska Department of Natural Resources Division of Land Northern Region 3700 Airport Way Fairbanks, AK 99709-4699	451-2751	451-2732 (Fbks) 659-2830 (Ddhrse)
Jack Kerin ADNR-ADW (Fairbanks)	451-2751	451-2736
Brad Fristoe Alaska Dept. of Environmental Conservation 410 University Ave. Fairbanks, AK 99709-3643	451-2187	451-2360
Federal		
Bruce Batton Asst. Regional Director-Public Affairs U.S. Fish & Wildlife Service 1011 East Tudor Road Anchorage, AK 99503-6199	786-3640	786-3544
Philip Martin United States Dept. of the Interior Fish and Wildlife Service Northern Alaska Ecological Services 101 - 12 Avenue, Box 19 Fairbanks, AK 99701-6267	456-0208	456-0325
Lloyd Fanter U.S. Army Corp of Engineers Regulatory Branch P.O. Box 898 Anchorage, AK 99506-0898	753-5567	753-2720
Ted Rockwell U.S. Environmental Protection Agency 222 W. 7th Avenue #19 Anchorage, AK 99513-7588	271-3424	271-3689

Name	Fax	Phone
Carl Lautenburger EPA (Anchorage)	272-0690	271-4206
Dee Ritchie, District Manager U.S. Dept. of the Interior Bureau of Land Management 1150 University Avenue Fairbanks, AK 99709-3844	474-2280	474-2302
Joe Dygas U.S. Dept. of Interior Bureau of Land Management 6881 Abbott Loop Road Anchorage, AK 99507-2591	267-1267	267-1246
Jeff Walker U.S. Dept. of Interior Minerals Management Service 949 E. 36th Avenue, Room 603 Anchorage, AK 99508-4302	271-6805	271-6008
Jeanne Hanson National Marine Fisheries Services 222 W. 7th Avenue #43 Anchorage, AK 99513-7577	271-3711	271-3029
North Slope Borough (NSB)		
Mayor Ahmaogak	852-0337	
Ralph Davis	852-0322	852-2611
Warren Matumeak P.O. Box 69 Barrow, AK 99723	852-0351	
Tom Lohman NSB (Anchorage)	349-2602	349-2602
Arctic Slope Regional Corporation (ASRC)		
Bill Thomas P.O. Box 129 Barrow, AK 99723-0129	852-9460	852-8633

Name	Fax	Phone
Nuiqsut		
Mayor Gordon Brown/ Leonard Lampe Nuiqsut Mayor's Office P.O. Box 148 Nuiqsut, AK 99789	480-6518/6727	480-6928
Joe Nukapigak/Lanston Chinn Kuukpik Corp. P.O. Box 187 Nuiqsut, AK 99789-0187	480-6126	480-6220
Arctic Slope Native Association		
Michael Pederson P.O. Box 1232 Barrow, AK 99723-1232	852-2763	852-2762 x3015
Colville Village		
Mark Helmericks Colville Environ. Svcs. (Anchorage)	345-9095	345-9095

5.1.5 Summary of Significant Issues

This section summarizes some of the main issues of concern raised during meetings and presentations on the ADP. Agencies or entities that participated are listed above in Sections 5.1 and 5.1.2. Following each issue is the location in the EED draft where that issue is addressed. In cases where the issue is not addressed in the document, a response is given.

Nuiqsut residents raised the following issues:

1. The socio-cultural impacts of the project, particularly in reference to Native subsistence activities are a concern. It will be important for people working on the project to be familiar with the Nuiqsut Cultural Plan and to meet with the community in Nuiqsut. The City, jointly with the Kuukpik Corporation and the Native Village of Nuiqsut, passed a resolution on June 26, 1995 formally adopting *nuiqsut paisanich* (Nuiqsut Heritage: A

Cultural Plan). In addition, archaeological and cultural sites need to be preserved and undisturbed. (Section 4.5.1.1 pages 4-116 to 4-121, Section 4.5.1.2 pages 4-123 to 4-124, Section 4.5.1.3 page 4-124, and Section 4.5.4 pages 4-132 to 136)

2. The City of Nuiqsut government is concerned that permits are being issued by the NSB government without adequate local review and input. (Section 1.4 page 1-13, Section 4.5.2.2 page 4-126, and Section 4.5.3.1 page 4-130)

3. Nuiqsut and the Kuukpik Corporation jointly proposed an alternative development scenario which was named the "Western Initiative." Their view is that production facilities should be located to the west of the Nechelik Channel of the Colville River outside the delta and, thus, in what they regard as a less environmentally sensitive location. They propose a permanent gravel road connected from there to the village which would permit use of the existing airport for Alpine-associated activities. (Chapter 3)

4. Residents felt that if permanent roads are not built along the pipeline, it may not be possible to respond in a timely manner to an oil spill. The pipeline should be equipped with oil spill alarms and shut-off valves. (Section 2.2.1 page 2-10, and Sections 2.7, 2.8, and 2.9 pages 2-18 to 2-19)

5. Water that is pumped from lakes for the project (including construction of ice roads) could affect fish by removing habitat and creating air pockets under the ice. (Section 4.3.1.2 pages 4-21 to 4-22, and Section 4.4.1.2 page 4-52 and pages 4-54 to 4-55)

The Kuukpik Corporation related these concerns:

6. Kuukpik representatives expressed the view that an EIS should be prepared for the proposed project. They felt that it would be more comprehensive than the Environmental Assessment process. (Section 1.1 page 1-12)

7. It is the Kuukpik Corporation's preference that the main production facilities be sited on the west side of the Nechelik Channel with a permanent road connection south to Nuiqsut and beyond to the main channel of the Colville River and subsequently to the Kuparuk road system.. The airstrip at the Village of Nuiqsut could be used as the staging and support area for the project. (Chapter 3)

8. Fish habitat could be impacted by withdrawing too much water from lakes. (Section 4.3.1.2 pages 4-21 to 4-22, and Section 4.4.1.2 page 4-52 and pages 4-54 to 4-55)

9. There is a concern over the proposal to place the pipeline under the Colville River. Other alternatives to this option should be explored, especially if this type of development has never been tried or tested in the Arctic before. A more common method would be to have the pipeline cross over the river on a bridge. If the underground pipeline were to rupture, fish could be affected. (Chapter 3)

10. The current route for the pipeline crosses the Colville River Delta which is regarded as more environmentally sensitive than the proposal to route the pipeline along the west side of the Nechelik (Nigliq) Channel to Nuiqsut and then south to a main channel crossing and along higher, drier land to Kuparuk. The higher land is regarded as less sensitive to wildlife concerns than a pipeline route through the delta. (Chapter 3, Section 4.4.1.2 page 4-54, and Section 4.4.2.2 pages 4-105 to 4-106)

11. Construction should be timed to avoid impacting the local community's subsistence activities. (Section 4.5.1.2 pages 4-123 to 4-124, and Section 4.5.4.2 pages 4-135 to 4-136)

12. The development may also cause some restrictions on hunting activity in the vicinity of the in-field facility and the pipeline. They would like to have an exception to the 1,000 ft rule (an offset specified in state of Alaska lease operating stipulations for hunting in the vicinity of oil and gas production and pipeline

facilities) when animals are near the pipeline or facility. The view is that this 1,000 ft zone on either side of the pipeline or facility (or, two-fifths of a mi) is far too large in an area known to be a significant subsistence use area for both waterfowl and caribou hunting. (Section 4.5.4.2 page 4-135)

13. Kuukpik approved the idea to continue training of the existing OSRT in Nuiqsut. They will do so by renewing the original contract dated 1989 with some revisions. Kuukpik will provide the administration for the training program. The NSB may also want to have some of their employees continue training and participation on the Nuiqsut OSRT. (Section 2.7 page 2-18)

14. Kuukpik expressed an interest in a Community Subsistence and Advisory Panel that would serve as the principal means of maintaining regular communication between the community and the operator on subsistence and other concerns related to the construction and operation of the Alpine Development. (Section 4.5.1.3 page 4-124, and Section 4.5.4.3 page 4-136)

15. The weather in the project area is unpredictable and harsh and might affect the ability to respond promptly to an oil spill. Delaying response could impact waterfowl, caribou, fish, and people in the Colville River Delta. In addition, during the annual ice break-up, an elevated pipeline could be damaged by moving ice. (Section 4.6.2 pages 4-143 to 4-149)

16. Concerns were raised about the effectiveness of counting spectacled eider nests from an aircraft to determine the potential project impacts on that species. (Section 4.4.3.1 pages 4-110 to 4-113)

17. The elevated pipeline may block travel by snow machines and impact the movement of large mammals such as caribou. (Section 2.2.1 page 2-8)

18. Previous exploratory drilling has taken place to the north in the delta and there is a concern that the project may expand throughout this area. (Section 4.7.1.3 pages 4-152 to 4-157)

19. Kuukpik is interested in the opportunity to bid on contract services for the development and other opportunities for employment. (Section 4.5.3.2 page 4-131)

Kuukpik Corporation and ASRC:

20. ASRC mentioned unresolved issues that exist between the Kuukpik Corporation (the surface owner) and ASRC (the subsurface owner) concerning oil and gas activities on lands subject to the ANILCA 1431(o) consent agreement required on Native-owned acreage within NPR-A. This acreage lies on the west side of the Nechelik (Nigliq) Channel outside the area of the proposed Alpine Development. The parties are currently negotiating a settlement of their differences which requires that Kuukpik grant its consent in order for oil and gas development to occur on those lands to which it holds surface ownership and ASRC owns subsurface rights in NPR-A. (Section 4.7.1.3 pages 4-152 to 4-157)

The North Slope Borough raised the following questions or concerns:

21. The NSB asked whether ARCO plans to negotiate a new surface use agreement with the Kuukpik Corporation for lands east of the Nechelik (Nigliq) Channel. (Section 4.7.1.3 pages 4-152 to 4-157)

22. The entry point for the pipeline traveling under the river should be set back enough to allow caribou to use the river bank, since they walk up and down the river looking for places to cross. (Section 2.2.3.1 page 2-12)

23. The NSB desires that natural gas supplies be made available to the NSB for shipment to, and use in, Nuiqsut as a major source of heating fuel and energy generation. (Section 4.5.3.2 page 4-131)

24. While on duty, Alpine Development employees should be subject to the same non-hunting policy as currently exists in the other North Slope oilfields. (Section 4.5.4.2 page 4-135)

25. The proposed airstrip will cause noise and interruptions to wildlife, and it may be necessary to have operational or seasonal restrictions on flights. (Section 4.4.2.2 pages 4-100 to 4-103, and Section 4.5.4.3 pages 4-106 to 4-109)

The Alaska Department of Natural Resources, Division of Oil and Gas, had the following comments:

26. The location of the gravel source for the construction of the project is important. (Section 2.4 page 2-17, and Section 3.2.4 page 3-16)

27. ADNR is concerned that there be an opportunity to provide natural gas for the Village of Nuiqsut. (Section 4.5.3.2 page 4-131)

28. More details are needed about the proposed unitization of the project. It will be particularly important to address cumulative impacts (that is, any other development that may occur in the foreseeable future in the proposed Colville River Unit). This matter should be addressed in the environmental document. (Unitization: Section 4.7.1.3 pages 4-152 to 4-157; Cumulative Impacts: Section 4.7.2 pages 4-157 to 4-161)

The Alaska Department of Fish and Game had the following concerns:

29. The department is concerned about river-crossing impacts on fish, garbage disposal (and attraction of animals such as bears), and gravel mining. They have not raised concerns about the potential impacts to wildlife from the elevated pipeline. The department also raised the question of whether there would be any off-site mitigation included in the proposal. (River Crossing: Section 2.2.3.1 page 2-12; Attraction of Animals: Section 4.4.2.2 pages 4-103 to 4-104; Gravel Mining: Section 2.4 page 2-17; and Offsite Mitigation: Section 2.9 pages 2-19 to 2-31)

30. ADFG stated that the EA needs to address cumulative impacts such as the potential for expansion of the project. (Unitization: Section 4.7.1.3 pages 4-152 to 4-157; Cumulative Impacts: Section 4.7.2 pages 4-157 to 4-161)

31. Design of the pipeline crossings of the Miluveach and Kachemach rivers will need to address issues of bank erosion after trenching and how to fix this during the summer. ADFG will not require buried pipeline sections to facilitate caribou crossing as long as the pipeline is elevated at least 5 ft. ADFG does not see dredging as a water quality problem but indicated that an EPA Ocean Dumping permit may be needed. (Trenching is not proposed at the Miluveach and Kachemach rivers. Pipeline Elevation: Section 2.2.1 page 2-8)

The Alaska Department of Environmental Conservation expressed the following views:

32. The three oil spill scenarios selected for analysis in the environmental documentation will need to be reviewed to see if they are complementary to those in the KRU oil spill plan. DEC is most interested in the worst-case (as opposed to the most likely) oil spill scenario. Analysis of winter-oriented scenarios is not necessary, since the worst-case is an oil spill in the main channel during break-up. Spill projections are not necessary. (Section 4.6.2 pages 4-143 to 4-149)

33. The ability to control and clean up an oil spill in fresh water is a major concern. The impacts and volume of a spill in the most environmentally sensitive areas need to be assessed. (Section 4.6.2 pages 4-143 to 4-149)

34. The responsibilities, logistics, and placement of recovered oil relative to the potential amount of oil spilled must be defined in the spill response plan. (Section 2.7 page 2-18)

35. If no permanent road is planned, the applicant must mitigate for the absence of the road and provide adequate capability to respond to an oil spill. (Section 2.2.1 page 2-10, Section 2.7 page 2-18, and Section 2.9 pages 2-19 to 2-31)

The Alaska Joint Pipeline Office had the following concern:

36. The JPO was concerned that contacts and agreements with the Native resident subsistence hunters and fishermen be maintained. In their view, this may be the single most important issue bearing on the success of the permit issuance process. Particular attention should be given to ANILCA Section A (10) on subsistence issues. (Section 4.5.4.2 page 4-135, and Section 4.5.4.3 page 4-136)

The U.S. Fish and Wildlife Service made the following statements:

37. The use of helicopters should be minimized to avoid disturbance to waterfowl. They would also like to visit the site during field work. (Helicopters: Section 4.4.2.3 pages 4-100 to 4-103; Two site visits were arranged for USFWS staff, these occurred in July 1996, see Section 5.3)

38. ARCO should establish a program to determine the presence of denning polar bears in the project area. (It was determined that existing information on polar bears was sufficient for the purposes of this document - see Section 4.4.2.1)

The National Marine Fisheries Service expressed the following concerns:

39. The gravel source for the development is a concern. At the time of the original permit application, no need had been demonstrated to mine gravel from the ASRC site located east of the Colville River. (The project would use an approved gravel source located at the ASRC site or at KRU.)

40. The pipeline may alter or adversely affect fish over-wintering (under-ice) habitat. (NMFS stated there is uncertainty about whether over-wintering fish habitat or aquatic food resources constitutes the primary limiting factor on fish abundance). (The HDD crossing method is not anticipated to affect under-ice habitat.)

41. The facility footprints should be minimized to the extent possible. (Section 4.4.2.3 pages 4-106 to 4-107)

42. Construction work should be conducted under freeze-up conditions or during open water. Nuiqsut may want to continue using temporary structures such as bulkheads or docks after construction is completed. If so, such structures must be permitted separately from the project. (Construction work: Section 2.1.1 page 2-5; Temporary structures: Arco and Nuiqsut would negotiate the continued use of temporary structures.)

The U.S. Army Corps of Engineers stated the following:

43. The EA must (1) address issues associated with the various environmental acts concerning air, water, wildlife, etc; (2) fulfill the information requirements of the 404 (b)(1) evaluation; (3) evaluate the "likely worst case," "reasonable worst case" and "extreme worst case" for a major oil spill in the delta; (4) check that mitigation measures are practical, appropriate and economically justifiable; and (5) comply with the NEPA requirements set out in 40 CFR 1500. (The purpose of this document is to comply with the issues stated above.)

44. The NEPA document must be designed to minimize and compensate for impacts on the human environment arising from the proposed

project. In particular, the USACE's major concerns include the possibility of an oil spill; cumulative impacts of oil exploration, development, and production; impacts on subsistence lifestyle and fish and game resources; and impacts on socio/cultural structures and community cohesiveness. In addition, the EA should address construction costs, prospective O&M costs, and discussion of the practicality of avoiding impacts through various alternatives. (See Issues No. 28 and No. 33)

45. The draft pipeline right-of-way and facility siting designs must be reviewed by the USACE. (Section 1.4 page 1-13)

46. The water requirements for the project, both for the enhanced oil and gas recovery method, which employs the reservoir waterflood technique, and for potable use, must be adequately detailed in the EA. (Section 2.2.1.1 page 2-10, Section 2.2.2 page 2-10 to 2-12, Section 2.5 pages 2-17 to 2-18)

47. Navigational dredging of the Colville River may trigger the need for an EIS. (No navigational dredging is proposed for the project.)

The U.S. Environmental Protection Agency had the following comments:

48. The monitoring proposals provided by ARCO to EPA need to include water quality studies (water chemistry for NPDES purposes), and air quality studies. (Section 4.3.1 pages 4-17 to 4-23, and Section 4.3.2 pages 4-23 to 4-29)

49. Oil spill response planning is critical. (Section 2.7 page 2-18)

50. Detailed habitat mapping should not be done until the actual pipeline corridor is determined. It is important to consider alternative pipeline routes including connections to the 2-M and 2-K Kuparuk drill pads. (General habitat mapping was done in the transportation corridor for the purpose of this document. Alternative pipeline routes: Chapter 3.)

51. Depth of permafrost during winter or summer is a concern because of the possibility of a hot-oil pipeline creating water pools during summer. (Section 4.2.1.3 pages 4-14 to 4-15)

52. Is there a snow removal plan that indicates where excess snow would be dumped? (Snow removal would be addressed as part of the operating plan which is under development.)

53. Evaluate using boats for crew changes during "no use" times for airstrip. (This suggestion will be evaluated as part of the operating plan.)

5.1.6 Preapplication Meetings Attendance List

5.1.6.1 Attendance List for May 2nd Preapplication Meeting in Anchorage

Lloyd Fanter (USACE), Ted Rockwell (EPA), Tony Braden, Vic Manikian, Ed Barber and Molly Birnbaum (DGC/JPO), Joseph Dygas and Art Banet (BLM), Brian Schoof (Mineral Management Service), Carl Hemming (ADFG), Robert Watkins, Brad Fristoe and Cindi Godsey (DEC), Bruce Webb, Gary Schultz and Marie Crosley (ADNR, DO&G), William Thomas (ASRC), Joe Nukapigak, Brian Boyd, Lanston Chinn and Emily Ipakok Wilson (Kuukpik), Warren Matumeak, Susan Atosh and Tom Lohman (NSB), Leonard Lampe and Gordon Brown (Nuiqsut), Michael Pederson (ASNA), Alan O'Donnell and Jim Johnson (Anadarko Petroleum), Jim Watt (Union Texas Petroleum), John Eldred, Mike Joyce, Lisa Pekich, Bob Griffeth, Mitchell Honeycutt, Ryan Lance, Kay Takamiya, Dan Rodgers, David Marquez, Mark Landt and Joe Hegna (ARCO), Larry Moulton (MJM Research), Brian Lawhead and Torre Jorgeson (Alaska Biological Research), Jan Issacs (Dames and Moore), E.H. Owens (OCC), Carl Shepro (Arctic Research Associates) and Michael Jennings (UAF).

5.1.6.2 Attendance List for May 16th Preapplication Meeting in Nuiqsut

Lloyd Fanter (USACE), Molly Birnbaum, Ed Barber and Lori Quakenbush (DGC/JPO), Steve Schmitz (ADNR), Ruth Nukapigak, Leonard Lampe, Thomas Napageak, Lanston Chinn, Alice Woods, Annie Lampe, Clifton Lord, Frances Napageak, Samantha Tukle, Helen Tukle, Frederick Tukle, D. Nukapigak, Joe Akpik, Loni Akpik, Eli Nukapigak, Lena Lerp, Vera Ipalook, Lloyd Ipalook, Alice Ipalook, Virginia Kasak, Sarah Kunaknana, Patsy Tukle, Issac Nukapigak, Robert Nukapigak, Mark Ahmakak, Alice Woods, Rosie Ahtuangharuak, and Archie Ahkiviana (Nuiqsut), Jana Harcharek and Emily Wilson (Barrow residents), Joe Nukapigak (Kuukpik), Jacob Adams and Oliver Leavitt (ASRC), Ralph Davis, Susan Athos, Warren Matumeak, Craig George, Arnold Brower Jr. and Richard Glenn (NSB), Michael Pederson (ASNA), Mark Schindler, Mike Joyce, Frank Brown, Dave Sutter, Oliver Smith, and John Eldred (ARCO), Jay Brueggeman and Bob Griffeth (Parametrix), Larry Moulton (MJM), Brian Lawhead (ABR), and John Lobdell (Lobdell Associates).

5.2 CONSULTATION FOLLOWING PUBLICATION OF THE EED

5.2.1 Agency and Public Contacts

Agencies contacted in Section 5.1.1 were also consulted following publication of the EED.

5.2.2 List of Meetings

The following is a list of meetings held with agencies, organizations, and residents for the ADP:

December 7, 1996	*Meeting with NSB Mayor's office, Nuiqsut Corporation, City officials in Barrow, Alaska*
December 17, 1997	*Public meeting in Nuiqsut for general presentation of the Alpine project*
February 22-23, 1997	*Presentation of the Alpine Science Fair, community supper and meeting in Nuiqsut*
March 2-3, 1997	*Submittal of alpine permit requests to the State/JPO; agencies present at JPO to discuss completeness for CZM review*
April 22, 1997	*Presentation of the Alpine Science Fair for environmental organizations, USACE present at ARCO building, Anchorage*
April 23-23, 1997	*Presentation of Science Fair for public viewing at ARCO building, Anchorage*
May 13, 1997	*Meeting with Alpine contractors and agency personnel by teleconference, discussion of habitat mapping, hydrology, and other resources*
June, 1997	*EPA sponsored meeting to discuss hydrology, wildlife and habitat issues on Alpine at Federal Building, Anchorage. All state and federal agencies represented, ASRC, Nuiqsut and Kuukpik*
July, 1997	*Meeting and teleconference with agencies on Alpine hydrology issues, contractors present*
August 4, 1997	*Meeting between ARCO* and USACE in Anchorage

5.2.3 List of Site Visits

June, 1997	ADFG field visit to Alpine regarding hydrology and water use
July 29-30, 1997	Field trip for agencies (USACE, USFWS, ADEC, ADFG, NSB) to visit Alpine facilities; discussion meeting re: hydrology and drainage issues

5.2.4 List of Phone Contacts

Numerous phone contacts were made with all interested parties that reviewed the EED.

5.2.5 Summary of Significant Issues

Refer to Appendix K for issues and comments received prior to publication of the USACE Public Notice on the ADP. Refer to Appendix L for issues and comments received following publication of the Public Notice. Refer to tables K-1 and L-1 for section(s) of the EED where the text has been adjusted to respond to issues and comments documented in Appendices K and L.

Chapter 6

Chapter 7

Index

A

B

F

G

H

I

J

K

L

M

Q

R

S

T

U

V

W